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GENERAL ALPHABETICAL INDEX

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AUTHOR INDEX

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & ST___ MAGAZINE

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Lessons From Engineering Council For the New Federation

TWO questions which are bound to enter the mind of any engineer considering the pros and cons of the Federated American Engineering Societies are these: "If Engineering Council is a success, why should the proposed Federation supplant it? On the other hand, if Engineering Council is a failure, why should the Federation be organized along lines so nearly parallel?" Undoubtedly these thoughts were in the minds of many delegates to the organizing conference held last month in Washington, even if they were not directly stated on the floor, for at least three very influential delegates spoke in defence of Engineering Council, denying its ineffectiveness, yet explaining why it had not attained full measure of success.

It should be immediately pointed out, however, that the second question involves detailed information of the constitution, organization and personnel of both the Council and the Federation—upon inquiry it may be established that the two bodies are fundamentally different and the premise stated in the query therefore entirely unjustified. Such an investigation is not the present object; it is rather to inquire into the reason why Engineering Council did not attain its expected amount of influence. This known, some of the reefs and shoals along the course of the new organization will be charted, and a voyage steered accordingly.

Engineering Council, it will be recollected, is the child of the United Engineering Socities, which, in turn was formed by the four so-called Founder Societies—Civil, Mining, Mechanical and Electrical Engineers—and, quoting their official literature is an "organization of National Technical Societies of America, created to provide for consideration of matters of common concern to Engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible." The American Society for Testing Materials and the American Railway Engineering Association are also member societies. The executives of each of the member societies appoint representatives, who have subdivided their number into various committees, the personnel of which do whatever is done along their delegated line of activity. Their funds have been meager, being limited to some $13,000 annually contributed by the member societies.

Well informed engineers have characterized Engineering Council as an imposing body which did nothing. This is doubtless too harsh a criticism, for the Council has done a great deal of good work—much of it in a pioneering way, by trial and error. Yet unquestionably there has not been the activity in any line that was expected nor hoped. By its mode of organization about all it could do was to start the ball rolling along a desired path, and it had no means of reaching out into the great body of engineers in this country to get them behind the ball and keep it rolling faster. Consequently and naturally it settled back into rest.

In other words, the insurmountable defect in Engineering Council was its lack of connection with the "rank and file." All its admitted shortcomings can be ascribed to that one fact. The individual engineer knew very little about Engineering Council—he had no part in its actual organization beyond his collective urge that engineers organize nationally for economic ends. If he knew anything at all about Engineering Council, he probably felt that it should actively prosecute welfare work without any further help from him; was it not the body of men selected to do that particular job? Being thus built from the top down, it had an imposing head, but lacked a numerous body of men intelligently interested in its aims. Lacking this, is lacked the necessary funds even to operate effectively, let alone to sustain and widen the interest. Consequently only the close insiders actually knew what those at the head were doing, or what difficulties they were encountering.

A moral can easily be drawn from this little bit of history. The new Federated American Engineering Societies must have the interest of its ultimate members—the individual engineer. Only if it has this in good measure can any great success be attained. Its organization should be unrestricted, so that necessary movements may not be hampered; yet on the other hand, the organization should not be magnified as is the clear tendency in the large national societies to a point where it will be nothing but a large income with little net output except printed matter. Frequent and ready circulation from the top down, and the bottom up, is as necessary for right action, as good blood and exercise is for clear thinking.

Colorado Breaks With The Bureau of Mines

UNENVIABLE notoriety is again the portion of the Colorado School of Mines in forcing upon the Bureau of Mines a decision to sever relations between the two institutions and remove the Golden station of the Bureau from the State of Colorado. A report of the break appears elsewhere in this issue. Rumors differ as to whether the action was precipitated by President Alderson or by the Board of Trustees, but the official communication delivered to the superintendent of the station by Acting President Palmer, Alderson being absent in Europe, lays the responsibility at the door of the Board. That may be an inconsequential detail; but there is no question as to the temper of the mining and metallurgical leaders of the State regarding the inconsiderate folly of the act which has deprived Colorado of

federal recognition and co-operation. While they regret the loss they can only endorse the Bureau's decision and hope that some day Golden will clean house and restore to the School of Mines the prestige which it formerly enjoyed and which is still the pride of early graduates.

Golden may argue that it did not eject the Bureau, but that it suggested merely a change of quarters from Engineering Hall to the experimental mill. The transparency of this subterfuge will be evident to those who are familiar with the location of the mill in the creek bottom and its unfitness for use in the delicate and exact scientific work conducted by the Bureau. Perhaps this was an adroit and cunning attempt to turn to some useful purpose a building that has always been a white elephant! However that may be, the Bureau will have no difficulty in finding welcome quarters in some other State, but it is a pity to interrupt important work and spend money in the unpleasant task of moving a large laboratory to a new location where the process of taking root and resuming investigations must be repeated.

Chemical Societies In Industrial Works

WE ARE indebted to Dr. GEORGE E. EWE, chief chemist for the H. K. Mulford Co. of Philadelphia, for an interesting outline of a chemical society organized and maintained within that company's pharmaceutical and biological establishment. It began in June, 1914, with membership open to any employee, but preferably to those having chemical training. It meets on Friday afternoons whenever called, and papers relating to general and specific subjects are presented; discussions are held, the chief business of the meeting to follow is announced, and so are any new processes or products undertaken in the works.

The results have been, he assures us, very encouraging. A wide variety of subjects has been presented and considered, most of which, of course, have a pharmaceutical turn. And quite apart from the illumination contributed by the various papers, the discussions have proved to be helpful in co-ordinating the various departments and in establishing an *esprit de corps* throughout the organization.

The difference between an establishment in which all the members of the staff are interested and curious, where all pull together, and one in which each person works for the pay there is in it but without either interest or good will, is sometimes described as "all the difference in the world." The expression is hardly adequate. If members know what their fellows are doing this begets teamwork. The opportunity to talk things out and learn the reasons why things are done is the best possible insurance against misunderstandings. And misunderstandings are the worst of nuisances. Innovations may be presented and explained and the consequent rumble of grumble over anything new is avoided. It also gives a man who is not in an executive position a chance to suggest betterments where the operating force can hear them, and if the operating force feels convinced that the proposed changes are needed it makes a more forceful impression upon the main office if the staff recommends it than if the man who originates the idea tells it to the wrong person in authority. Again, if new instructions are given, whether they be of a general or a specific nature, they can be explained to substantially all to whom they should be explained. Sometimes an otherwise excellent man will get a grouch over any kind of a proposed change, but he can't very well hold fast to his grouch when everybody else understands and favors the measure. One of the greatest advantages of a works chemical society is that its members get to know one another, and personal acquaintance of this sort helps to avoid disputes. "How can I hate a man," asked CHARLES LAMB, "if I know him?" And it gives a scientific turn to the scientific men who spend their days in an industrial concern engaged in scientific work.

We have come across a number of these chemical societies within works of late, and usually they are of great value. That is, they are, unless they are dead. Sometimes such societies haven't anything but a name, like the "chemical laboratory" in a boarding school for young ladies that was exhibited to us with gusto to prove how progressive the head mistress was. It *was* a laboratory in design, but on closer observation we noted that it lacked gas and water connections and that the enclosed spaces were used for the storage of stationery. We have seen "research laboratories" very much like that, too. But a live chemical society within an establishment is worth while, if the establishment is not too small. We are not sure whether bigness may serve as an inhibition or not, but wherever it is feasible to establish such an organization we believe it is worth while. The main thing is that it be a live institution to arouse the scientific interest of the technically trained men employed. Such societies have to find themselves and find their proper level. The meetings in the research laboratory of the General Electric Co., for instance, would doubtless be over the heads of some technologists. So would those at the Mellon Institute or the Tuesday afternoon symposia at the Little laboratory in Cambridge. It is a delicate task to organize such a society, making it neither too high for the interest of its restricted number of members nor too low for their self-esteem. But it is a good thing to have.

British Nitrogen Production Plans

DURING the war Great Britain, like the United States, laid elaborate plans for fixing atmospheric nitrogen; but owing to confusion and delays the projected plant failed to materialize before the Armistice removed the immediate necessity for its construction. The result, as Mr. HAMER explains elsewhere in this issue, was that Billingham amounted to little more than a site, a few roads, some foundations and temporary structures. While this is in sharp contrast to our own Muscle Shoals, it is not certain that the United States is now in nearly so happy a position as Great Britain when their respective post-war nitrogen problems are concerned. The British have solved theirs, while ours not only remains unsettled but has become a basis for controversy.

Having no war-time investment in a plant of questionable present use and value, the British found no insuperable obstacle to an arrangement with Brunner, Mond & Co. whereby that firm has organized Synthetic Ammonia & Nitrates, Ltd., to acquire Billingham, retain the Government's technical staff and proceed with the erection of a plant for the synthesis of ammonia. British national safety is thus amply assured, and a

happy solution is apparently reached for domestic production of fertilizer and, if needed, explosives.

In addition to this arrangement between the Government and private industry, announcement is made also of a new British company which has purchased rights for the Claude high-pressure process, for which claims of unusual economy are made. No operations have been started in England but the projected plant will add greatly to Britain's independence in nitrogen fixation for both peace and war.

The Philosopher's Opinion Of the Scientist

THE responsibility of the chemist and his obligation to civilization come to our attention with increased force in the words of the great English philosopher and mystic, WILLIAM RALPH INGE, as delivered before the Chicago Chemists Club by JOHN SMALE, of Lewis Institute. In speaking of the future of the human race Inge says: "Science, I think, is our best hope."

This confirmation by an enlightened man of the scientist's opinion of his calling must be considered something more than a mere idea in the abstract. It assigns to him the task of developing and expressing that which is within for the advancement of the race to higher things, rather than the baser and more usual labor of securing something from without. It classifies him as a producer wholly above the overcrowded realm of sycophantic beings who seek returns without creative effort. It is a position to be envied above all others, and once attained, can be held only by continual introspection for the prevention of parasitic or piratical tendencies.

Organized Labor and The Steel Industry

THERE is a new turn in labor union affairs as relates to the great stumbling block, the iron and steel industry. The American Federation of Labor and the Amalgamated Association were "on the outs" as to jurisdiction, but the latest news is that the differences have been adjusted, or rather compromised. As to the method, report has it that Mr. GOMPERS has accorded the Amalgamated Association a 51 per cent vote on the general committee for organizing iron and steel workers authorized at the recent Montreal convention, to succeed the committee of the federation which conducted the late strike in the industry.

Presumably this arrangement was made because it was the best that Mr. GOMPERS could get. The Amalgamated Association's officials had ambitions looking to the whole industry being organized by that body, but Mr. GOMPERS could well say to it "Go get a reputation," as of late it has controlled only portions of certain branches of the industry, a really insignificant percentage of the whole.

It should be generally understood that this matter of attempting to "organize" the iron and steel industry is a very important one to the American Federation of Labor. This is not, by any means, because the industry offers a fertile field for the organizers. The federation management knows quite well, from past experience and from scrutiny of present conditions existing, that it does not. What it does see, as was frankly admitted at the annual convention of the federation in June, 1918, when it was resolved to attempt to organize the iron and steel industry, is that this great nonunion industry stands as the greatest barrier to the further progress of the federation's movement. Why should any nonunion industry be organized if the iron and steel industry is not? If that industry can remain nonunion, so can the others. The industry is a positive force for nonunionism or the open shop. If the industry could be made simply to disappear entirely, that would be the next best thing to its becoming union.

Rumors are thick, and probably correct, that the organizing attempt will be directed wholly or very largely against the United States Steel Corporation, which makes about 44 per cent of the country's steel, rather than against the industry as a whole. The management of the United States Steel Corporation should feel complimented, as doubtless it does, though the compliment is one it could be comfortable without. It being a case of a stumbling block, the singling out of the Steel Corporation is suggestive that the bid of the Steel Corporation for the loyalty of its workmen is particularly high.

If that is the case, however, what has the American Federation of Labor, or the Amalgamated Association, which it is understood will be a 51 per cent factor in the organizing campaign, to offer in competition? As to money, the iron and steel workers know they are well paid, by comparison with rates paid in other industries, and very much so by comparison with the wages paid for many months past to large classes of railway employes. As to social service, playgrounds, visiting nurses, hospitals, home gardens and other things, the iron and steel industry, including the ore and coke branches, has done a great deal. Only recently the Steel Corporation has put into operation a system whereby any one of its employees can own his own home, by paying down 10 per cent of the cost price and paying the remainder from his wages.

The organization methods employed in connection with the iron and steel strike of last September are wholly to be condemned, but from the practical standpoint they offered the best chances of success, and yet the affair failed. The appeal was to the least intelligent of the workers and there does not seem to be any means whereby those men can be fooled again, while as to the skilled men, they are in the main very well contented.

The Relative Demand For Cooks and Chemists

IT HAS been remarked lately that the day of the chemist has arrived; in fact some of us were of the opinion that it was already high noon. There is evidence, however, from some quarters that the dawn is just breaking. For example the Civil Service Commission of New York City would like very much to find a first-class cook; and for culinary ability of a sufficiently high order it will pay a stipend of $2500 per annum. Likewise the city is in need of the service of a chemist skilled in food and drug examination, but his value is marked down to $1800 per annum. Proceeding further we discover that a competent laboratory assistant in pathology may secure a fine position at $950 per annum. Comparisons are odious; but no one doubts that we need good cooks.

Western Chemical & Metallurgical Field

Smelters Not Responsible for Smoke Nuisance in Salt Lake City

For several years past Salt Lake City, Utah, has been vieing with Pittsburgh for the distinction of being the smokiest city in the world. Many of the influential residents believe that the nearby smelters contribute appreciably to the smoke nuisance, on the theory that the gases discharged from the smelter stacks float over the city in a heavy blanket which prevents smoke from the city chimneys from rising.

It may be remembered that the Garfield smelter of the American Smelting and Refining Co. is sixteen miles west of this city, the Murray smelter of the same company is eight miles south, and the Midvale smelter of the United States Smelting Company, twelve miles south. The smoke conditions at the two latter plants were discussed in detail in CHEMICAL & METALLURGICAL ENGINEERING for June 23, 1920, page 1145. While conditions at the Garfield smelter are not nearly so good, under normal operating conditions a relatively small amount of solid matter is discharged from these stacks. The toxic constituent of the discharge is SO_2, yet it was shown in the article just quoted that even in the opinion of a critical judge sulphur dioxide in the concentration caused by the two lead smelters is not injurious to either animal or vegetable growth, even in their neighborhood.

From a large number of determinations made by the Bureau of Mines it is shown that the sulphur dioxide in the air in Salt Lake City is the result of the combustion of soft coal on the spot. Even at worst the concentration of sulphur dioxide is at no time large enough to be an important factor.

The most interesting feature of this investigation, however, was an experiment made to test the theory that a blanket of sulphurous gas existed over the city. To determine this point analyses of upper strata of the atmosphere were made by the aid of an aeroplane. It was necessary to modify the standardized analytical procedure owing to lack of room for the apparatus and opportunity for its manipulation. Consequently samples of air were taken in the following manner:

Six brown glass bottles of 8 l. capacity were employed. These were charged immediately before the flight with 100 c.c. of a starch solution colored with iodine, and corked with rubber stoppers containing a glass tube closed by a rubber tube and pinch cock. The bottles were then evacuated to a pressure of one inch of mercury, and the pinch cock closed.

Trouble was encountered due to unequal decolorization of the starch solution, but this was eliminated after a thorough cleaning of the bottles and after a strong blue starch solution had been kept in the bottles with frequent shaking for several days.

These bottles were then fixed to the aeroplane fusilage and a flight made on a cloudy day when wind was blowing directly from the Garfield smelter. The top of the smoke cloud at that time was about 2,000 ft. above the city. Three samples of air were taken, the first at an elevation of 2,200 ft., the second at 3,000 ft. and the third on the descent at 1,000 ft. Sulphur dioxide was found in only one sample; at 2,200 ft. the air contained 0.2 part per million.

This meager data serves to substantiate the reasonable prepossession that no heavy blanket of sulphur smoke of high concentration was hanging over the city—at least at any level below 3,000 ft.! The day was typically smoky and undoubtedly conditions were not radically different from the other smoky days during that winter, consequently G. St. John Perrott of the Bureau of Mines' staff absolves the smelters from complicity and ascribes smoke conditions in Salt Lake City to combustion of industrial and residential fuel.

Golden Ejects Bureau of Mines Station

Those interested in the activities of the Bureau of Mines, especially the work in rare metals and the most excellent results in radium and radio-active metals achieved by its personnel in Colorado, will be surprised to know that this station now finds itself homeless as a result of precipitate action by authorities at the School of Mines.

It will be recalled that several years ago, the Bureau's activities were not as widely scattered as at present; in fact, when the Colorado Station was organized in 1910, it was one of the first four, the others being at Pittsburgh, Urbana and Salt Lake City. For five years it was housed in the Foster Building, Denver, and under the direction of Dr. R. B. Moore, now chief chemist of the Bureau, prosecuted very successful work on radio-activity and other problems.

In 1915 the Board of Trustees of the State School of Mines offered the Bureau the free and exclusive use of a three-story building on their campus known as the Engineering Building, but which had housed the department of physics for many years, and consequently possessed many conveniences and advantages which the Denver quarters lacked. A contract was negotiated between the parties, to be renewed year by year, confirming the arrangement, and the Bureau moved its equipment and personnel to Golden. At that time the School was being directed by a group of men who were actively interested in rehabilitating its lost prestige, and were hopeful that their faculty could engage in co-operative investigations with the Bureau's staff of scientists.

Unfortunately this ambition was never realized. In fact the present management of the school apparently is insensible to any advantage of the mutual association, since on June 11 they notified Superintendent S. C. Lind, that they declined to renew the contract expiring July 1 for the Engineering Building, offering instead space in the Experimental Mill, a corrugated iron building equipped as a concentrator, and obviously quite inadequate for the work being done at Golden.

Whereas it has not been definitely decided where the Colorado station will be moved, it is very probable that it will go to Reno, Nevada. The State University has offered to construct a building for such a station, and it should be as well situated as Golden for the prosecution of the special activities intrusted to it.

Properties and Constitution of Glues and Gelatines—I

A Study of Factors Influencing Viscosity and Jell Strength — Effect of Time, Mechanical Treatment, Heating and Dehydration—Influence of Concentration, Temperature and Added Substances

BY ROBERT H. BOGUE, PH.D.*

GLUES and gelatines† belong to that class of emulsoid protein-like substances which have been a Mecca for hypotheses and speculations to the colloid enthusiast, but a constant source of trouble and embarassment to the analytical chemist who encounters them. Their place among the emulsoid colloids stamps their physical properties as vague and ill-defined, and pronouncedly variable with slight alterations in the conditions under which the measurements are taken. And their protein-like nature at once assigns to them that complexity of constitution which is today, as it has always been, one of the most intricate and still unanswered problems which the chemist has set himself to solve.

A few publications[1] have appeared from time to time upon the subject in one or another of its many phases, and a few books have long been upon our shelves which have treated very briefly of the chemical and chemico-physical aspects of glues and gelatines; but, on the whole, the subject has not received a great deal of systematic attention. True, the colloid chemist has demonstrated many of his most striking colloid phenomena with gelatine, and the protein chemist has isolated many amino-acids and polypeptides from the hydrolysate of gelatine, but in both of the above cases the examination of gelatine has been merely incidental to their main problem. Manufacturers are still depending in large measure upon the "rule-of-thumb" method in production, and what advance has been made has resulted from the inevitable and costly teacher "Experience," rather than from systematic research.

This series of investigations is an attempt to correlate some of the factors upon which physical measurements depend; to systematize methods for physical and chemical examination; and to discover the relations which exist between the physical constants and the chemical constitution of glues and gelatines.

For convenience the report upon these investigations is divided into sections as follows:

A Study of Factors Influencing Viscosity and Jell Strength.

The Effect of Electrolytes Upon Degree of Dispersion; and the Structure of Gelatine Sols.

The Relation of Melting Point to Viscosity and Jell Strength.

Relations Between Physical Properties and Chemical Constitution.

Influence of Size of Molecule Upon Physical Constants.

The Physical and Chemical Significance of "Craze."

On Chemical Constitution by Determination of the Groups Characteristic of the Amino Acids.

A Study of Adhesive Properties.

Bibliography.

A STUDY OF THE FACTORS INFLUENCING VISCOSITY AND JELL STRENGTH

This section deals with a number of preliminary experiments which have as their object the determination of the effects produced upon the viscosity and jell strength of glues and gelatines by a variation in the conditions under which these measurements are taken. That these effects may be of importance has long been recognized, but the exact extent of their influence under varying conditions has not been thoroughly investigated. While no pretense is made of an exhaustion of the subject in this paper, a few of the important factors influencing viscosity and jell strength have been studied and are presented herewith. The factors considered are: time, mechanical treatment, heat treatment and dehydration, concentration, temperature, and added substances. These latter include formaldehyde, alcohols and non-electrolytes, alums, acids, bases and salts. The influence of these added substances are likewise examined under varying conditions of concentration, time, mechanical treatment, temperature and dehydration.

The results obtained are summarized at the conclusion of each section. An interpretation of the experimental findings will be considered in subsequent papers in this series of articles.

EFFECT OF TIME

The influence of time as a factor affecting the viscosity of glues was noted by running hide glues and bone

TABLE I. EFFECT OF TIME ON VISCOSITY[2]

Concentration, 30 g glue to 150 g water Temperature, 60 deg. C.

Time Interval, Min.	Glue H_4	Glue B_8
0	48.6	45.0
10	48.8	44.8
20	48.8	45.2
30	49.4	46.0
40	48.6	45.6
50	48.4	45.0
60	48.8	45.2
70	48.2	45.0
80	48.0	44.4
90	48.2	45.2

[2]Grades are specified as follows: H refers to hide glues and fleshing stock. B refers to bone glues. Sub-numerals from 1 to 9 indicate relative order of the strength of their jellies, 1 being the strongest, 9 the weakest.

This paper presents the results of a part of the work done during the author's incumbency of the Armour Glue Works' Industrial Fellowships Nos. 4, 5 and 6 (1917-1920), at the Mellon Institute of Industrial Research of the University of Pittsburgh. The investigation was carried out with the collaboration of J. R. Powell, chemist of the Armour Glue & Soap Works, and the administration of the Mellon Institute. The author is especially indebted to the late Dr. David S. Pratt, and to W. A. Hamor and E. R. Weidlein. The research is still in progress, and the conclusions presented in this paper will be elaborated and extended in future reports.

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†The word "gelatine" throughout this series of articles is used when reference is made to the commercial substance, and the word "gelatin" is employed when the protein of that name is under discussion.

[1]A résumé of a part of this report was presented before the American Section of the Society of Chemical Industry, New York, May 21, 1920.

glues through the viscosimeter[3] at 10-min. intervals for 90 min. At the temperature at which these measurements are carried out (60 deg.), there is no appreciable change in viscosity with time. This agrees with measurements made by von Schroeder[4] and Levites,[5] who find, however, that at the low temperatures of 21 deg. and 25 deg. the viscosity increases with time.

Effect of Mechanical Treatment

The effect of mechanical treatment was noted by subjecting glues to different kinds of agitation for different periods of time. Vigorous agitation in each case lowered the viscosity. This agrees with results obtained by Biltz and von Vegesack.[6]

TABLE II. EFFECT OF AGITATION ON VISCOSITY

Concentration, 30 g. glue to 150 g. water. Temperature, 60 Deg.

Glue H_4	Stirred with Rod, 1 Min.	Stirred with Mechanical Beater ½ Min.	Stirred with Mechanical Beater 2 Min.
50.8	50.2	49.0	48 8

Effect of Heat Treatment and Dehydration

To determine if there were any relation between the moisture content of glues and their physical properties, glues were subjected to partial and complete dehydration by heating at 110 deg. C. for different intervals of time. The loss in moisture was noted after each heat treatment, from which was calculated its remaining moisture content, and the viscosity, jell strength,[7] solubility in cold water and solubility in hot water determined. No uniform variation in these properties could be noted until the glues had been heated for 15 hr., at which time the moisture content had fallen to zero and the resulting glues become "insoluble." The solubility of these "insoluble" glues in *cold* water was noted to be greater than before this "insoluble" state was reached. The term "insoluble" is here used to mean that condition at which the glue will no longer form a homogeneous emulsoid in hot water, after proper soaking in cold water.

TABLE III. EFFECT OF DEHYDRATION ON PHYSICAL PROPERTIES

Glue H_3. Sample ground and heated at 110 Deg. C.

Time Heated in Hr.	Moisture Content	Viscosity	Jell Strength	Solubility in Cold Water	Solubility in Hot Water
0	11.72	51.0	79	6.12	Soluble
1	5.87	51 4	79	6 28	Soluble
2	2 38	51 8	78	6 48	Soluble
3	1 46	52 2	79	6 59	Soluble
4	1.00	52 2	79	6 11	Soluble
5	0.50	52.0	78	6 18	Soluble
6	0 21	51 6	79	6.78	Soluble
8	0.45	51 8	78	6.49	Soluble
15	0.00	Insoluble	..	8.43	Insoluble
24	0 00	Insoluble	..	8.27	Insoluble
48	0.00	Insoluble	..	8.52	Insoluble

This insoluble phase is spoken of in the literature as a reversion of the gelatin to collagen, and Hofmeister[8] considers collagen the anhydride of gelatin. He writes the equation:



$$C_{102}H_{151}O_{39}N_{31} \leftrightharpoons C_{102}H_{149}O_{38}N_{31} + H_2O$$

Gelatin Collagen

To test this point, the insoluble phase was treated as an original ossein by soaking in lime-water for several days, and after this treatment heating for some time. A portion left in milk of lime dissolved completely, even in the cold, after ten days. A portion treated with clear lime-water remained firm. This was washed with acid and heated to 70 deg. Solution did not occur readily, but after prolonged heating most of the mass had been dissolved. This seems to be a confirmation of Hofmeister's conclusions.

The effect of prolonged heating on a solution of gelatine was found by Amon,[9] von Schroeder[10] and Levites[11] to produce a marked decrease in viscosity.

Influence of Concentration

The influence of concentration on the viscosity and jell strength was shown by running the entire list of standard glues through the viscosimeter at four different concentrations, and allowing these solutions to set for jell strength measurements. In all cases the viscosity increases with the concentration, slowly at the lower concentrations but very rapidly at the higher values.

TABLE IV. EFFECT OF CONCENTRATION ON VISCOSITY AND JELL STRENGTH

Ratio of Glue to Water	Viscosity: Hide Glues H_1	H_2	H_3	H_4	H_5	H_6	Bone Glues B_1	B_2	B_3	P_4	P_5	B_6	B_9
10/170	42.0	42.4	42.6	42.0	41.8	41.4	40.8	41.8	42.0	41.0	42.0	41.8	41.4
20/160	46.4	46.4	44.2	43.8	42 6	42.6	43.0	44.0	42.8	42.4	42.4	41.4	41.4
30/150	59.8	58.4	49.4	49.0	47.0	47 0	48.4	50.6	53.2	44.6	43.8	42.4	41.6
40/140	99.8	83.6	60.0	63 2	56.4	57.8	59 8	61.4	52.8	50.0	47.6	46.2	43.4
Jell Strength													
10/170	70	65	60	57	58	48	56	42	40	33	23	22	liquid
20/160	79	78	75	74	73	71	75	69	65	58	55	52	liquid
30/150	83	80	78	77	76	75	80	76	74	65	62	60	liquid
40/140	89	86	82	79	78	77	83	78	77	72	67	64	53

Influence of Temperature

The influence of temperature on the viscosity was shown by running glues at 5 deg. temperature intervals between 30 and 75 deg. The results show a regular increase in viscosity with decrease in temperature. The graph does not, however, show a straight line, for the viscosity increases slowly at high temperature and becomes rapid as the temperature falls toward the jelling point of the glue.

TABLE V. INFLUENCE OF TEMPERATURE ON VISCOSITY

Temperature, Deg. C.	Viscosity in Order of Decreasing Temperature 1, H_4	Viscosity in Order of Increasing Temperature 1, H_4	Viscosity 2, H_4	[illegible]ty 3, B_2
75	47.6	....	....	....
70	47.6	47.2	47.6	42.6
65	48.2	48.2	47.0	43.0
60	48.8	48.6	47.8	43.2
55	49.6	48.8	49.6	43.8
50	50.6	50.2	50.4	44.0
45	50.8	51.4	53.2	44.8
40	51.8	53.6	56.2	45.2
35	53.8	56.6	....	46.0
30	60.0	....	70.6	47.6

Influence of Added Substances

Varying Concentration of Formaldehyde

Runs for viscosity were made with the entire set of standard glues to which were added amounts of formaldehyde varying from 0.8 to 40.0 c.c. of 10.0 per cent solution. This entire series was repeated four times,

[3] The instrument used consisted of a glass tube 4 cm. in diameter and 30 cm. long, from which the liquid issued by a capillary orifice. It was standardized to pass 180 g. of water at 60 deg. C. in 48 sec. The time is noted by a stop watch, and the viscosity expressed in seconds.

[4] *Z. physik. Chem.*, vol. 45 (1903), p. 75.

[5] *Kolloid Z.*, vol. 2, (1908), p. 240.

[6] *Z. physik. Chem.*, vol. 73 (1910), p. 481.

[7] Jell strength is measured by allowing a blunt inverted cone-shaped weight to rest upon the jelly in a glass tumbler, after chilling at about 10 deg. C. The depression is measured on a graduated scale.

[8] See "Allen's Commercial Organic Analyses," 4th ed. (1913), vol. 8, p. 586.

[9] Unpublished investigation conducted at Mellon Institute.

[10] *Z. physik. Chem.*, vol. 45, (1903), p. 75.

[11] *Kolloid Z.*, vol. 2 (1908), p. 240.

with varying concentrations of glue; e.g., 10, 20, 30 and 40 g. of glue to 180 g. total weight of solution.

The results may be summarized as follows:

The viscosity varies directly as the amount of formaldehyde added.

After the addition of a certain amount of formaldehyde, the glue sets rather suddenly to a jelly which may not again be brought into solution by the usual means.

The transitional stages between the time when a glue shows only a moderate viscosity and when its viscosity has become too high to measure in the tube may be very short, especially in the weaker concentrations; so short that even in the time it takes to make the test the glue may have changed from a solution of watery consistency to a jelly.

The effect of formaldehyde on viscosity varies very considerably with the different grades of glue, much

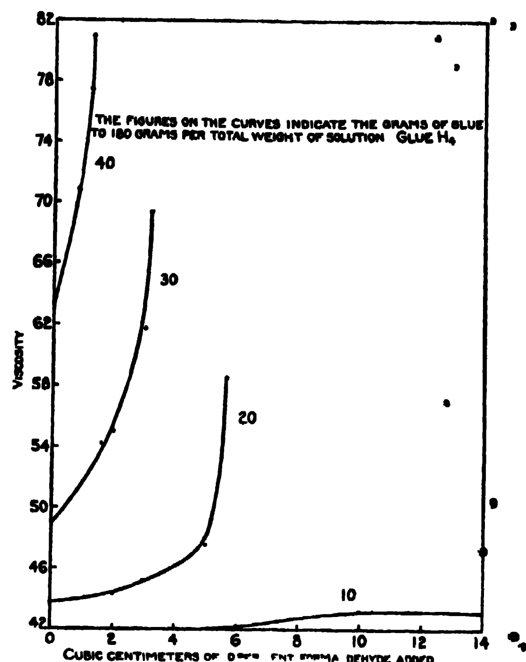


FIG 1 THE EFFECT OF FORMALDEHYDE ON VISCOSITY

smaller amounts of formaldehyde being required to produce marked changes in viscosity and insolubility in the higher than in the lower grades of glue.

In the case of the weaker concentrations, a slight but persistent drop in viscosity is noted following the addition of the first few c.c. of formaldehyde.

The data obtained from glue H_4, which is typical of the series, are given in Table VI and are expressed graphically in Fig. 1.

TABLE VI. EFFECT OF FORMALDEHYDE ON VISCOSITY GLUE H_4
TEMPERATURE 60 DEG

Ratio of Glue to Water C c of 10 per Cent HCHO Added	10/170	20/160	30/150	40/140
0 0	42 0	43 8	49 0	63 2
0 8			50 2	70 8
1 2			53 0	77 6
1 6			54 2	93 6
2 0		44 4	55 0	Set
3 0	42 0	45 2	61 8	
5 0	42 0	47 6	Set	
7 0		Set		
10 0	43 2			
20 0	43 2			
40 0	43 6			

The effect of formaldehyde on the jell strength was noted by allowing solutions of all grades of glue in four different concentrations, and containing formaldehyde as above, to chill at 35 to 40 deg. F. and jell strength observed.

In the higher concentration of glue, the formaldehyde induced the formation of a hard crust on the surface, often harshly wrinkled, which rendered the readings on such samples quite valueless. In the lower concentrations, however, this effect was not pronounced, and the readings are reliable. The results may be summarized as follows:

The jell strength diminishes regularly as the amount of formaldehyde added increases.

This decrease in jell strength is most marked in the weaker glues, which often would not jell at all after the addition of but a few c.c. of formaldehyde.

The results of formaldehyde treatment on the jell strength of Glue H_4 are expressed graphically in Fig. 2.

TABLE VII EFFECT OF FORMALDEHYDE ON JELL STRENGTH
GLUE H_4

Ratio of Glue to Water C c of 10 per cent HCHO Added	10/170	20/160	30/150	40/140
0 0	57	75	80	84
0 8			79	79
1 2			78	80
1 6			78	79
2 0		69	77	
3 0	54	70	72	69
5 0	50		69	64
7 0			66	70
10 0	42	60	64	68
20 0	38			
40 0	31			

The "formaldehyde capacity" of all of the standard glues at working concentrations was also determined. By "formaldehyde capacity" is meant the maximum amount of formaldehyde which a glue at that concentration may contain without producing insolubility. The

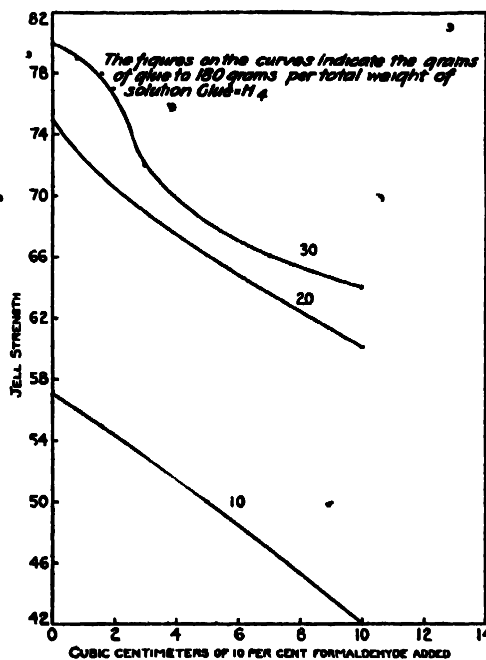


FIG 2 THE EFFECT OF FORMALDEHYDE ON JELL STRENGTH

glues were made up in concentrations of from 1 to 2½ up to 1 to 1 and small amounts of formaldehyde added. These were then watched constantly for 2 hr., and the time required to produce insolubility noted.

The general tendency toward a greater formaldehyde capacity in the weaker glues is clearly evident from the data obtained and shown in Table VIII, and expressed graphically in Fig. 3. This formaldehyde capacity is

TABLE VIII. SETTING PERIODS OF FORMALDEHYDE GLUES AT HIGH CONCENTRATIONS

Figures given in minutes to set. Maximum observation, 2 hr. Temperature 60 Deg. Weight solution, 180 g.

Grade	Glue Concentration	Wt. Glue	C.c. of 1 per Cent HCHO 1.0	1.5	2.0	2.5	3.0	4.0	7.0
H1	1 to 2⅓	51.4	60	..	15	..	..	..	..
H2	1 to 2⅓	51.4	150	..	15	..	..	..	..
H3	1 to 2⅓	51.4	..	50	15	..	..	..	..
H3	1 to 2	60	60	..	15	..	..	..	..
H4	1 to 2	60	150	..	15	..	..	..	..
H5	1 to 2	60	..	60	15	..	..	..	..
H6	1 to 2	60	..	..	..	30	..	..	..
H6	1 to 1½	72	.	..	25	..	..	..	..
B1	1 to 2	60	..	.	60	..	..	..	..
B2	1 to 2	60	..	..	60	..	..	..	..
B3	1 to 2	60	..	..	..	..	25	..	..
B3	1 to 1½	72	..	.	35	..	..	..	..
B4	1 to 1½	72	..	..	90	..	..	..	..
B5	1 to 1½	72	..	..	..	..	20	..	..
B6	1 to 1½	72	..	..	..	..	..	25	..
B8	1 to 1	90	..	..	35	..	..	..	..
B9	1 to 1	90	..	..	..	..	..	..	90

undoubtedly a function of the chemical composition, the amount of formaldehyde required for precipitation being inversely proportional to, for example, the protein present in the glue.

VARYING CONCENTRATION OF GLUE

The effect of varying the concentration of the glue may readily be observed by selecting a given amount of fosmaldehyde to be added and noting the effect of this amount on varying concentrations of glue. When this is done, it will be observed that the effect of the formaldehyde becomes felt at much lower concentrations in the high-grade glues than in the low-grade glues.

TABLE IX. EFFECT OF FORMALDEHYDE ON VISCOSITY

Temperature, 60 Deg. C. Weight solution, 180 g. Formaldehyde added, 3 c.c. 10 per cent solution.

Weight Glue	H1	H2	H3	H4	H5	H6	B1	B2	P3	B4	B5	P8	P9
10	41.8	41.6	43.4	42.0	42.0	41.0	40.4	41.0	41.8	41.0	41.8	41.8	41.4
20	48.8	51.2	45.0	45.2	44.2	43.0	44.0	44.2	42.8	42.2	42.6	41.4	41.6
30	Set	Set	54.8*	61.8*	63.4*	57.0	56.4	52.4	47.6	45 8	45.0	43.6	42.0
40	Set	Set	Set	Set	Set	80.2*	75.0*	80.0*	60.8	58.6	50.0	49.0	44.0

* Indicates that the glue set shortly after viscosity was taken.

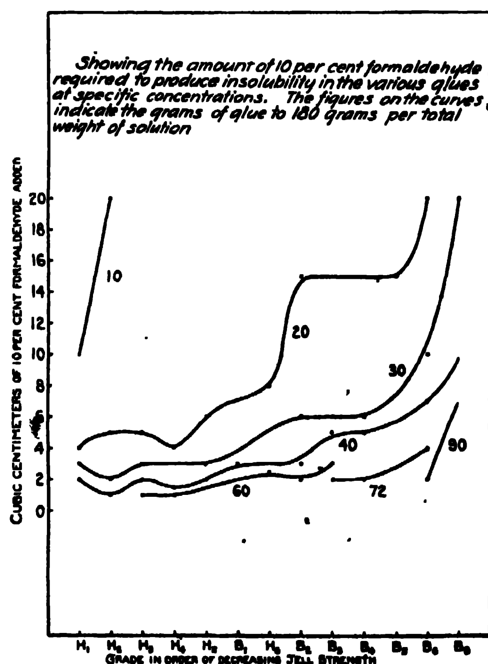


FIG. 3. INSOLUBILITY CURVES

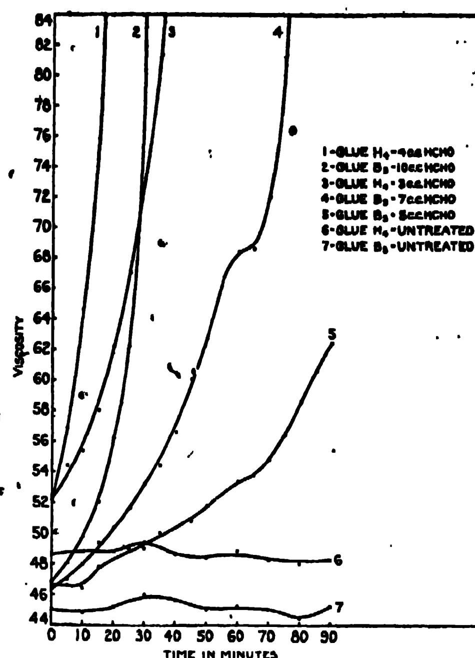


FIG. 4. THE EFFECT OF TIME UPON THE VISCOSITY OF FORMALDEHYDE-TREATED GLUES

INFLUENCE OF TIME

The influence of time on the effect of formaldehyde on glue was shown by treating two glues with varying amounts of formaldehyde and noting the viscosity at 5-min. intervals for 90 min., or until set. The results show viscosities increasing with time, slowly at first,

TABLE X. EFFECT OF TIME ON VISCOSITY OF FORMALDEHYDE GLUES

Concentration, 30 g. glue to 180 g. total weight. Temperature, 60 deg. C.

C.c. 10 per Cent HCHO / Temperature Interval in Min.	Glue H4 0	Glue H4 3	Glue H4 4	Glue B3 0	Glue B3 5	Glue B3 7	Glue B3 10
0	48.6	52.2	52.2	45.0	46.6	46.4	46.8
5	....	54.4	56.8	....	46.6	47.0	48.0
10	48.8	55.4	64.6	44.8	46.4	48.0	49.8
15	....	58.0	75.8	....	47.8	49.4	52.0
20	48.8	62.2	93.4	45.2	50.6	50.4	56.2
25	....	67.0	Set	....	49.0	51.6	62.2
30	49.4	73.2	....	46.0	49.0	53.2	83.6
35	....	81.4	....	....	50.0	54.4	Set
40	48.6	99.6	....	45.6	50.4	56.6	....
45	....	Set	....	....	50.8	60.0	....
50	48.4	....	....	45.0	51.8	63.0	....
55	....	....	....	....	52.6	66.6	....
60	48.8	....	....	45.2	53.4	68.4	....
65	....	....	....	....	53.8	68.6	....
70	48.2	....	....	45.0	54.8	72.0	....
75	....	....	....	....	56.4	100.0	....
80	48.0	....	....	44.4	58.6	Set	....
85	....	....	....	....	60.6	....	....
90	48.2	....	....	45.2	62.4	....	....

but becoming very rapid as the point of setting is approached. The rate of increase is much greater in the high-grade than in the low-grade glues, and much more rapid with the higher than with the lower concentrations of formaldehyde.

These results are expressed graphically in Fig. 4.

INFLUENCE OF MECHANICAL TREATMENT

The effect of agitation on the viscosity of formaldehyde-treated glues was noted by subjecting glues to which varying amounts of formaldehyde had been added, to different kinds of agitation and noting its effect on the viscosity.

Although the actual viscosity after the treatment was greater in most instances than before treatment, yet, when this increase is compared to the increase noted in a glue treated similarly with formaldehyde but not agitated, it is found to be less than normal. This lessening in the rate of increase is, however, no greater than the actual decrease observed in an untreated glue on similar agitation. It is concluded, therefore, that the effect of agitation on the viscosity of a formaldehyde glue is relatively to decrease it, although the increase due to the time factor is so great as to reverse the actual readings, an actual increase being observed.

Influence of Temperature

The influence of temperature on the viscosity of formaldehyde glues was shown by treating glues with varying amounts of formaldehyde, after the desired temperature has been reached, allowing to stand at that temperature for 15 min., and then taking the viscosity. The time factor is thus entirely eliminated.

TABLE XI. EFFECT OF AGITATION ON VISCOSITY OF FORMALDEHYDE GLUES

Concentration, 30 g glue to 180 g total Temperature, 60 deg C.

	Glue H_4				Glue B_3	
C c of 10 per Cent HCHO added	0	2	3	4	7	10
Viscosity no agitation	50 0	50 6	51 6	53 8	46 6	48 0
Stirred one minute	50 2	51 2	53 6	56 4		
Beaten one half minute	49 0	52 0	55 4	60 2		
Beaten two minutes	48 8	52 2	58 0	74 0	45 0	48 6

A study of the results shows in all cases first a drop in viscosity with rise of temperature. When the curves

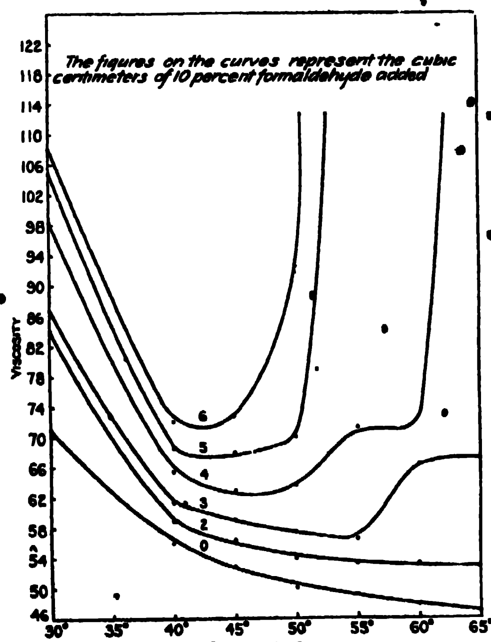


FIG. 5. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF FORMALDEHYDE-TREATED GLUE

are plotted in such a way as to eliminate the influence of the temperature on the untreated glue, it will be seen that the formaldehyde has the least effect at a temperature of 40 deg. C. Below and above this temperature the effect is very pronounced. The effect of a few degrees variation in temperature becomes more and more decided as the amount of formaldehyde is increased, and the range through which the resulting mixture remains mobile is considerably narrowed. It is evident that if it is desired to work a high formaldehyde glue the optimum temperature of 40 deg. should be selected.

TABLE XII INFLUENCE OF TEMPERATURE ON VISCOSITY OF FORMALDEHYDE GLUES

Glue H_4 Concentration, 30 g. glue to 180 g total weight Time, 15 min

C.c of 10 per Cent HCHO Added	0	2	3	4	5	6
Temperature, Deg C						
30	70 6	83 8	86 6	98 2	104 8	108 6
40	56 2	58 8	61 6	65 2	68 6	72 0
45	53 2	56 4	58 8	62 8	68 0	72 8
50	50 4	53 8	57 4	63 8	70 2	92 4
55	49 6	53 4	56 8	71 2	135 4	Set
60	47 8	53 4	66 4	71 0	Set	Set
65	47 0	53 0	67 0	Set		
70	47 6	55 2	88 8	Set		

These results are expressed graphically in Fig. 5.

Effect of Drying on Viscosity and Solubility

To determine the permanent effect which formaldehyde might have on a glue, the glue H_4 was treated in two concentrations with varying amounts of formaldehyde. The viscosity was taken after 15 min., the glues then dried and, after drying, were again brought into solution, if possible, and the viscosity taken.

It is seen that the viscosity of the samples after treatment is greater in all cases than that of the original solutions. This increase is proportional to the volume of the formaldehyde used and to the concentration of the glue. It seems probable that the mere physical process of drying alone has no influence on the viscosity, but rather that the change noted is a function of the time factor alone.

TABLE XIII. EFFECT OF DRYING ON VISCOSITY AND SOLUBILITY OF FORMALDEHYDE GLUES

Glue H_4 Temperature 60 Deg C Time, 15 Min

C c of 10 per Cent HCHO Added	30 g Glue to 180 g Total Weight					40 g Glue to 180 g Total Weight	
	0	1	2	3	4	0	1
Viscosity after 15 min	48 8	51 0	43 4	66 4	71 0	63 2	75 8
Viscosity after drying	49 0	53 2	56 0	75 2	Insol	63 0	Insol

Alcohols and Non-Electrolytes

The influence of three alcohols on viscosity was tested. Methyl, ethyl and amyl alcohols were added to glues H, H and B and allowed to act for 15 and 90 min. after which time intervals the viscosities were taken.

In all cases the viscosity is increased above that of the untreated samples. This increase diminishes, however, with time. An excess of the methyl and ethyl alcohols produces insolubility by precipitation of the proteins. These were not precipitated by the amyl alcohol, but a persistent white crust as of a crystallizing salt formed on the surface.

TABLE XIV. EFFECT OF ALCOHOLS ON VISCOSITY

Concentration, 30 g glue to 180 g total weight Temperature, 60 deg C

	Glue H		Glue H		Glue B	
	15 Min.	90 Min.	15 Min	90 Min	15 Min	90 Min
Distilled water	55 2		47 6		45 2	
10 c c methyl alcohol	57 4	55 4	49 4	48 2	45 8	45 8
10 c c ethyl alcohol	60 6	56 0	50 0	49 0	47 0	45 8
10 c c amyl alcohol	58 4	56 6	50 8	49 6	47 4	46 6

The influence of chloral hydrate on viscosity and jell strength was studied. This substance was added to glues H and H in amounts varying from 1.0 to 30.0 per cent. Its influence was very marked. It was found to increase the viscosity very considerably and to lower the jell strength until the mixture would no longer jell

at 5 deg. C. The increase in viscosity was found to continue regularly even after such concentrations had been added that the solution would not jell.

TABLE XV. INFLUENCE OF CHLORAL HYDRATE ON VISCOSITY AND JELL STRENGTH

Concentration, 30 g. glue to 180 g. total weight. Temperature, 60 deg. C.

Amount added, g...	0	1.8	3.6	9.0	10 8	18 0	27.0	36.0	54.0
Equivalent to per cent............	0	1	2	5	6	10	15	20	30
Glue H_5, viscosity..	49.8	49.8	49.6	50.6	....	52.2	..	....	....
Glue H_3, viscosity..	54.2	....	55.4	....	56.0	56.8	60.0	64.6	75.2
Glue H_5, jell.......	83.0	84.0	83.0	82.0	....	77.0	....	....	...
Glue H_3, jell.......	84.0	....	84.0	....	83.0	81.0	76.0	66.0	liquid

These results are plotted in Figs. 9 and 10.

Alums

Influence of Concentration

Aluminum, chromium and iron potassium alums were made up in tenth normal solutions and added to several

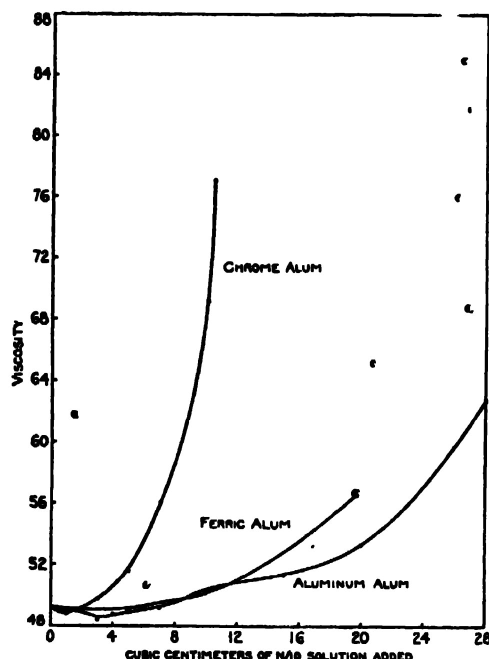


FIG. 6. THE EFFECT OF ALUMS ON VISCOSITY

glues in amounts varying between 1 and 50 c.c., and the viscosities taken after standing for 15 min. at 60 deg. C.

The iron alum formed minute droplets on contact with the glue unless greatly diluted, and a satisfactory

TABLE XVI. EFFECT OF ALUMS ON VISCOSITY AND JELL STRENGTH

Glue H_4. Concentration, 30 g. glue to 180 g. total weight. Temperature, 60 deg. C.; time, 15 min.

	Al		Cr		Fe	
C.c. N/10 Solution	Viscosity	Jell	Viscosity	Jell	Viscosity	Jell
0	49.2	78	49.2	78	49.2	78
1	49.0	78	48.8	78	.	.
2	49.0	79	....	.	....	..
3	48.4	80	49.8	80	...	..
4	48.8	79	....	..	....	.
5	....	..	51.6	79	49.0	81
7	49.2	.	56.0	78	...	.
10	50.4	78	69.2	76	50.2	81
15	51.4	82	Set	75	...	.
20	53.4	80	....	..	56.8	79
30	64.6	77	....		....	..
40	84.0	77	....	..	....	.
50	Set	76	....	..	....	..

solution could not be effected with larger amounts than 20 c.c.

The alums all produced increases in viscosity much the same as the formaldehyde had done except that a much larger amount of the former had to be added in order to obtain the same degree of increase. The chrome alum showed much the greatest effect of the three, producing insolubility when only 15 c.c. had been added, as against 50 c.c. of the aluminum alum.

The influence of these substances on the jell strength does not seem to be appreciable.

These results are expressed graphically in Fig. 6.

Influence of Time and of Temperature

The influence of time on the viscosity of alum glues was noted by adding different amounts of the alums to the glues, and measuring the viscosity at intervals up to 80 min.

The data reveal the fact that the influence of time on the viscosity of alum glues is exactly opposite to its influence on formaldehyde glues. Whereas with the latter the viscosity rapidly increases from a condition of watery consistency to its setting point, the alum glues, on the other hand, develop their maximum viscosity very quickly, after which, however, it rapidly decreases with time to a low value, approaching that of the untreated glue.

TABLE XVII. EFFECT OF TIME ON VISCOSITY OF ALUM GLUES

Glue H_4. Concentration, 30 g. glue to 180 g. total weight. Temperature 60 Deg. C.

Time Interval		Al (N/10)		Cr (N/10)	
in Min.	0 c.c.	20 c.c.	40 c.c.	10 c.c.	12 c.c.
1	49.2	56.4	Set	66.4	135.0
2	....	....	280.0	....	144.2
4	....	...	....	68.4	Set
6	....	54 8	175 0	. .	Set
8	....	.	.	66 6	Set
10	. .	53.4	130 0	64 4	144.6
20	..	51.8	80.6	60.4	89.6
30	...	51.4	78.0	60.6	85.2
40	....	51.4	73.4	58.6	80.4
50	....	51.6	69.4	57.8	79.4
60	....	49.8	61.4	57.2	74.2
70	....	49.8	61.6	55.6	72.4
80	....	50.0	61.6	56.2	73.0

These results are expressed graphically in Fig. 7.

The influence of temperature on the viscosity of alum glues was noted by treating glues with different amounts of alum solutions, after heating to the desired temperature, and allowing to stand at that temperature for

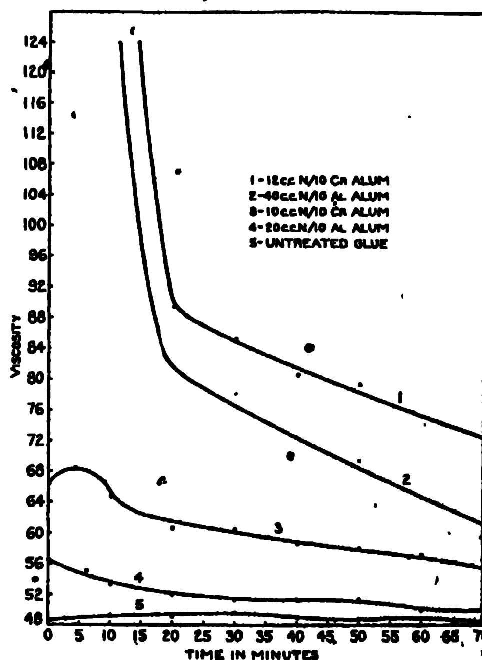


FIG. 7. THE EFFECT OF TIME UPON THE VISCOSITY OF ALUM-TREATED GLUES

15 min. The viscosities were then taken. Temperature intervals of 10 deg. were used between 30 and 70 deg. C.

The data show the effect of varying temperature on the viscosity of alum glues to be likewise different from its effect on formaldehyde glues. Between 30 and 40 deg. the effect is the same, e.g., a lowering in viscosity, but above 40 deg. the alum glues continue regularly to decrease in viscosity, whereas in the formaldehyde glues it rises rapidly from that temperature.

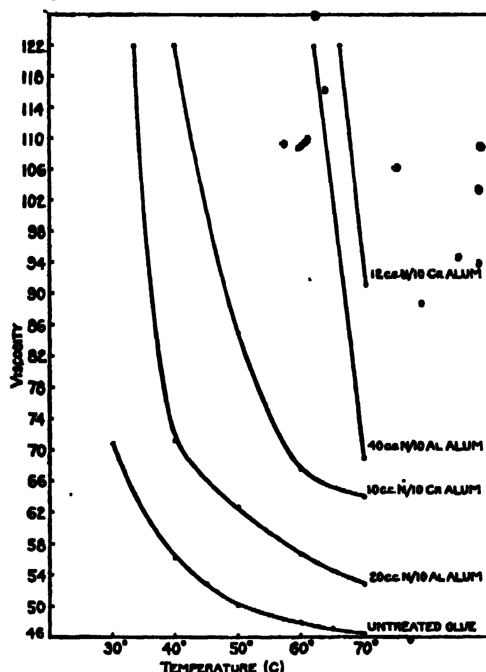


FIG. 8. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF ALUM-TREATED GLUES

From the above experiments, it would seem that although both alums and formaldehyde may produce insolubility in glues and increase their viscosity in proportion to the amount used, yet, inasmuch as the effects of time and temperature are so different in the two cases, the physical or chemical mechanism of the processes is undoubtedly quite different.

TABLE XVIII. INFLUENCE OF TEMPERATURE ON VISCOSITY OF ALUM GLUES

Glue H_4. Concentration, 30 g. glue to 180 g. total weight. Time, 15 min.

Temperature, Deg. C.	Al (N/10) 20 c.c.	Al (N/10) 40 c.c.	Cr (N/10) 10 c.c.	Cr (N/10) 12 c.c.
30	260.0	Set	Set	Set
40	70.8	Set	123.0	Set
50	62.4	400.0	85.0	Set
60	56.4	143.0	67.4	Set
70	53.0	69.2	60.0	91.2

These results are expressed graphically in Fig. 8.

Acids, Bases and Salts

The influence of acids, bases and salts on viscosity and jell strength has been tested in a number of ways. Several salts, acids and bases were added to nine different glues in varying concentrations from 0.1 to 30.0 per cent and the viscosities and jell strengths noted.

The results obtained may be summarized as follows:

Practically all of the substances added lowered the jell strength.

Strong (9N) sodium hydrate had the greatest effect, followed by potassium iodide, strong (9N) sulphuric acid, sodium sulphate, acetic acid and magnesium chloride. The effect of the others was small.

The viscosity was raised constantly by magnesium chloride, chloral hydrate and sodium silicate.

The viscosity was raised to a maximum, after which it fell more or less rapidly by sodium hydrate, disodium phosphate and acetic acid.

The viscosity was lowered constantly by potassium iodide, sulphuric acid, phosphoric acid and sodium sulphate.

There was no appreciable effect on the viscosity due to sodium chloride and magnesium sulphate.

Monosodium phosphate produced a sharp drop of one second at 0.1 per cent, followed by a sharp rise of 3½ sec. at 0.5 per cent, after which it rose a little further and then dropped again.

A part of the data for glue AA which is typical of the whole series is given in Table XIX, and is expressed graphically in Figs. 9 and 10.

TABLE XIX. EFFECT OF ELECTROLYTES ON VISCOSITY AND JELL STRENGTH GLUE H_2.

Concentration, 30 g. glue to 180 g. total weight.

	Per Cent added	KI	CH_3COOH	$MgCl_2$	H_3PO_4	NaH_2PO_4	Na_2HPO_4	H_2SO_4 c.c.N/2	NaOH c.c.N/2
Viscosity	0.0	54.2	54.2	54.2	54.2	54.2	54.2	54.2	54.2
	0.1	54.2	. ..	. .	53.4	53.2	54.2	....	....
	0.5	54.0		..	52.6	56.8	54.8		
	1.0	53.8			51.4	58.0	57.6	54.8	54.4
	2.0	53.4	53.6	54.6	49.4	57.4	60.2		
	5.0				47.2	57.2	58.2	53.6	54.0
	7.0		54.6	57.2				53.0	55.0
	10.0		55.4	59.0	45.4	58.4	57.0	52.6	55.4
	15.0		56.4	62.2			....	52.8	55.8
	20.0	52.6	58.8	67.2				....	....
	25.0							51.4	59.0
	30.0	48.0	48.2	71.0				....	....
Jell Strength	0.0	84	84	84	84	84	84	84	84
	0.1	84			84	83	84	..	..
	0.5				83	83	84		
	1.0	84			84	83	83	84	84
	2.0	83	84	83	84	83	81	..	..
	5.0	79			83	83	83	..	..
	7.0		83	83					
	10.0	70	81	83	81	82	84	84	83
	15.0		78	80		..		83	82
	20.0	liq	73	77		..	..		
	25.0				..	..	..	82	78
	30.0	..	liq.	liq	..	..	..		

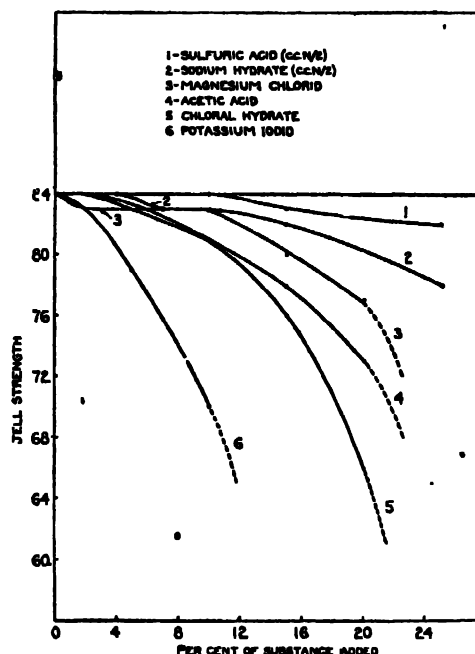


FIG. 9. THE EFFECT OF ADDED SUBSTANCES UPON JELL STRENGTH

The experimental findings which have been presented in this chapter may be briefly summarized as follows:

There is no variation in the viscosity of normal glues with time up to 90 min.

Vigorous agitation of a glue or gelatine results in a lowering of the viscosity.

Prolonged heating results in a decrease in viscosity.

Dehydration produces a reversion of "soluble" gelatine to "insoluble" collagen.

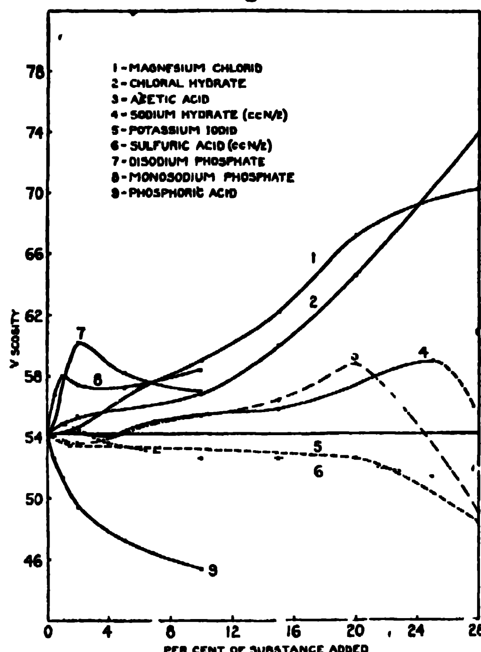


FIG 10 THE EFFECT OF ADDED SUBSTANCES UPON VISCOSITY

At temperatures well above the melting point the viscosity increases nearly as a logarithmic function of the concentration.

The viscosity varies inversely as the temperature.

The viscosity varies directly as the amount of formaldehyde added. The higher the grade of a glue, and the higher the concentration, the less the amount of formaldehyde required to produce "insolubility."

The jell strength varies inversely as the amount of formaldehyde added. This effect is the more marked in the weaker grades of glue, and in the lower concentrations.

The viscosity of formaldehyde-treated glues increases with the time.

The viscosity of formaldehyde-treated glues decreases with rise in temperature up to about 40 deg. C. Above this temperature the viscosity rapidly increases to the setting point.

The addition of chloral hydrate results in a continually increasing viscosity, and a continually decreasing jell strength.

Alums produce increasing viscosities, but have little or no effect upon jell strength.

The viscosity of alum-treated glues increases very rapidly with time for a few minutes, after which maximum it decreases slowly.

The viscosity of alum-treated glues decreases regularly with rise in temperature.

Nearly all electrolytes produce a lowering in the jell strength, but their effect upon viscosity may be continually to increase, continually to decrease, or first to increase and later to decrease the viscosity.

(Part II will appear in a subsequent issue.)

Utilization of British Water Powers

The report of the British Government Water Power Resources Committee (which will shortly be published) sets forth a scheme for the utilization of the water power of the United Kingdom in place of coal and oil. The committee's task was to consider the extent to which the water power in rivers can be made available as power for industry, and to advise on the steps to be taken to insure that the water resources are properly conserved and fully utilized for all purposes.

The chief recommendation is the creation of a body of water commissioners as a department of the Board of Trade, with general authority to see that the water power in the country is utilized to the best advantage. These commissioners would have functions similar to the electricity commissioners already appointed, and would be able to approve local schemes for the development of the water supply without the reference to Parliament now necessary. They would also encourage the promotion of local schemes and prevent wasteful competition between local authorities for water supplies.

An important recommendation of the forthcoming report is that where one authority has more water than it requires it should be compelled to supply it to a less favored district at a reasonable cost. The committee has mapped out the whole of England and Wales into districts as they are served by different watersheds, and suggests the creation of local committees in counties and groups of counties to arrange for the best use of the water supply in those districts.

Market for American Dyes in Burma

The few consignments of American dyes that have arrived in Burma are reported so satisfactory in quality that importers have signified their desire to receive more, especially of those adapted to dyeing silks, as the supplies of the native cotton-dyeing works are obtained from India. The colors most in demand are pink (three shades), green, blue, first red, scarlet, orange, lemon, yellow, violet, black, and blue-black. Dyes for this market should be put up in 1-oz., 7-oz. and 1-lb. tins, wrapped in labels showing the color, and packed in tin- or zinc-lined cases, as the usual paper wrappings are worthless in this climate. The smaller sized tins have the readier sale. Aniline dyes pay an import duty of 7½ per cent ad valorem upon the fixed tariff valuation of 2 rupees per pound moist, and four rupees per pound dry.

Alberta May Resume Sugar-Beet Raising

The present high price and scarcity of cane sugar have led J. A. Grant, British Columbia Fruit Commissioner, with headquarters in Calgary, Alta., to declare that resumption of sugar beet growing is necessary to prevent extreme shortage.

Sugar beets were formerly grown successfully in Alberta and a factory was operated at Raymond, but at that time competition with cane sugar, which sold at 8c. and 10c. per lb. was too keen and the industry was abandoned.

At the present price of cane sugar, it is estimated that beet sugar can be produced at a profit in competition with it, and already commercial interests are seriously considering entering this field. Mr. Grant is quoted as saying that beet sugar can be produced in Alberta at 10c. a lb.

The Heat Treatment of a High-Chromium Steel

A Study of the Relation of Various Heat Treatments on the Physical Properties and Microscopic Appearance of Stainless Steel — Comparatively High-Temperature Annealing Is Required to Alter the Structure of the Hardened Material

BY H. J. FRENCH* AND YOSHITO YAMAUCHI†

HIGH-CHROMIUM steel containing about 11 to 15 per cent of chromium and usually 0.20 to 0.40 per cent of carbon is manufactured under the name of "Stainless Steel," because of its peculiar property, when properly hardened and finished, of resisting oxidation and corrosion by the ordinary agents.

Originally employed in the manufacture of cutlery, such steel has proved its value in other fields and gives promise of wider application. It has been successfully used to replace high-nickel and high-speed steels for valves in airplane and automobile engines and will probably receive attention for other machine parts subjected to corrosive action or oxidizing service conditions.

One of its main disadvantages is its high chromium content, which makes it a costly alloy. It is also quite sensitive to mechanical and thermal treatments, but combines high strength and good ductility with its ability to resist corrosion, which is a combination difficult to duplicate.

While chromium was one of the first of the steel-alloying elements, its use was for many years confined to high-carbon products due to the difficulty of manufacturing carbon-free chromium. So-called "Stainless Steel" is, therefore, one of the indirect results of improvements in the manufacture of carbon-free ferro-alloys.

Previous Investigations

Comparatively little information has been published concerning the physical properties of "Stainless Steel." In 1917, W. H. Hatfield[1] published results of tensile and impact tests of a steel containing 0.30 per cent carbon and 13.0 per cent chromium. A comparison between air, oil and water quenching followed by relatively high temperature tempering is given. His tensile test results have also been incorporated in the tentative report of the Iron and Steel Committee of the Society of Automotive Engineers[2] and constitute the major portion of the physical test data there given. The latter report, however, includes a valuable and interesting discussion of the proper methods of working, annealing and finishing such steel and a comparison between stainless, high-speed and some commonly used structural alloy steels, in resistance to oxidation at high temperatures.

A rather complete discussion of the properties of stainless steel is given by Seidell and Horvitz in *Iron Age*.[3] The work of previous investigators on high-chromium steels of varying carbon content is reviewed, and typical differential heating and cooling curves are given for a steel containing 0.33 per cent carbon and 11.02 per cent chromium. The authors clearly show the suppression of the ferrite transformation together with the lowering of the A_1 transformation as maximum heating temperature is increased. Brinell hardness values under varying quenching and temperature treatments and relation to so-called "red-hardness" are also shown. Little data are given, however, on the tensile properties.

Material Used

In order to determine the effect of various heat treatments on the tensile properties of such high-chromium steel and throw further light on its possible use for various machine parts, a series of tests has been carried out on two bars of annealed 1-in. hot-rolled rounds of the following composition:

	Ladle Per Cent	Checks Per Cent
Carbon	0 27	0 29 (0 24)
Manganese	52	38 (0 36)
Phosphorus	011	009
Sulphur	009	.015
Silicon	695	70
Chromium	12 4	13 2 (13 2)

In the annealed condition, as supplied, the steel showed the following tensile properties, in which condition it machines quite readily:

Proportional limit, lb per sq in	64,000
Tensile strength, lb per sq in	106,900
Elongation in 2 in, per cent	26 0
Reduction in area, per cent	58 5
Brinell hardness number	222
Shore hardness number	34

Methods Used

All treatments were carried out on standard Zimmerscheid tensile test specimens, the gage length being left 1/32 in. larger than the specified diameter (0.505 in.) for grinding after heat treatment. The effective diameter in treatment was, therefore, 17/32 in. For hardening, samples were heated in gas-fired furnaces, while for tempering, an oil bath was used at 400 deg. F. (205 deg. C.), a 2 to 1 mixture of sodium and potassium nitrates at 800 and 1,000 deg. F. (427 and 538 deg. C.) and a Hoskin's electric muffle furnace at 1,200 deg. F. (649 deg. C.). All temperatures up to and including 2,100 deg. F. (1,149 deg. C.) were measured by standardized 14-gage chromel-alumel couples connected to a Leeds & Northrup potentiometer. Quenching from 2,250 deg. F. (1,233 deg. C.) was controlled by a Leeds & Northrup optical pyrometer.

All tensile tests were made on a 100,000-lb. Riehle testing machine. Proportional limits were obtained from stress-strain diagrams, the deformation being taken with an extensometer reading to 0.002 in. Brinell hardness values were obtained under standard conditions (3,000 kg. load on a 10 mm. ball ∓0.025 mm.) using an alpha machine, and a recording scleroscope was used for Shore hardness.

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Published by permission of the Director, Bureau of Standards
[1]W. H. Hatfield, "Heat Treatment of Aircraft Steels," *Automobile Engineer*, 1917, vol. 7.
[2]Journal of the Society of Automotive Engineers, vol. 5, No. 3, September, 1919, pp. 262 and 263.
[3]L. R. Seidell and G. J. Horvitz, "Physical Qualities of High Chrome Steel," *Iron Age*, vol. 103, No. 5, Jan. 30, 1919, pp. 291-[illegible]

Thermal Analysis

Before carrying out the various thermal treatments heating and cooling curves were taken with the modified Rosenhain type furnace in use at the Bureau of Standards, a description of which will be found in the August, 1919, *Bulletin* of the American Institute of Mining and Metallurgical Engineers.[4] The inverse-rate curves obtained showed discontinuities with rising temperature at 700 and 870 deg. C., and on cooling at 800 and 700 deg. C. (approximately).

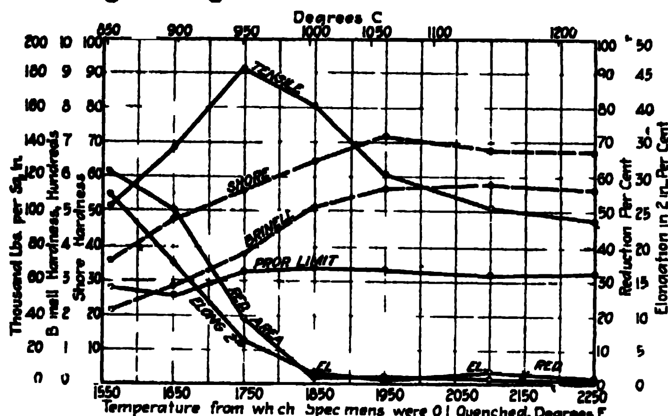


FIG. 1. EFFECT OF VARYING QUENCHING TEMPERATURES

Varying Quenching Temperatures

The effects on tensile properties and hardness of varying the oil-quenching temperature are shown in Fig. 1, based on experimental results. For the temperatures chosen interesting features are noted:

(*a*) The best combination of strength and ductility is obtained in quenching from 1,750 deg. F. (958 deg. C.), which condition is coincident with maximum tensile strength.

(*b*) Maximum hardness and maximum strength do not coincide.

(*c*) Ductility, as measured by both elongation and reduction, decreases rapidly as quenching temperature is increased. It reaches a very low value at 1,850 deg. F. (1,010 deg. C.), above which temperature it remains practically constant. This decrease in ductility and also increase in grain size with increase in oil-quenching temperature is clearly indicated in fractures obtained in tensile tests, as shown in Fig. 2.

(*d*) Minimum ductility, as measured by both elongation and reduction, does not correspond to maximum tensile strength or proportional limit.

(*e*) Proportional limit is a difficult factor to determine in cases where ductility is low, its exact value largely depending upon the observer. A typical stress-strain diagram shows marked resemblance to a curved line.

Varying Tempering Temperature

The effect of varying tempering temperature up to about 1,200 deg. F. (649 deg. C.) on samples previously

[4] H. Scott and J. R. Freeman, Jr., "Use of a Modified Rosenhain Furnace for Thermal Analysis," *Bull.* A.I.M.E., No. 152 (1919), pp. 1429-1435

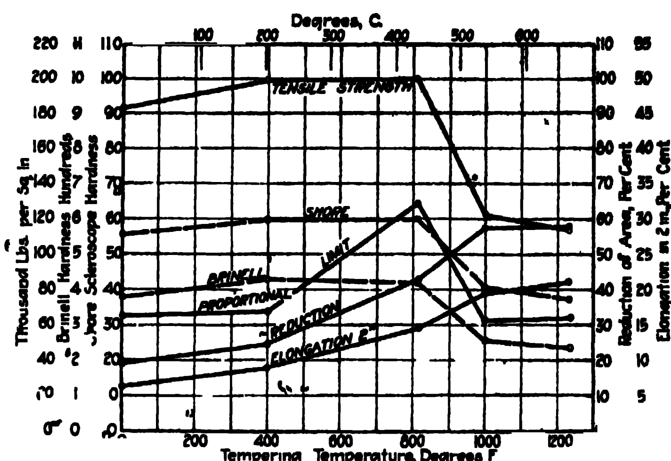


FIG. 3. EFFECT OF DIFFERENT ANNEALS ON STAINLESS STEEL QUENCHED FROM 1,750 DEG. F.

quenched from 1,750 deg. F. (958 deg. C.) and 2,100 deg. F. (1,149 deg. C.) is shown in Figs. 3 and 4. It is interesting to note that the strength of this steel is not lowered upon tempering for short periods of time until a temperature in the neighborhood of 800 deg. F. (427 deg. C.) is reached. Between 800 deg. F. (427 deg. C.) and 1,000 deg. F. (538 deg. C.) a marked decrease in strength and increase in ductility are obtained.

The inherent brittleness of those samples quenched from the higher temperatures probably accounts for the marked increase in tensile strength with increase in tempering temperature up to 800 deg. F. (427 deg. C.) on those samples quenched from 2,100 deg. F. (1,142 deg. C.), as shown in Fig. 4. Short time tempering gradually relieves the initial stresses set up in quenching until at about 800 deg. F. (427 deg. C.) these are

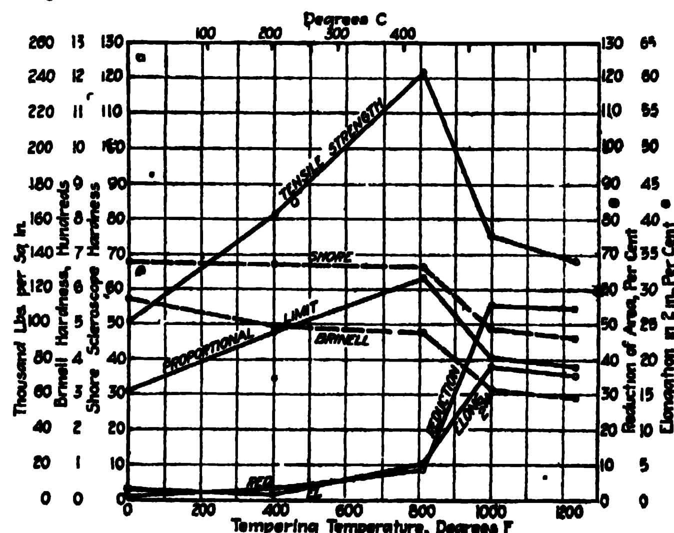


FIG. 4. EFFECT OF DIFFERENT ANNEALS ON STAINLESS STEEL QUENCHED FROM 2,100 DEG. F.

overcome to such an extent as to allow the material to develop its maximum resistance to static tensile stress. Evidence of brittleness but to a smaller degree in those samples quenched from 1,750 deg. F. (958 deg. C.) is likewise clearly shown by the shape of the tensile

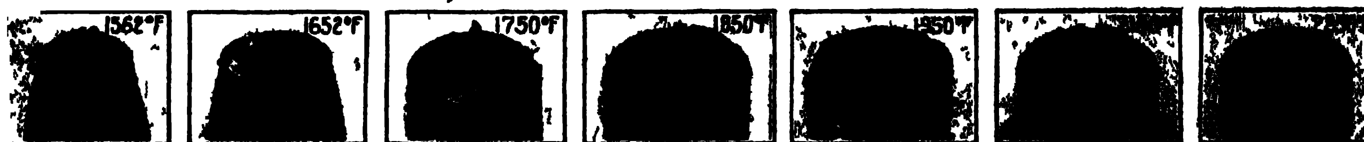


FIG. 2. FRACTURES OF QUENCHED BARS

strength curve in the range of low tempering temperatures (Fig. 3).

It is possible that the low tensile strength of these hard specimens is affected somewhat by the conditions of heating.

If the specimens are not perfectly straight, the stress applied in the testing machine is not parallel to the

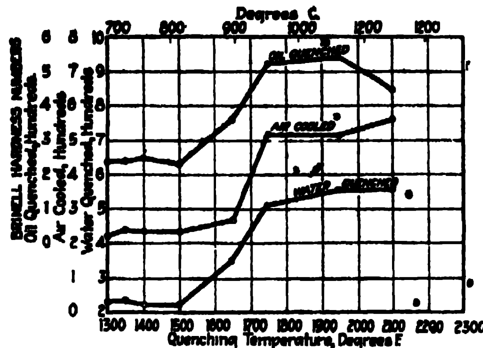


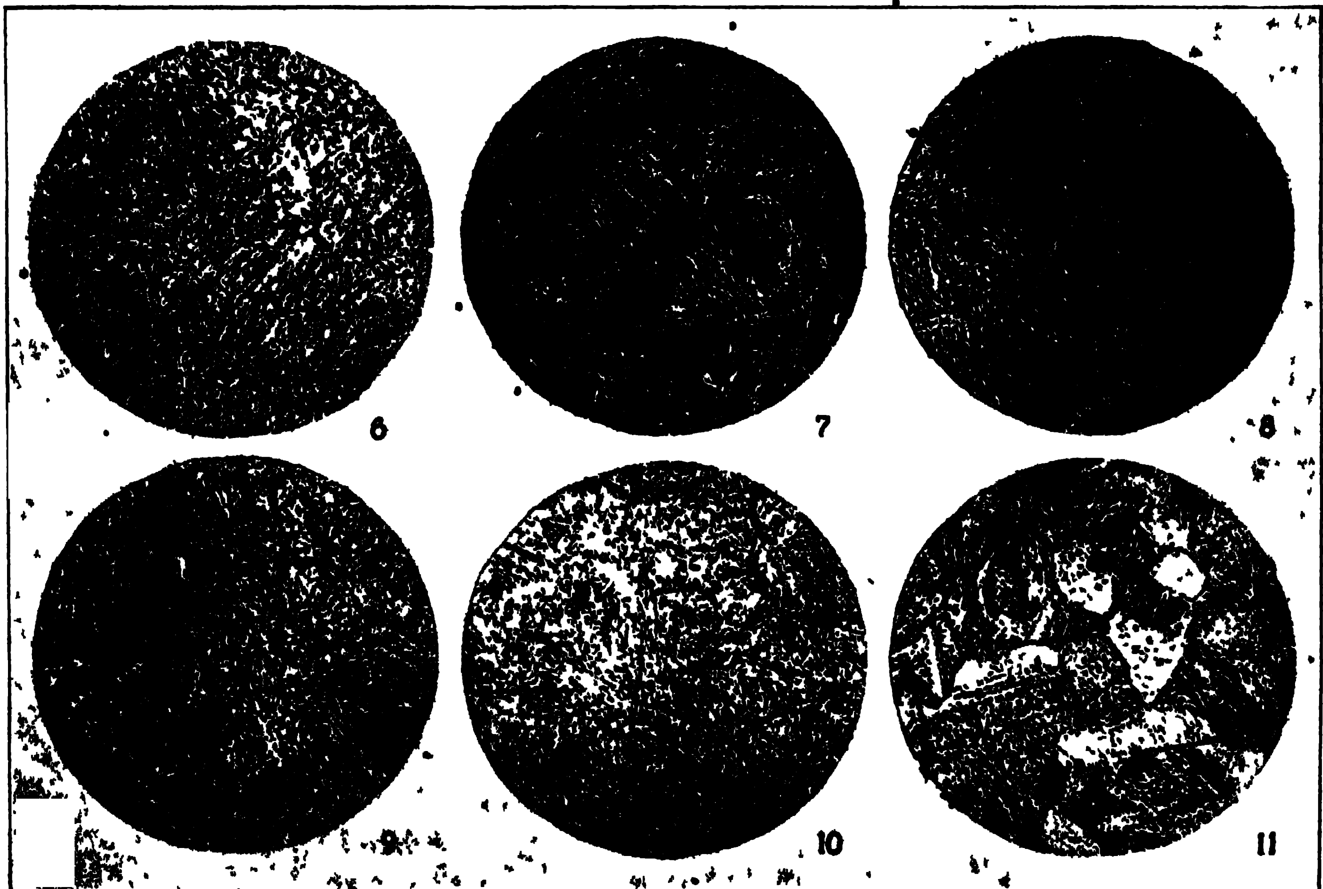
FIG. 5 HARDNESS QUENCHED DISKS, 1 IN DIAMETER, ½ IN THICK

axes of the specimen and as the material has low ductility it cannot adjust itself and so breaks at a value lower than the true tensile strength. However, as all test specimens were ground after heat treatment, this effect has been kept to a minimum.

According to Guillet's constitutional diagram the steel under consideration is in the martensitic range; that is, on normal air-cooling from above the critical ranges only partial transformation of the solid solution takes place, so that on reaching room temperature martensite remains as the stable constituent. Such steel is referred to as "self-hardening steel," and it is necessary to resort to very slow cooling, as in a furnace, for annealing. Comparison of Brinell hardness values between water, oil and air cooled ½-in. thick, 1-in. disks heated to various temperatures is given in Fig. 5 and clearly indicates that the steel in small sizes will harden equally well in air as in oil or water. In practice furnace cooling from about 1,400 deg. F. (760 deg. C.) to a temperature in the neighborhood of 1,000 deg. F. (538 deg. C.) followed by air-cooling to room temperature is a satisfactory method of annealing. By heating to about 1,750 deg. F. (953 deg. C.) and cooling in a manner similar to the above, the steel is brought into an even softer condition though one not quite as satisfactory for ordinary machining.

Micro-examination of all heat-treated tensile test samples was made, and in some cases reveals interesting structures. For etching the reagent mentioned by Seidell and Horwitz[8] consisting of a mixture of 2 parts of 50 per cent solution of hydrochloric acid, 2 parts of 15 per cent solution of ammonium persulphate and 1 part of concentrated alcoholic solution of o-nitrophenol was at first used. This in general gave satisfactory results, but a mixture of 2 parts of concentrated nitric acid and 1 part of concentrated hydrochloric acid diluted with 3 parts of water was finally adopted as meeting all requirements. With this reagent satisfactory development of structure was obtained by immersion

[8] Loc cit



FIGS. 6 TO 11. MICROSTRUCTURE OF HEAT-TREATED SPECIMENS × 500

Fig. 6—Oil quenched from 1,5[illegible] deg. F. Fig. 7—Oil quenched from 1,950 deg. F. Fig. 8—Oil quenched from 2,100 deg F. Austenitic grains evident only on a portion of cross-section. Fig. 9—Oil quenched from 1,750 deg. F. Tempered 30 min. at 815 deg. F. Fig. 10—Oil quenched from 1,750 deg. F. Tempered 30 min. at 1,235 deg. F Fig 11—Oil quenched from 2,100 deg F. Tempered 30 min. at 1,000 deg. F.

for from 30 to 90 seconds. Samples quenched from the highest temperatures without subsequent tempering required the longest immersion, while the remainder required only 30 to 60 seconds.

All samples oil quenched from above 1,750 deg. F. (955 deg. C.) without subsequent tempering show a martensitic structure as shown in Fig. 6. Above 1,850 deg. F. (1,010 deg. C.) the "needles" become quite large (Fig. 7) and in those samples quenched from 2,100 and 2,250 deg. F. (1,149 and 1,233 deg. C.) there is evidence of retention of the solid solution. Fig. 8 shows a portion of the cross-section of one sample, which in particular exhibits the polygonal structure characteristic of austenite. Partial preservation of these grain boundaries is also evident in a sample quenched from 3,250 deg. F.

Close examination of micrograph 6 and others not shown further reveals minute carbide globules in samples representing the steel as oil quenched from temperatures between 1,562 and 1,750 deg. F. (852 and 955 deg. C.). The steel as quenched from 1,750 deg. F. (955 deg. C.) and 2,100 deg. F. (1,149 deg. C.) and tempered at various temperatures between 400 and 1,235 deg. F. (206 and 668 deg. C.) shows similar features as illustrated in Figs. 9, 10 and 11. Samples quenched from the lower temperature show a partial precipitation of carbide (Fig. 9), while those first quenched from the higher heat are practically free from this constituent until tempered at 1,000 deg. F. (538 deg. C.) or above, but show evidence of retention of polyhedral grain boundaries even when tempered at the higher tempering temperatures used (Fig. 11).

It is interesting to note that the structures obtained in quenching generally persist even at tempering temperatures fairly close to the critical ranges, a phenomenon which is undoubtedly directly associated with the special properties of this steel.

Summary

Samples of a high-chromium steel quenched in oil from various temperatures show:

(*a*) That with increasing quenching temperature hardness as measured by Brinell and Shore instruments increases until a temperature of about 1,950 deg. F. (1,066 deg. C.) is reached. Maximum range of hardness is generally obtained by quenching from this temperature up to the highest heat used, but in some cases this hardness actually decreases due to retention of the solid solution.

(*b*) That quenching from about 1,750 deg. F. (955 deg. C.) develops the best combination of strength and ductility which is not coincident with range of maximum hardness. Quenching from this or lower temperatures does not retain all the carbide in solution as is the case in samples quenched from considerably higher temperatures (notably 2,100 and 2,250 deg. F. (1,149 and 1,232 deg. C.).

(*c*) That ductility as measured by elongation and reduction is very low in those samples quenched from 1,850 deg. F. (1,010 deg. C.) or above.

Short time tempering at temperatures up to about 800 deg. F. (427 deg. C.) of samples previously quenched from both 1,750 deg. F. (955 deg. C.) and 2,100 deg. F. (1,149 deg. C.) decreases brittleness. However, ductility is increased to a greater extent in those samples quenched from 1,750 deg. F. (955 deg. C.) than in those quenched from the higher temperature.

Tempering above about 800 deg. F. (427 deg. C.) markedly decreases strength values and hardness, which is of course accompanied by greatly increased ductility.

In general, the structure of the hardened steel tends to persist even when tempered for a short period of time at temperatures comparatively close to the lower critical range, the characteristics depending upon the quenching temperature used.

The most rapid change in tensile properties and hardness occurs in tempering between about 800 and 1,000 deg. F. (427 and 538 deg. C.).

Effects of Oils and Heat on Glues*

Plywood may be used near machinery and tanks with little likelihood of being dangerously weakened by the action of oil or gasoline on the glue joints. Plywood panels glued with animal, vegetable, blood albumin and casein glues were immersed for nearly a year in engine oil and gasoline. At regular intervals specimens were removed from the liquids and tested for joint strength. All the glues weakened somewhat during the early part of the test, the animal and vegetable glues more than the casein and blood albumin glues. The total loss of strength in any case, however, was small enough to be negligible under most conditions of service. A glue shear strength of 100 to 125 lb. per sq.in. is considered sufficient for practically any purpose for which plywood is used. Only in two or three instances did the strength of the casein and blood albumin glues fall below 150 lb. per sq.in. Engine oil, castor oil and gasoline seemed to have practically the same effect on the glue joints.

During the forty-five weeks' test, the wood absorbed 60 per cent of its original weight in engine oil and 70 per cent of its original weight in gasoline. The absorption of these oils did not cause any noticeable swelling of the wood.

Long-continued heating, however, will reduce the strength of animal glues. Solutions of a high-grade joint glue and a veneer grade glue were heated for forty-eight hours at 104, 140 and 176 deg. F., and tested every few hours during this period for strength and viscosity.

In the first seven hours of heating at 176 deg. the veneer glue lost approximately one-half its joint strength, and the high-grade glue joints weakened almost as much. The greatest loss in the strength of the glue joints occurred at this temperature. In the solutions kept at 104 deg. there was a sudden drop in the strength of the joints made with the high-grade glue after thirty-one hours of heating, due possibly to a combination of bacterial and chemical action. The veneer glue joints showed a more gradual decrease at this temperature. The most favorable of the three temperatures tried was 140 deg., but even at this temperature an appreciable weakening in both glues was noted at the end of seven hours, and longer heating caused greater loss.

The viscosity of the high-grade glues declined more rapidly than that of the veneer glue, but at the end of the heating test the viscosity of the high-grade glue still averages higher than that of the veneer glue.

Covered glue pots were used in this experiment. When open glue pots are used the loss in strength caused by the heat is less apparent, since the loss is compensated to some extent by evaporation of the water. But the concentration of the glue solution through evaporation is an expensive means of gaining strength.

*From Forest Products Laboratory Technical Note, [illegible], 1922.

Permeability of Rubber to Gases—I

Nature of Permeability and Methods and Apparatus for Its Determination Described—Effect of Factors: Characteristics of Rubbers Used, Pressure Differences, Sheet Thicknesses, Time and Temperature*

BY JUNIUS D. EDWARDS† AND S. F. PICKERING‡

RUBBER has been in everyday use as a gas-retaining material for a great many years. Nevertheless, until the recent development of the modern rubberized balloon fabric, comparatively little advance was made in our knowledge of the permeability of rubber to gases. With the development of fabrics for lighter-than-air craft came the demand for accurate methods of measuring permeability, together with a demand for the most varied kinds of information regarding the permeability relations of rubber and gases. The Bureau of Standards has already, in its Technologic Paper 113[1] (hereafter referred to as T.P. 113) published the results of an investigation of methods for the determination of the permeability of rubber to hydrogen. Correlated with that work has been the present investigation of the factors involved in the passage of gas through rubber and the permeability of rubber to different gases.

NATURE OF PERMEABILITY PROCESS

Graham[2] in his classic and pioneer work on the "Dialytic Separation of Gases by Colloid Septa" was the first to point out that the characteristic passage of gas through rubber took place by solution in the rubber and

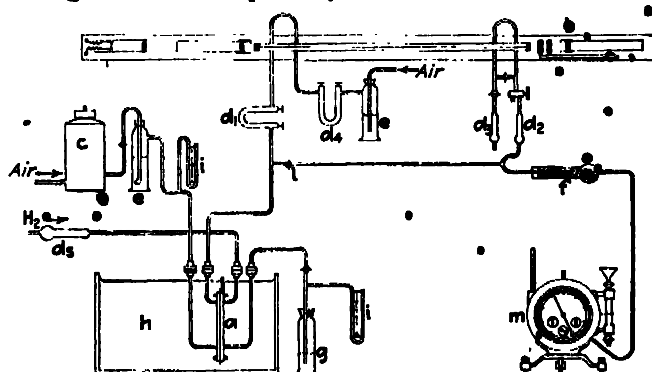


FIG. 1. DIAGRAM OF STANDARD APPARATUS FOR DETERMINING PERMEABILITY

not by diffusion through microscopic openings. If gases passed through rubber by the process of diffusion as through a porous plate, their rates of penetration should be approximately inversely proportional to their viscosities. As pointed out by Graham, the relative rates of penetration of different gases bear no relation to their densities or their viscosities. In fact, it is difficult to correlate the permeability with any of the well-known properties of the gases. It is quite obvious from a consideration of the facts that some phenomenon other than diffusion through small openings is concerned, and that the properties of both rubber and gas determine the rate of penetration.

METHODS OF DETERMINING PERMEABILITY

The permeability of a rubber film may be defined as the rate at which it is penetrated by a certain gas. Permeability will be expressed in terms of liters of gas per square meter per twenty-four hours, the volume of gas being corrected to the standard conditions of zero deg. C. and 760 mm. mercury pressure. Unless stated otherwise, all determinations are made under the following conditions, which are adopted as standard for this work: The fabric is held at a temperature of 25 deg. C. with air at atmospheric pressure (760 mm. of mercury) on one side of the fabric and the gas in question at an excess pressure of 30 mm. of water on the other side.

DESCRIPTION OF METHODS AND APPARATUS

Most of the different types of apparatus available for the determination of permeability have been described in T.P. 113, to which reference has been made. What may be called the standard apparatus of the Bureau of Standards is shown in diagram in Fig. 1. The rubber sample to be tested is held in the permeability cell *a*, which is maintained at a constant temperature in an air or water bath *h*. The cell consists of two circular plates with a shallow chamber in each. The test piece is held between the flanges of the cell and separates the two chambers; it is supported by a series of crossed wires in the form of a screen. A constant concentration of the gas whose permeability is to be measured is maintained in one chamber. The gas which penetrates the exposed area of rubber passes into the other chamber, from which it is continuously removed by a stream of air or other gas and determined quantitatively.

Because of the common use of hydrogen in balloons, the permeability to hydrogen is the property most often determined in the case of balloon fabrics. For this reason, and because of the accuracy with which the permeability to hydrogen can be determined, the permeability to any other gas will be referred to its permeability to hydrogen as the standard of comparison.

In determining the permeability to hydrogen, a current of pure dry hydrogen is passed over one side of the fabric and out through a water seal. Dry air under carefully regulated pressure is passed over the other side of the fabric, through a drying tube d_1 and into one chamber of a gas interferometer where the percentage of hydrogen in the air is determined optically. The gas then passes out through the drying tube d_2, which prevents diffusion of water vapor into the interferometer, through the saturator *f* filled with glass beads partly covered with water and then through the wet meter *m*. The saturator is employed to prevent loss of water from the meter by evaporation into the gas which

*This paper is a condensation of a comprehensive report to be issued by the U. S. Bureau of Standards.

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[1] J. D. Edwards, "Determination of Permeability of Balloon Fabrics," Bureau of Standards, 113; 1918.

[2] *Phil. Mag.*, vol. 32, p. 401; 1866.

is being measured. Arrangements are made for by-passing the air stream from the interferometer to the meter when the interferometer is being read and for supplying the comparison chamber of the interferometer with pure dry air.

The gas interferometer[3] of the Rayleigh type measures the difference in refractivity of the two samples of gas contained in the gas chambers of the instrument. Several interferometers were used and their sensitivity was such that each scale division indicated from 0.007 to 0.01 per cent hydrogen in air. The average of ten settings of the instrument gave a reading which was good to somewhat better than one scale division; this gives ample precision in the determination of the hydrogen. The calibration of the interferometer, both for hydrogen and other gases, was accomplished by the method described by one of us in the *Journal* of the American Chemical Society.[4]

Characteristics of Rubber Samples Employed

The greater part of the determinations recorded were made with rubber films as they are contained in balloon fabrics. This was done not only because of the immediate application of the results in that field, but also because balloon fabrics of great variety were readily available. Rubber films of satisfactory uniformity and low permeability are also most easily secured in the form of balloon fabrics. The support given the rubber film by the cloth on which it is spread simplifies the handling and testing of the material. The question might be raised as to whether in some cases the results might not be influenced by the cloth on which the rubber is spread. To test this point, determinations were also made on thin sheet rubber in those instances. The absolute permeability of the rubber is profoundly modified by the cloth, as will be shown later; its relative permeability to different gases is apparently not affected thereby.

Relation of Permeability to Composition of Rubber

For the present purpose rubber may be considered to be a mixture of "polyprene," $(C_5H_8)_x$, in different stages of polymerization, together with resins, nitrogenous matter, water and inorganic material in varying proportions. Vulcanized rubber, which we will hereafter refer to simply as rubber, contains in addition varying proportions of sulphur, combined with or adsorbed by the polyprene together with some free sulphur. Compounding materials in great variety may also be added to the rubber to give it desirable characteristics but where imperviousness to gases is desired their use is usually restricted.

Relation Between Permeability and Composition

Without going into the detailed evidence contained in the complete report it may be desirable to summarize some of the observed facts in regard to permeability and composition:

The aging of rubber in thin films is accompanied by a characteristic decrease in permeability.

The aging of rubber is usually accompanied by a decrease in the percentage of total sulphur; the combined sulphur increases by varying amounts and the free sulphur decreases eventually to a low value.

In one series of fabrics where the degree of cure was varied, no significant change in permeability was observed. In this case the percentage of combined sulphur varied from 0.3 to 2.5 per cent. In another series, large changes in permeability were noted with change in the degree of cure; the combined sulphur varied from 1.6 to 5.0 per cent. The original acetone extract was approximately constant in each series.

Because of the number of factors involved it would be unwise to draw any very extensive conclusions. The view is quite widely held by manufacturers and others that the permeability of a fabric can be reduced by increasing the degree of cure. Between certain limits this is true. That this reduction in permeability is caused entirely by the increase in combined sulphur is not at all certain. Opposed to this latter view is the fact that as great and greater decreases in permeability are noted on fabrics exposed to the weather where there are relatively small changes in combined sulphur. The most striking change in exposed fabrics is the increase in acetone extract, which increase is a measure of the resinification and oxidation of the rubber. It appears reasonable to believe, therefore, that an increase in combined sulphur and acetone extract each cause a decrease in permeability. This would be the natural result if hydrogen was insoluble in both the acetone-soluble material and the "polyprene sulphide."

It has been thought by some that the free sulphur plays an important part in determining the permeability. The free sulphur which is present in the colloidal condition in the rubber after vulcanization frequently crystallizes out. This is strikingly shown by the microsection of a sample of ballonet fabric illustrated in Fig. 2. The sulphur crystals are seen as dark dendritic masses in the rubber between the two plies of cloth. A certain amount of this sulphur eventually penetrates to the surface and evaporates. This process might possibly produce a certain porosity which would increase the permeability. Tests made on portions of the fabric of Fig. 2 where crystallization was extensive showed no significant difference in permeability as compared with portions where crystallization had not occurred. Certainly our tests and experimental methods have not



FIG. 2. MICROSECTION OF BALLONET FABRIC (× 138) SHOWING SULPHUR CRYSTALS

[3]For detailed description see L. H. Adams, *J. Am. Chem. Soc.*, vol. 37, p. 1,181; 1915.

[4]Edwards, *J. Am. Chem. Soc.*, vol. 39, p. 2,382; 1917. See also Chem. & Met. Eng., vol. 21, p. 560; 1919.

been of sufficient delicacy to detect any effect on the permeability which can be ascribed to this blooming out of sulphur.

Compounding materials may be added to the rubber either to make it more impervious to gases or to give it greater durability. Paraffine and glue are two substances which are said to lower the permeability of rubber to hydrogen. It is known that either of them alone will give a film of very low permeability providing it is non-porous. Their use is not essential, however, to the production of a satisfactory coating for balloon fabrics. Lampblack, zinc oxide, litharge may be incorporated in the rubber to give it greater life by protecting the rubber from the injurious action of light.

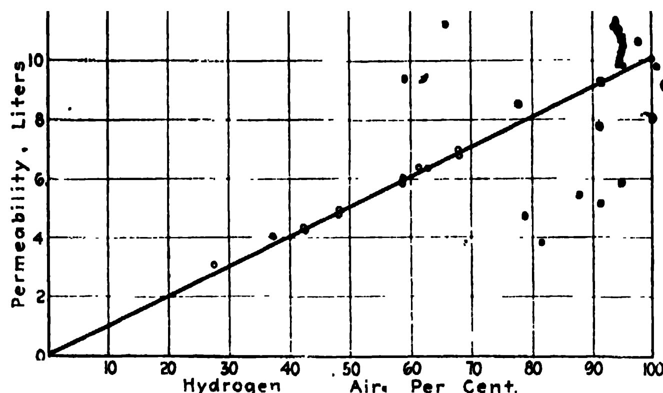


FIG. 3. RELATION BETWEEN PERMEABILITY AND PARTIAL PRESSURE OF HYDROGEN

Relation of Permeability to Pressure

In considering the effect of pressure, a distinction should be made between the total pressure and the partial pressure of any constituent. A difference in the total pressure on the two sides will produce tension in the rubber film and a change in thickness or physical properties may result. The effect of a change in the total pressure will be influenced by the support given the rubber film such as when it is held between cloth of one or more plies, as in the case of a balloon fabric. The work of previous investigators indicates that the permeability of rubber to any gas is about proportional to the partial pressure of that gas. The agreement on this point is not unanimous, however, and the methods and data recorded are not satisfactory in all particulars.

In Fig. 3 is shown the relation between permeability and difference in partial pressure of hydrogen as shown by tests on six different test pieces of the same fabric. The percentages of hydrogen in the air were determined by means of the interferometer. The permeability of the different test pieces with 100 per cent hydrogen varied from 9.4 to 10.0 liters; each result was therefore multiplied by the ratio of 10 to the observed permeability at 100 per cent so that the 100 per cent value became 10 in each case and all the other values were directly comparable. It may be concluded from these results that the permeability is directly proportional to the partial pressure within the limits of experimental error. Similar results were obtained with carbon dioxide as shown in Fig. 4.

In accordance with the conclusion that the permeability was directly proportional to the partial pressure, the results of all permeability determinations have been corrected to the standard condition of a partial pressure of 760 mm. in the following manner. For example: In one determination with carbon dioxide (99.9 per cent pure) there was 0.6 per cent carbon dioxide in the air on the opposite side of the fabric; the barometric pressure was 750 mm. and the observed permeability 20.0 liters. The corrected permeability is then equal to

$$20.0 \times \frac{760}{750} \times \frac{100.0}{99.9 - 0.6} = 20.4 \text{ liters.}$$

The change in permeability when the difference in the total pressure on the two sides of the sample is varied follows no simple law. In this case, not only does the permeability change with the change in partial pressure but also it may change with any variation in thickness caused by the tension on the rubber. Obviously the effect will vary with the support given the rubber. In the case of a balloon fabric the rubber film is given very intimate support by the cloth on which it is spread. The cloth may to some extent be prevented from stretching by the manner in which it is held in the cell during a test. In the case of a sheet of rubber such as dental dam, the only support the rubber receives is from the screen on which it rests in the cell and the fact that it is clamped at the edges. In Fig. 5 are shown the graphs of several experiments where the pressure of the hydrogen was varied. The two balloon fabrics (Nos. 50,313 and 47,174) show about the same small rate of increase of permeability with increase of pressure. The two samples of dental dam show a slightly higher rate. The extensibility of rubber and cloth may vary so greatly that no great uniformity in the shape of these curves can be expected and, in general, that is our experience.

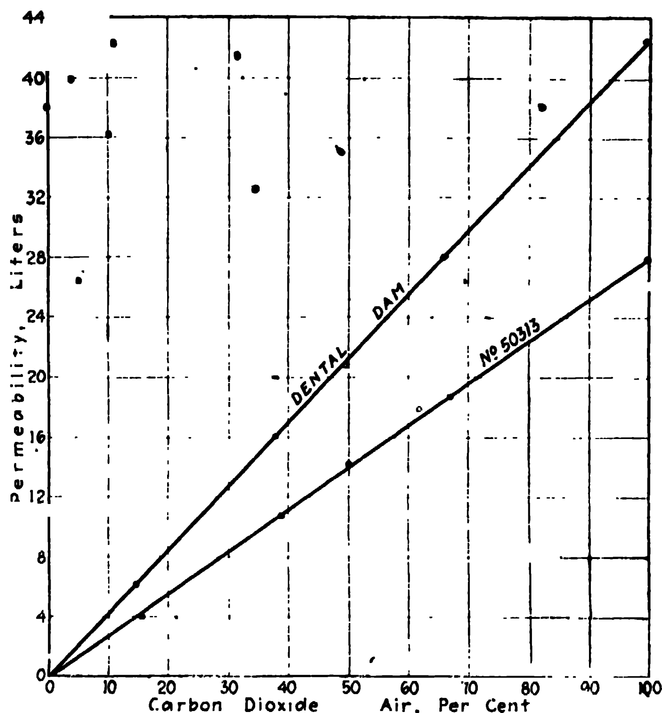


FIG. 4. RELATION BETWEEN PERMEABILITY AND PARTIAL PRESSURE OF CARBON DIOXIDE

Relation of Thickness of Rubber to Permeability

The permeability of a sample of rubber should obviously bear some relation to the thickness of the material. The most reasonable assumption, and the one usually

made, is that the permeability is inversely proportional to the thickness of the rubber. A series of samples of rubber, identical in chemical composition and physical properties, was not available for testing this point. It was necessary, therefore, to use material from different sources and varying in composition. The samples tested varied from the thin sheet rubber known as dental dam, about 0.2 mm. in thickness, up to sheets of 2 mm. thickness. Certain of the samples were "vapor cured" with sulphur chloride and the rest steam cured in the usual manner. The permeability of these samples was determined with zero difference of pressure on the two sides of the samples in order not to introduce any variation in the tests because of stretching of the material. Their permeability was determined with a Shakespere permeameter which was furnished to us by Prof. Shakespere of Birmingham University. For descriptions of this apparatus and method the reader is referred to Reports of the British Advisory Committee for Aëronautics for the last two years, which will undoubtedly be made available eventually. The instrument gives reproducible results of good precision for purposes of comparison.

The results of these tests are shown in Fig. 6, where the gas impedance, by which term the reciprocal of the permeability is designated, is plotted as a function of the thickness. There is clearly a linear relation between the two variables over a considerable range. Such uniformity as was found was hardly expected, considering the fact that the samples represented the product of a number of different makers and made no pretense of being uniform in composition. It will be noted that the very thin samples, about 0.2 to 0.3 mm. in thickness, show a lower impedance (higher permeability) than corresponds to the straight line. This may possibly be due to the greater effect of non-uniformity in the very thin material. The sample, 0.8 mm. in thickness, which showed an impedance of over 0.6, was old and stiff and its high impedance was anticipated because of our observations on the decrease of permeability with age. This might also be inferred from its high acetone extract and combined sulphur values. The sample 1.93 mm. in thickness contains glue, which may account for its slightly greater impedance.

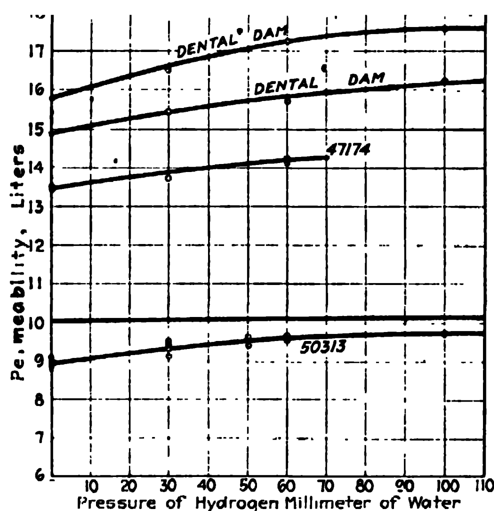


FIG. 5. RELATION BETWEEN PERMEABILITY AND TOTAL PRESSURE OF HYDROGEN

The results of Fig. 6 show sufficient uniformity to warrant calculating what may be called the specific permeability of rubber. It may be defined in terms analogous to those in which such a property as thermal conductivity is defined, by stating that it is the volume of gas which passes through unit area of a sample of unit thickness in unit time with a difference in partial pressure of 760 mm. of the gas. The centimeter and minute can be conveniently used as units. The specific permeability to hydrogen at 25 deg. C. of vulcanized rubber of the character tested as calculated from the graph of Fig. 6 is 20.4×10^{-6} c.c. per minute. The volume of hydrogen (measured at 0 deg., 760 mm.) passing through a sample of rubber at 25 deg. C. can be approximately calculated from the following equation:

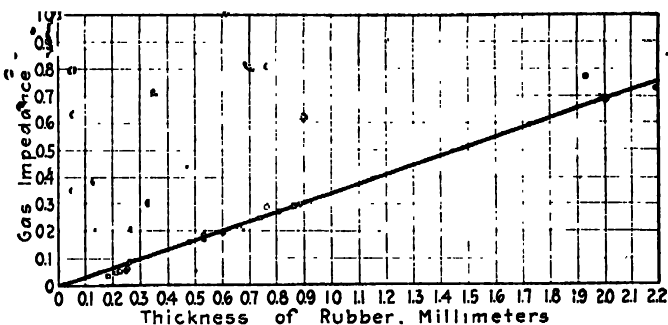


FIG. 6. RELATION BETWEEN PERMEABILITY AND THICKNESS OF RUBBER

$$V = \frac{20 \times 10^{-6} \times At}{d}$$

where V is the volume in c.c., A the area in sq.cm., t the time in minutes, and d the thickness in cm.

The only other data in the literature which can be compared with the above value are those of Kayser.[5] The specific permeability to hydrogen at 25 deg. C. as calculated from Kayser's equation is 27.4×10^{-6} c.c. per minute, which value is in fair agreement with ours. Although care should be taken not to place too great reliance on any value for the specific permeability of rubber the characteristics of which are unknown, nevertheless the preceding equation will be found useful in arriving at an approximate figure in many cases. A direct permeability determination is the only sure method in any case.

The data of Fig. 6 confirm the very interesting observation of Prof. Shakespere that the gas impedance for a given weight of rubber is greatly increased by being spread on cloth. For example, a sheet of rubber (density 0.96) having a weight of 120 g. per sq.m. (about 3.5 oz. per sq.yd.) will have a thickness of 0.13 mm. and, according to Fig. 6, a permeability of $\frac{1}{0.042}$ = 23.8 liters. This weight of rubber properly spread on cloth can be made to give a fabric having a permeability of about half that value, or 10 to 12 liters. The cloth therefore performs a very important function in reducing the permeability in addition to giving the rubber support and protection. As pointed out by Prof. Shakespere, this fact is of importance in securing balloon fabrics of the lowest permeability.

Time of Penetration of Rubber

For some purposes, notably for use in gas masks, it is not the maximum permeability which is of most

[5] Kayser, *Wied. Ann.*, vol. 43, p. 544; 1891.

importance, but the time required for the gas to penetrate the fabric. A gas mask fabric loses its protective value about as soon as the poison gas penetrates in appreciable quantities. Permeability determinations of the kind considered in the present work are therefore of very little value in this connection.

One test made on a balloon fabric with the Shakespere permeameter indicated that hydrogen penetrated the fabric in less than 1 minute and the fabric reached its maximum permeability in from 1 to 2 minutes. These times include the lag of the instrument so that the actual time required to penetrate this fabric must be very small. The permeability of this fabric was about 8 liters per sq.m. per 24 hours. Tests made with hydrogen sulphide, in which the gas penetrating the rubber was detected with lead acetate solution, showed that rubber films of the character used in balloon fabrics were penetrated with great rapidity by hydrogen sulphide also. Any considerable time required to reach equilibrium in testing may be generally considered to be caused by instrumental lag. Sometimes, however, there are actual changes in permeability with long continued tests, which make it appear that equilibrium is being reached very slowly.

Relation of Permeability to Temperature

Graham first called attention to the large temperature coefficient of permeability. The relation between temperature and permeability has been examined since then by a number of investigators, most of whom are

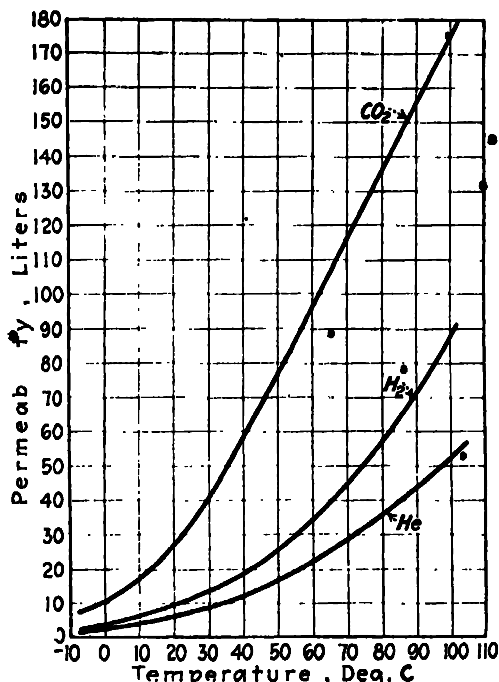


FIG. 7. RELATIVE PERMEABILITY OF RUBBER TO CARBON DIOXIDE, HYDROGEN AND HELIUM AT VARIOUS TEMPERATURES

in general agreement, although Frenzel's[4] results alone indicate that the relation is a linear one. However, there are no reliable values which cover a very large range of temperatures.

A special cell was designed for determining the permeability at different temperatures. It was similar to the regular cell, except that each half was provided with a water jacket through which water could be circulated by means of a pump. By regulating the temperature of the water, the fabric could easily be kept at any desired temperature within the range covered. The temperature of the fabric itself was measured by means of a copper-constantan thermocouple of No. 36 wire whose "hot junction" was mounted on the fabric before assembling the cell.

For graphic comparison the relative permeabilities of carbon dioxide, hydrogen and helium are shown in Fig. 7. It will be noted that the curves for hydrogen and helium show about the same relative increase with temperature. The change of permeability to carbon dioxide, however, becomes practically linear after 30 deg. C. No simple relation between permeability and temperature has been discovered.

(Part II of this paper will be published in our next issue.)

[4]Frenzel, Über die Gasdurchlässigkeit der Ballonstoffe." Druckerei des Elsässichen Textilblattes im Gebweiler.

Grave Shortage of Print Paper in United Kingdom

If the difficulties of the American newspaper publishers are considerable, they are perhaps not more embarrassing than those of their British confrères. In November last the price per ton in Scandinavia of mechanical pulp was 120 crowns, as against 330 crowns today. (The normal exchange value of the crown is $0.268.) The Scandinavian association virtually controls the market, and Lord Northcliffe's press remarks that there is nothing to prevent it from raising the price to 600 or even 900 crowns.

The *Times*, in reviewing the situation, concludes that the paper trade cannot become easier until the supply of mechanical pulp wood is enormously increased, and suggests that this be done by opening up the vast region lying between Hamilton Inlet and Lake St. John in Canada, where there is a supply of the right sort of timber sufficient to furnish the requirements of the country for years to come and where mills laid down today could be worked in eighteen months. It is explained in detail that wood can not be imported into Great Britain to be pulped on account of the expense and other insuperable difficulties.

The *Newspaper World* states that 321 newspapers have increased their price during the present year. The journal continues:

> An analysis of the Board of Trade returns for the past four months shows that the average price for mechanical pulp has risen in the course of six years from about £4 10s. ($22) per ton to about £24 ($117) per ton, and for high-grade pure sulphites from £10 ($48) a ton to between £50 and £60 (between $243 and $292) per ton. Seeing that the cost of all other raw materials and chemicals is double or treble what it was, and workers' wages are, reckoned according to the time worked, more than double, it is little wonder that pure white printings at 2d. ($0.04) per pound are things of the past, and likely to be, so long as this generation lasts.
>
> The action of the Norwegian Government with regard to paper may have an effect upon the quantity of pulp coming across to England. Some think that it will reduce the tonnage of paper being made in that country, so that the pulp mills will have more for export and will be willing to sell at a reduced price; but others consider that, as the pulp mills and paper mills so often belong to the same companies, they will want to make up on the pulp for anything they may lose on the paper from home consumption, and so will keep up the price as at present or even force it higher. If mechanical pulp advances much more, the British paper makers will be compelled to turn their attention to waste paper as a raw material to a far greater extent than they do now.

British Nitrogen Production Plans

By Frederick E. Hamer

THE experimental factory which the British government set about establishing during the war at Billingham-on-Tees, in the County of Durham, for the fixation of atmospheric nitrogen is at last to be turned to commercial and national account. The history of the enterprise is still somewhat obscure, and if it were fully disclosed would probably reveal the usual confusion and delays which characterize State action in such matters. It is not strictly correct to speak of a "factory." Such an establishment was contemplated and plans had been nearly completed, but with the signing of the armistice operations came to a stop. Billingham at present is understood to be little more than a site, with some partially constructed roads, a few foundations for plant, hutment accommodations for workers, etc. But as regards plant, there is practically none, and the Billingham "factory" is, like the nitrogen to be fixed, something in the air.

Of late there has been much speculation as to what was to become of the government's scheme, together with the results of the valuable research work undertaken. It is a relief to know that at last the matter has been finally settled on what is generally regarded here as a satisfactory basis. The great firm of Brunner, Mond & Co. has formed a new company, Synthetic Ammonia & Nitrates, Ltd., with a capital of £5,000,000, to take over the whole concern from the government. The company is to be British-controlled, the directors are to be British-born, and the first directors are to be approved by the government. The purchase price has not been disclosed.

Large Technical Staff Organized

In addition to acquiring the site and what stands on it at Billingham, the new company will take over the leading engineers and chemists employed by the government in research work on the subject, and with these as a nucleus has already organized a large staff of scientists and technologists. Members of this staff have already visited and inspected the German plant at Oppau, where the Haber process had been worked out. The company's experts have also visited the U. S. Government plant at Sheffield, Ala., and the General Chemical Co.'s plant at Laurel Hill, N. Y. The experimental plant of M. Georges Claude at La Grand Paroisse has likewise been inspected, and in addition the experimental plant of Dr. Maxted, one of the leading British authorities on nitrogen-fixation, has been acquired. With this very complete equipment, and with the independent research and design carried out by the company's own staff, it is claimed that the British company is now in a position to erect plant "in the full confidence that the process chosen will prove to be superior to any now in existence."

Modification of the Haber Process Chosen

The process is essentially a modification of the Haber process and was developed without any German assistance. In the matter of patents, however, the company will be fully protected by the government against German interference. It is intended to erect immediately at Billingham a plant for the manufacture of 100 tons of 100 per cent ammonia per day, equal to 150,000 (rising to 450,000) tons of sulphate per year. It is held, however, that chloride of ammonia is equal, if not superior, to sulphate as a fertilizer, and since by converting the ammonia into this form, carbonate of soda (soda ash) can be produced (a product in which Brunner, Mond & Co. are pre-eminent), it is hoped that the agricultural community will adopt the chloride for agricultural purposes.

So far the scheme is purely commercial, but national safety in the event of another war is amply provided for—it has been, in fact, all through the primary consideration. Arrangements have been made with Explosives Trades, Ltd., to take its requirements of ammonia from the company, and to erect plant to the extent desired by the government for the oxidation of this ammonia to form nitric acid and explosives derived therefrom. The scheme generally is regarded as well planned to safeguard British interests as regards fertilizers and (in the event of war) explosives.

Another Company to Use Claude Process

Side by side with this plan may be mentioned the purchase by an English company, Cumberland Coal, Power & Chemicals, Ltd., of the rights in the Georges Claude process, which works up to pressures of 1,000 atmospheres, and which, it is claimed, is peculiarly economical on account of its simplification of plant. So far no operations have been started in England, but a director of the company informs the writer that the operation of the first commercial unit in France is most satisfactory and when the tests have been fully completed an immediate start will be made here. The first unit to be installed will correspond with a production of 50,000 tons of sulphate of ammonia a year, and in addition a small plant will be erected for the production of chloride of ammonia, this company, like the other, having a strong belief in the future of chloride as a fertilizer.

These plans contemplate an enormously increased use of ammonia in some form for agricultural purposes, and they fit in with the national demand for bringing more land into cultivation and for introducing intensive methods of cultivation to safeguard the nation against the threatened shortage of foodstuffs.

London, England.

Electrical Sterilization of Milk

The British Medical Research Committee has recently, according to *Commerce Reports*, published results of experiments in sterilization of milk by Profs. Beattie and Lewis of Liverpool University, who largely carried on the work. They enumerate the results of fifteen experiments under varying conditions, with different degrees of current and with several qualities of milk. The final conclusions arrived at by the investigators are:

Milk can be rendered free from *B. coli* and *B. tuberculosis* by the new electrical method without raising the temperature higher than 63 or 64 deg. C. This temperature effect is very short in duration and in itself is not the principal factor in the destruction of the bacteria. Though the milk is not sterilized in the strict sense of the word, the percentage reduction of the bacteria over a fortnight period is 99.93. The keeping power of the milk is considerably increased.

The taste of the milk is not altered, and so far as careful chemical examination can determine the properties of the milk are not in any way impaired. The milk may accurately be described as "raw milk" free from pathogenetic bacteria.

Oxygen the Prime Factor in Corrosion*

A Discussion of the Nature of Passivity, and the Various Characteristics of Rust and Other Oxygen-Bearing Substances in Promoting Corrosion—It Appears Impossible to Produce a Micro-Section Which Will Corrode Under Water Attack According to Crystalline Areas

BY WILLIAM D. RICHARDSON

ONE who has followed the experimental work done on the corrosion of iron and steel during the past ten or fifteen years must have noticed the apparently contradictory nature of many of the experimental results and conclusions drawn from them and must have felt that the theory of corrosion lacked some essential factor or factors to make it even an approximately complete generalization. No chemist today can safely predict on the basis of theory what metal or metals will corrode most or least under a given set of conditions, even with the results of the very large number of experiments made by different investigators before him. In any given set of circumstances wherein iron and steel are exposed to the weather or to conditions which favor corrosion, there is always a doubt as to which of several metals will have the longest life and how the corrosion or pitting will proceed. The common statement of the theory of corrosion based on Nernst's theory of electromotive force,[1] while entirely convincing in the abstract, fails, when subjected to test, to explain the experimental results obtained. However, the electrolytic theory undoubtedly includes all the fundamental facts, and if it fails to explain the course of corrosion in any given instance, this is probably because some essential facts have been overlooked or have not been sufficiently emphasized and correlated.

POTENTIAL DIFFERENCE—SOLUTION PRESSURE

Corrosion depends in part on the solution pressure of iron and its place in the electrochemical series. While varying somewhat with the nature of the electrolyte used, this series as commonly given is as follows, beginning with oxygen at the negative end and ending with caesium at the positive end of the series. Hydrogen is placed differently in different tables, in some being shown as more, in others less electropositive than iron. The very lack of agreement on the exact position of a given element in the electrochemical series indicates the influence of lesser factors in locating the element in one position or another. These factors are in general

ELECTROCHEMICAL SERIES OF THE ELEMENTS

Non-metals	Metals		
—	Osmium	Hydrogen	Magnesium
Fluorine	Rhodium	Lead	Calcium
Oxygen	Iridium	Tin	Strontium
Chlorine	Gold	Nickel	Barium
Bromine	Platinum	Cobalt	Lithium
Iodine	Palladium	Iron	Sodium
Sulphur	Silver	Hydrogen occluded by Iron	Potassium
Phosphorus	Iron Carbide	Hydrogen	Rubidium
Selenium	Mercury	Cadmium	Caesium
Iron Oxides	Copper	Zinc	+
Nitrogen	Arsenic	Manganese	
Boron	Bismuth	Chromium	
Carbon	Antimony	Aluminum	
Silicon			

similar to those which influence and modify the course of corrosion.

In order to ascertain the place of hydrogen in relationship to iron in the electrochemical series, the following experiment was tried based on the well-known fact that a pure or nearly pure iron when soaked in dilute sulphuric acid absorbs considerable quantities of hydrogen.

Two strips of pure open-hearth iron, measuring about 1 x 3 in., were carefully cleaned by means of fine emery paper. One was allowed to soak in sulphuric acid of something less than 1 per cent strength over night. In the morning the untouched piece of metal, still bright, was once more polished with fine emery and both pieces were connected through a sensitive millivoltmeter and simultaneously plunged into neutral salt solution. The voltmeter showed the acid-soaked iron positive and the clean iron negative.

On the face of it this experiment indicates that hydrogen, or rather iron with hydrogen occluded, is electro-positive to clean iron, but it was considered that the experiment might only prove that completely reduced iron (iron with hydrogen occluded) was electro-positive to iron with oxygen condensed on its surface (clean, bright iron). However, the conditions of the experiment were similar to those which might obtain during corrosion, so that it may be accepted for practical purposes that iron with hydrogen occluded on its surface or any area of iron with hydrogen occluded is electro-positive to clean, bright iron and, of course, more so to iron with occluded oxygen or coated with oxides of iron. This holds true for water, neutral salts and generally for dilute non-oxidizing acids.

FACTORS INFLUENCING CORROSION

The main factors influencing corrosion considered in this paper are four in number:

1. Composition of the metal.
2. Physical treatment to which the metal has been subjected.
3. The influence of atmospheric oxygen (and other atmospheric constituents).
4. The influence of the products of corrosion or rust.

COMPOSITION

According to the electrolytic theory, based on the solution pressure hypothesis of Nernst, corrosion of iron has been held by many chemists to be determined by the composition of the metal, and perhaps the majority of papers written on the subject take this point of view. All of the kinds of iron and steel investigated by the writer corrode easily with the single exception of Duriron[2]. There must be some point, more or less

*Extracted from a paper on "Experiment on the Corrosion of Iron and Steel" presented before the American Institute of Chemical Engineers, June meeting, 1920.

[1]Whitney, *J. Am. Chem. Soc.*, vol. 25, p. 1394.

[2]This metal is stated to contain approximately 15 per cent silicon and hence is an alloy of so different a composition from the other metals considered as to require entirely separate treatment. It is possible that there are no or few ferrite areas or surfaces exposed in this alloy and hence little opportunity for iron, owing to its solution pressure, to go into solution under any conditions even in the presence of strong and weak acids.

critical, at which corrosion or corrodibility rapidly diminishes or ceases, and the study of the composition corresponding to this point or curve region should throw much light on the general problem of corrosion. For present purposes only the ordinary types of iron and steel are under consideration and any statements made, if not otherwise qualified, refer to such varieties. Further discussion of the influence of composition on corrosion will appear later.

PHYSICAL TREATMENT

Under physical treatment are to be considered the various heat treatments, working the metal under heat, rolling and annealing, method of manufacture, etc. Some of these treatments change the composition of the metal, others only its physical structure, or, more important, its surface, and corrosion, it may not be amiss to emphasize, is distinctly a surface phenomenon. There are occasions then when physical treatment may be more important in influencing the commencement and course of corrosion than composition itself. Where deep pitting or slight but uniform general corrosion takes place its progress may be determined by so simple a factor as mill scale remaining closely adherent on certain parts of an iron surface only, and again corrosion may be prevented entirely for a long period of time by thin tightly adherent mill scale.

OXYGEN

Oxygen is considered by the writer to dominate over composition in determining the initial stages of corrosion and, acting through the medium of the products of corrosion, in determining more than any other single factor its entire course. Water is, of course, always assumed to be present either continuously or intermittently. It is possible that some corrosion results which have been reported as due to composition of the metal may have been due and perhaps determined by the physical treatment to which the metal has been subjected. On the other hand, atmospheric air or oxygen, and particularly the products of corrosion, are able to overbalance physical treatment as they are composition.

PRODUCTS OF CORROSION

The products of corrosion are themselves great accelerators of corrosion, just as mill scale is. This accelerating action is due first to the fact that the iron oxide formed during corrosion is strongly electronegative compared to iron and when concerned in corrosion is always a cathode. Ferric oxide may also act as a depolarizer in corrosion, since it is oftentimes reduced to Fe_3O_4. Its activity may be increased by condensation or adsorption of atmospheric oxygen on its surface, although Friend believes his experiments have disproved this. It also acts by absorbing and holding water.

After the commencement of corrosion, its subsequent course is determined very largely by the physical character of the rust formed, its distribution over and its adhesion to the surface of the metal. It may so act as to stimulate general corrosion. It may be responsible for deep pitting or under other circumstances may retard corrosion or prevent it altogether, for considerable periods at least, by close adhesion over considerable areas. It may cause corrosion to take different courses at different times, due to the fact that the rust formed at one time may be loose and wet, later on tightly adherent and later still dry and hard, so that by the influence of moisture or temperature or physical strain it scales off from large surfaces, exposing the metal beneath, and the cycle is thus renewed. Altogether rust appears to be the main feature of ordinary corrosion, not only as a result, but as a causative agent.

Rust itself is dependent for its formation upon atmospheric oxygen with the slight assistance of carbon dioxide and its physical characters are developed chiefly by the conditions of corrosion. The behavior of the rust formed may also be dependent upon the physical treatment to which the metal has been subjected and to the composition of the metal, so that the conclusion appears warranted that composition of the metal, at least among the ordinary varieties of iron considered here, does not influence the progress of corrosion directly but rather indirectly through the behavior of rust and the relationship of the rust to the metal composition and surface.

Thus the products of corrosion or rust act in a dual capacity, electrochemically as accelerators of corrosion and physically as a protective against corrosion. It is needless to point out that these two ways of functioning are diametrically opposed to each other and it can easily be imagined how many types of corrosion and peculiarities and apparently unexplainable differences in corrosion might be due to this fact alone.

RELATIVE IMPORTANCE OF COMPOSITION, OXYGEN AND IRON OXIDE

The relative importance of these three factors of corrosion, and particularly the importance of composition, is of paramount interest. If oxygen determines the commencement of corrosion, and iron oxide and other products of corrosion determine its subsequent course, of what possible influence can the composition of the metal be? Composition of the metal is the one factor which can be more or less controlled for a given service. It is unthinkable that composition should not have some influence of corrosion. It is well demonstrated that irons containing much silicon, for example, do not corrode under ordinary circumstances and are very nearly insoluble in the common acids. Iron containing much nickel is also practically non-corrodible. Ordinary cast iron under many conditions corrodes less than steel or mild steel. These are well-known facts and our theories of corrosion must take them into consideration.

Apparently composition of metal does not influence corrosion directly, if we consider the ordinary varieties of iron and steel. However, the composition of the metal evidently does influence the course of corrosion profoundly in an indirect way through the influence of the products of corrosion. We have seen that the products of corrosion may behave in three different ways in influencing the course of corrosion:

1. The rust formed may fall or scale off.
2. The rust may be partially adherent and an accelerator.
3. The rust may be protectively adherent.

Naturally there may be also some intermediate stages between these three principal divisions. The physical and electrical behavior of the rust are dependent upon two factors:

1. The conditions under which the corrosion takes place.
2. The composition of the metal.

Thus, of two different metals of different compositions but subjected to the same circumstances as regards corrosion, the rust in the one case may act as an accelerator of corrosion and in the other may tend to

act rather as protective coating. In other words, the rust may tend to adhere less in one case and more in another, over smaller areas in one case and over larger areas in another, and thus, under the same conditions, one metal will corrode more and another of different composition will corrode less.

The correlation between composition and the behavior of the products of corrosion on the basis of this theory of indirect influence of composition of the metal is most important but requires a vast amount of work to bring it to a satisfactory and practical conclusion. If hydrogen is included as one of the products of corrosion, the phenomenon of polarization as a negative influence in corrosion should also be included; but in this paper by "products of corrosion" are meant the hydroxides, oxides and carbonates of iron produced during rusting in water and the salts and basic salts in salt solutions.

Corrosion of Polished Iron Surfaces

A perfectly polished iron surface consists of a film of pure iron spread over the entire metal surface and covering pure iron and impurities alike. The pure iron is apparently caused to flow in such a manner as to form a mirror-like film, under the influence of the polishing powder and the friction induced by the polishing mechanism, whether hand or machine. On such a polished surface corrosion starts with some difficulty, compared with ordinary smooth, clean iron, and more particularly with rather rough but clean surfaces. It is also less easily attacked by acid. As is often found to be the case in metallographic work, when etching the polished specimens the higher the polish the more difficult it is to start the etching. Nevertheless if a drop of very pure redistilled water be placed on a highly polished iron or steel surface and allowed to dry, a spot of rust will be left. As a rule, the higher the polish the smaller will be the amount of rust remaining, and since samples of pure iron or steel take a higher polish than cast irons, the rust spot on polished cast iron is usually more prominent than on polished pure irons or steel.

If metals are polished to a high degree with perfectly dry and grease-free abrasives, a drop of water, instead of spreading over the surface, rolls up into a spheroid as though in contact with an oily surface. If the metal is capable of taking a very high polish, rust formation begins slowly at a few points only, and after the drop has dried only a small residue of rust remains, sometimes in the form of a narrow rim around the place where the drop stood. Less pure irons such as cast iron and semi-steel, which, as a rule, do not take as high a polish as pure irons and steels, also cause a drop of water to assume the spheroidal shape, but corrosion begins at numerous points and much sooner than in the other cases. In such water-drop experiments the progress of corrosion can be followed by means of a microscope or hand lens, as the greenish-white ferrous hydroxide spreads outwardly through the water from the points at which the corrosion is occuring and gradually oxidizes to red rust.

After corrosion test on polished surfaces, whether either plain water or the ferroxyl indicator in agar is used to cover an area of several inches square or more, it usually happens that there are more and larger electro-negative areas left with their original bright polish, on highly polished and comparatively pure samples than on less polished and comparatively impure samples.

The fact that the highly polished surface of iron starts to corrode more slowly than the less polished surface, such as that of cast iron or relatively less pure metal, might seem to hold out a faint hope that extreme purity of metal, if possible of attainment in a practical way, would be a means of reaching the much desired goal of corrosion-resisting iron. However, this hope does not seem warranted by the facts. Very pure open-hearth iron corrodes in the presence of oxygen more rapidly than cast iron. Electrolytic iron corrodes readily. Even highly polished surfaces corrode slightly in the beginning and at an accelerated rate after the first rust spot is formed. So long as oxygen is the dominating influence which governs the commencement of corrosion, and rust and oxygen together control the subsequent course so largely, neither pure iron nor polished surfaces appear to offer the solution of the problem.

Passivity of Iron an Oxidation Phenomenon

When either commercial or electrolytic iron is immersed in strong oxidizing agents, such as chloric, chromic or fuming nitric acids, or when touched with gold or platinum while dissolving in nitric acid of sp.gr. 1.35, or when heated momentarily in air, or when it is made the positive electrode in an electrolyte containing oxygen, it becomes passive and thereafter is not attacked by ordinary acids, no longer precipitates copper, silver or lead from their salts, and in general behaves like a noble metal.

All of these processes for producing passivity in iron are oxidizing processes.

Passive iron may be reactivated by heating in a reducing atmosphere, by the action of water, salt solutions, the diluted common acids, by making it the cathode in an electrolyte, and by other means.

All of the processes for reactivating passive iron are reducing processes, since hydrogen is disengaged in all of them, including contact with water and salt solutions, as in the ordinary processes of corrosion in water.

The oxide theory[3] of passivity apparently offers the best explanation, and even though no actual oxides are formed on the surface of the iron, an equivalent gain in valence or loss of electrons can be visualized by the oxidation hypothesis and suggests an interesting parallelism between passive iron and iron covered with mill scale and adherent rust. This parallelism may be stated as follows:

If all exposed pure iron surfaces in the crystallographic sense are uniformly covered by a layer of oxide either thin or thick, and if this film be tightly adhering, no corrosion takes place. A sub-microscopic film may be assumed to be produced over an iron surface by immersion in strong oxidizing agents such as chromic and nitric acids (the passive layer), a thicker and visible layer by an oxidizing flame (mill scale) and a more irregular and thicker layer during corrosion under

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[3]Dr. H. G. Byers does not accept the oxide theory of passivity, although he offers no substitute. Abstracts of his extensive investigations are found in *Chem. Abs.*, vol. 3, p. 274; vol. 4, p. 1933; vol. 6, p. 452; vol. 7, p. 318; vol. 7, p. 3268; vol. 8, p. 3738; vol. 10, p. 717. The original papers are as follows:

"The Passive State of Metals," *J. Am. Chem. Soc.*, vol. 30, pp. 1718-42.

"The Influence of the Magnetic Field on the Passive State of Iron," *J. Am. Chem. Soc.*, vol. 32, pp. 750-6.

"The Influence of the Magnetic Field on Passive Nickel and Iron," *J. Am. Chem. Soc.*, vol. 33, pp. 1757-61.

"Passivity of Iron under Boiler Conditions," *J. Am. Chem. Soc.*, vol. 34, pp. 1368-79.

"Relation Between the Magnetic Field and the Passive State of Iron," *J. Am. Chem. Soc.*, vol. 35, pp. 759-67.

"Passivity of Metals," *J. Am. Chem. Soc.*, vol. 36, pp. 2004-11.

"Anodic Relations of Passive Iron, With Notes on Polarization Potentials as Influenced by Gas Pressures," *J. Am. Chem. Soc.*, 38, pp. 862-74 (1916).

certain conditions (rust). All three types of oxide layers protect against corrosion. However, if portions of such surfaces are removed by either physical or chemical means, corrosion starts at once, the abraded or dissolved areas becoming electro-positive and the oxide areas electro-negative. In all cases corrosion is prevented or delayed until the film of oxides is lifted or removed. Iron surfaced in any of these ways may in a very large and general sense be considered passive as regards corrosion in substantially the same sense, namely, by the uniform action of oxygen on exposed ferrite areas. There may be some doubt about the exact condition of the surface in passive iron induced by treatment with oxidizing agents, one view holding that the surface is simply polarized, another that it holds condensed or occluded oxygen and another that a sub-microscopic layer of oxide has been formed, but there can be no difference of opinion about oxygen being the active agent. In the case of iron surfaces coated with magnetic oxide, the nature of the protection against corrosion is obviously both electrical and mechanical. When such a protective layer of magnetic oxide is lifted from the iron surface in places by a film of water or is removed from certain areas mechanically, the remainder acts as an accelerator of corrosion and deep pitting generally results. This is also true for adherent rust. It probably would hold for passive areas provided these could be maintained in place for considerable periods of time.

Ferroxyl Indicator on Polished and Etched Surfaces

If the entire surface of a clean piece of iron be moistened and if the surface be free from oil or grease so that the water spreads over it rather uniformly, certain irregular areas will be covered with rust and other areas will not—the rusting will not be uniform, although the rust areas in some cases are large patches and in other cases very small, in the form of specks or flakes of rust. If initial rusting were guided and determined by the composition of the iron, one might naturally expect that the rusted areas would bear a definite relationship, when examined under the microscope, to the crystallographic structure of the metal and that if the corrosion took place under carefully regulated conditions the ferrite areas would become anodes and produce rust spots corresponding to them in area and that various segregated impurities in the iron would become cathodes and would remain bare of rust in the initial rusting, or until colloidal ferric hydroxide, moving with the electrolytic currents of corrosion, deposited on them. Nothing of this sort can be observed under the microscope, however carefully the rusting process is conducted.

In order to ascertain whether in fact ferrite areas are by their nature anodes and areas of impurities cathodes, in the rusting process, use was made of the very sensitive indicator developed by Messrs. Cushman and Walker and named by them ferroxyl indicator. Samples of all of the irons used were polished on the wheel in the ordinary way and slightly etched by nitric acid in alcohol. After the etching the acid was removed by immersion in successive beakers containing absolute alcohol and ether. Different procedures were followed, some of the samples being dried after alcohol treatment and some after ether treatment. Duplicates were dried in the air and in hydrogen and various modified manipulations were made use of. Standard ferroxyl indicator in agar was dropped on the surfaces thus prepared and observations were made by means of a microscope of moderate power. The crystallographic structure of the metal could be readily seen and the development of the blue and red areas in the jelly could also be followed. If initial corrosion were determined by the composition of the metal, the red and blue areas should bear a definite relationship to the crystallographic structure of the metal and it would be natural to expect blue areas to form only over ferrite areas and red over impurities of various sorts. However, the red and blue areas in no case bore any definite relationship to the crystallographic structure. By no manipulation which was used could red and blue areas be made to coincide with crystallographic areas.

I do not wish to convey the impression that it would be impossible to refine the manipulation to such a degree that this correspondence might not be brought about, but in any of the manipulations adopted with any of the samples experimented on it did not occur. Mild alkaline solutions were tried for the neutralization of acids used in etching, the alkali afterward being removed by absolute alcohol and ether and the drying being conducted both in air and hydrogen. But in this series of experiments the results were like the previous ones in that there was no correspondence between crystallographic areas and anode and cathode areas as indicated by the ferroxyl reagent.

Oxygen Dominates in Initial Corrosion

All of the above experiments indicate what must have been thought by many experimenters on corrosion, that some influence dominates the composition of the metal in determining at what points or over what areas the initial corrosion may begin. This dominating influence in initial corrosion is undoubtedly oxygen. It may be oxygen which has been occluded or adsorbed by certain areas of the metal as opposed to other areas or it may be that some oxide or sub-oxide has been formed on certain areas in the form of an invisible film, but in any case the determining influence is oxygen, whether free or in combination or held to the surface by occlusion or adsorption. That it dominates over metal composition in the initial stages of corrosion can readily be demonstrated by the fact that the red areas produced by the ferroxyl indicator extend over comparatively large surfaces, considered from the standpoint of crystallography, including very many ferrite crystal surfaces in the case of a mild steel or pure open-hearth iron.

It might be argued that the preliminary treatment of the polished samples, such as the etching with an oxidizing acid, removal of the acid and the drying in air, superimpose such conditions on the iron surface that certain comparatively large areas, at any rate larger than the crystallographic units, become electro-negative under conditions favoring corrosion. It should be noted, however, that while all the samples were etched by means of nitric acid, some of them were dried in oxygen and others in hydrogen. Etching, itself, by means of acid, is a form of corrosion, and on the basis of the accepted theory presupposes polarity on the polished surface. The etched surface would not be visible under the microscope were not certain crystallographic areas attacked by the acid and certain other areas left unaffected. Etching then follows the crystallographic structure of the metal, as would be expected, and if polarity is induced by the etching process, one would naturally expect that this polarity would also be

definitely related to the crystallographic structure. We might assume that a given sample of polished iron or steel at the conclusion of the etching process would be in such condition that the subsequent corrosion under ordinary atmospheric conditions would be initiated in strict conformity with the crystallographic structure and the first corroded areas patterned after that structure. Whenever the corrosion takes place under atmospheric conditions or under water saturated with air, this is not the case. Hence again the conclusion seems warranted that some influence dominating over composition and structure of metal determines the initial course of corrosion.

Why the oxygen of the air influences considerable areas to become electro-negative is difficult to say. An ordinary iron surface is a very sensitive one as regards corrosion. The slightest film of iron oxide over pure iron makes such an area electro-negative. Areas which appear tarnished and exhibit thin-film color phenomena are electro-negative with reference to non-tarnished areas. The tarnish probably consists of an extremely thin film of iron oxide or, if the area has been in contact with acid, of an iron salt, probably a ferric salt. Everything indicates that the ordinary clean iron surface is exquisitely sensitive to numerous influences affecting corrosion, chief among which under ordinary circumstances are oxygen and the oxides of iron or rust.

The Rôle of Oxygen

The importance of oxygen in the corrosion of iron was pointed out by William H. Walker as early as 1907 and was emphasized by him and others subsequently. Walker is of the opinion that when oxygen acts in such a way as to further the process of corrosion it does so by its action on the hydrogen film which otherwise would bring the action to a close. That this action occurs and that it is catalyzed under certain conditions more than others cannot be doubted, but there is also the explanation that it may act simply and directly on the ferrous ions, changing them to ferric, and thus permitting more ferrous ions to enter the solution to restore equilibrium. At any rate, this would seem to be an explanation which accounts for the marked difference in behavior under corroding influences in the absence and presence of oxygen of such bivalent metals as aluminum and zinc as compared with iron and manganese, which are both capable of forming higher oxides and hydroxides. Air and oxygen do not accelerate the corrosion of aluminum in the presence of water to any appreciable extent. It might be argued that this is due simply to the fact that the aluminum surface does not catalyze the oxygen-hydrogen reaction as does the iron surface. Against this we have the much greater solution tension of aluminum compared with iron, one volt for aluminum as compared with 0.06 for ferrous iron. This explanation also has the advantage of agreeing with what actually and visibly occurs in corrosion experiments.

The Rôle of Rust

Perhaps the most definite statements concerning rust as an accelerator of corrosion come from Friend[4]. Friend observes, "When iron has once begun to rust in air, further corrosion proceeds rapidly, until the whole surface of the metal is oxidized, even although the temperature of the air is well above dewpoint, so that a piece of bright iron exposed in a similar manner would remain unaffected for an indefinite time." He rejects the suggestion of Kuhlmann[5] that rust acts as an oxygen carrier and thus catalytically assists further corrosion. He upholds the view held by Hutton, Grace Calvert, Wagner and Crum Brown to the effect that rust is decidedly hygroscopic and becomes charged with water in an atmosphere in which bright iron would not be affected.

Friend's experiments, however, to prove that rust does not act as an oxygen carrier may not be entirely conclusive. None of the experiments precisely corresponds to rusting in air and in water.

Friend points out that the action of rust when iron is corroding in air and submerged in water may be different. In the latter case it acts as an accelerator on account of its electro-negative character.

Mill Scale vs. Ferric Oxide as an Accelerator

Mill scale as a rule causes deeper pitting than rust, although ferric oxide, Fe_2O_3, on account of its higher degree of oxidation, should be more electro-negative than Fe_3O_4. The question naturally arises, therefore, Why does mill scale under ordinary circumstances act as a more powerful accelerator of corrosion? The answer is probably to be found in the different physical properties of the two substances as they usually occur. Ferric oxide is formed by dehydration of flocculent ferric hydroxide and is never as dense or as closely adherent as mill scale. The latter not only adheres closely but is very dense as usually formed by heat on the surface of iron and in addition is an excellent conductor. It is very difficult to obtain Fe_2O_3 of the same relative density and adhering to the surface in the same way as mill scale and it would be quite impossible to attain equal conductivity in the two substances.

Does "Busy Iron" Corrode?

Engineers are unanimous in the belief that iron or steel in active service does not tend to corrode to the extent that idle iron or steel does; that the steel rail which carries many trains daily will outlast the rail carrying no trains; that the used hammer or other tool rusts less than the unused. The universal testimony of all observers indicates that their belief is well founded.

It may well be questioned whether there is anything intrinsical in use itself as affecting the metal physically, chemically or electrically, which would modify its corrodibility. The observed results are most likely due to surface changes induced by effects of service and may be explained usually by one or more of the following consequences of continued use:

1. The polishing effect of hammering or rubbing which, like all polishing actions, produces a surface which resists corrosion.
2. The shaking or rubbing off of all but tightly adherent rust which in the end forms a protective layer.
3. The accidental coating of the surface of the used iron or steel with oil or oily substances during use, which also prevents corrosion.

Cushman has suggested that continued vibration of iron or steel has the effect of equalizing potential differences, and Friend believes that in the case of "busy rails" the passage of trains keeps them above the temperature of their surroundings and tends to prevent the condensation of moisture on their surfaces. Sang has suggested that "vibration causes a shedding of the rust as soon as it is formed on the spots that are not

[4]Corrosion of Iron and Steel, pp. 98-98, 252-253.

[5]Dammer, Handbuch der anorganischen Chemie, 1893, III, 303.

protected by mill scale, and there is, therefore, no acceleration of the action due to the accumulation of spongy and electro-negative rust." Sang's explanation of one of the effects of vibration is undoubtedly correct as far as it goes, and Friend's idea also is undoubtedly true, but none of these explanations goes to the bottom of the matter.

The used rail or old tool generally presents two surfaces: one, a polished surface, as the head of a hammer or the top of a rail, the other a dull surface covered with brownish, black closely adherent rust, as the sides of a hammer or rail. The polished surface is naturally resistant to corrosion and the tightly adherent rust protects the iron under it. That neither type of surface rusts easily is a matter of common observation. Where these two types of surface join, there is, however, the likelihood of corrosion starting whenever suitable conditions arise, as when the iron or steel becomes idle.

When a railway rail remains idle for several hours during a rain the bright upper surface invariably becomes covered with rust, but if trains are passing at frequent intervals the rust either is not formed at all or is quickly removed.

No more than a mere mention of oil on used iron is necessary. Casual reflection will indicate to anyone that the used tool or machine (or even the steel rail), when there is no intention of oiling it, is more likely to have oil dropped upon it accidentally than the unused.

Perhaps a more correct statement than the usual one of the case of "busy iron" would be to say that (in the absence of oil protection) busy iron is protected on certain surfaces by polishing action, but that on surfaces where it does corrode, it corrodes in a self-protective manner.

Analysis of High-Speed Steel

By H. O. Ward

THE following is an analytical method that fills a long-felt want in laboratories analyzing high-speed steel in quantity. The experimental work on the method was done in the laboratory of the National Twist Drill & Tool Co., Detroit, Mich., by the author, working in collaboration with J. G. Lahr, chief research chemist of the Studebaker Corporation of America. The original feature is the method for the solution of tungsten. The method is one for the determination of manganese, chromium and vanadium in high-speed steel, using a single sample and without filtering during the operation.

A 0.5-g. sample in a 600-c.c. beaker is dissolved with 50 c.c. of sulphuric acid-silver nitrate solution[1] by the application of heat. When solution is complete 5 c.c. of nitric-phosphoric solution[2] is added. (If the tungsten does not immediately disappear, boil until the solution assumes a clear green color.) The contents of the beaker are then diluted to 200 c.c. and about 1 g. of crystals of ammonium persulphate added in small successive portions. (This will oxidize, in order, the chromium, vanadium and manganese, the last appearing as permanganic acid, giving the solution a deep pink color.) The beaker is removed from the hot plate and cooled before titrating the manganese with standard sodium arsenite solution.[3]

[1]Sulphuric acid-silver nitrate solution. 3 l. sulphuric acid (conc.). 15 l. water distilled. 27 g. silver nitrate c.p. crystals.

[2]Nitric-phosphoric solution. 50 per cent nitric acid (conc.). 50 per cent phosphoric acid. U. S. P. syrup.

[3]Sodium arsenite solution. Stock solution: 4 g. arsenious oxide per liter. 16 g. sodium carbonate per liter. Solution for use: 100 c.c. stock solution. 900 c.c. water distilled.

The contents of the beaker are now diluted to 500 c.c. and heated to boiling. A few drops of hydrochloric acid are added to destroy the permanganate coloration and precipitate the silver nitrate. Continue the boiling for at least ten minutes to expel the excess of ammonium persulphate. Cool to room temperature.

The chromium is titrated by adding an excess of standard ferrous ammonium sulphate solution[4], running in standard potassium permanganate[5] to a pink color and, after stirring for thirty seconds, destroying the excess of permanganate with standard sodium arsenite solution.

The vanadium is determined immediately after the chromium by first adding 10 c.c. of standard ferrous ammonium sulphate solution, destroying the excess by adding 10 c.c. of ammonium persulphate solution,[6] and titrating with standard potassium permanganate (for vanadium) solution.[7] Here again an excess of permanganate is added and titrated back with standard sodium arsenite solution (so using the same arsenite solution for the manganese, chromium and vanadium titrations).

Calculations

Manganese. Number c.c. of sodium arsenite solution divided by 5 multiplied by 0.1 = per cent Mn.

Chromium. Number c.c. of ferrous ammonium sulphate solution less number c.c. of potassium permanganate solution multiplied by 0.1 = per cent Cr. Ferrous ammonium sulphate must be corrected to the permanganate value before the subtraction and the permanganate corrected for the amount destroyed by the arsenite solution. The arsenite is compared to the permanganate to find out how many c.c. of arsenite 1 c.c. of permanganate is equal to. Then the number c.c. of arsenite used in the titration is divided by this value and the result subtracted from the permanganate used.

Vanadium. Number c.c. of potassium permanganate solution used less the arsenite as in the case of chromium determination multiplied by 0.2 = per cent V.

When the nitric-phosphoric solution is added it not only oxidizes the iron, carbides and tungsten present but also dissolves the tungstic acid formed, the tungsten forming a phospho-tungstate much the same as molybdenum will do under similar conditions. This saves the process of filtering. However, a little tungstic acid remaining in the solution will do no harm. If the solution is dark colored and not a clear green when diluted the first time, you may be sure it was not boiling when the nitric-phosphoric solution was added. The slight opalescence due to the presence of silver chloride in the solution will not be a detriment but rather a help, as it more distinctly shows the delicate color changes found in the chromium and vanadium titrations.

The arsenite determinations are recommended by several authorities such as Lord and Scott. The addition of the arsenite titration here adds probably 50 per cent more speed to the titration proper.

National Twist Drill & Tool Co.,
Detroit, Mich.

[4]Ferrous ammonium sulphate solution. 11.1296 g. per liter c.p. crystals. 10 c.c. sulphuric acid (conc.). Standardize against permanganate.

[5]Potassium permanganate solution. 0.9117 g. c.p. crystals per liter. 0.02885 normal. 0.0580 g. sodium oxalate = 30 c.c. of solution.

[6]Potassium permanganate solution (for vanadium). 0.6200 g. c.p. crystals per liter. 0.01961 normal. 0.0402 g. sodium oxalate = 30 c.c. of solution.

[7]Ammonium persulphate solution. 125 g. per liter c.p. crystals.

Electric Smelting of Iron Ore With Coke*

BY GEORG STIG, MET. E.

ALTHOUGH pig iron must be considered as a raw material, its manufacture is nevertheless one of the most important processes in the iron and steel industry. In order to satisfy the enormous and steadily increasing demand and to attain the best economical results, it has been found necessary to produce it with coke in furnaces producing quantities as large as 700 tons per day. The change from charcoal to coke as a reducing agent required more than 100 years and took place under great difficulties and with great expenditures. It was found that a charcoal furnace was not suitable for coke, and consequently the design of the blast furnace as well as the mode of operation had to be changed considerably before a suitable coke blast furnace was obtained. What chiefly contributed to the solution of the problem, except the change of shape, size, etc., was the increase in the temperature and the pressure of the blast.

When comparing the ordinary method for producing pig iron with the electrothermic process certain analogies will naturally be found and it might be said that the temperature and pressure of the blast in the ordinary process corresponds to the current density and the load in electric furnaces. Consequently when smelting with coke, the best results, technically as well as economically, will be obtained with furnaces capable of utilizing a great amount of power.

POSSIBILITIES OF DEVELOPMENT

It may be advantageous to enumerate here the present types of furnaces, their possibilities of development and as a consequence of this, their suitability for operation with coke.[1] According to the principal characteristics of the designs they may be tabulated as follows:

1. With single shafts.
   Electrometal.
   Harmet, etc.
2. With several shafts.
   Keller.
   The California furnaces.
   Heroult-Haanel-Tinfos.
   Helfenstein-Kopparberg.

No results from operations on a large scale are obtainable from the Harmet and Keller types of furnaces, as they have been tried with loads of only 500-600 kw. The possibility of developing the Keller type is relatively limited and the same holds probably true also of the Harmet furnace, the roof of which will cause difficulties due to lack of cooling by gas circulation.

The California furnaces and the Helfenstein furnace (and its modification the Kopparberg furnace) are similar inasmuch as they are all polyphase furnaces with at least two shafts and have approximately the same possibilities of development. The size is limited only by the amount of energy the electrodes can carry and by the number of shafts, which, however, in very large furnaces will be so many as to make the operation uneconomical; the upper limit of capacity is probably 5,000 to 6,000 kw.

The Heroult-Haanel-Tinfos type is somewhat similar to the Helfenstein-Kopparberg furnace. The principal difference consists in its being a single-phase furnace with a bottom electrode. However, the voltage between the transformer busbars is only half of what it is on other types. Consequently, in order to obtain a great load, very high currents must be employed. To carry a higher current than 50,000 amp., however, is probably uneconomical, so that the maximum load is not more than 3,000 kw. It must also be borne in mind that the leads on furnaces with bottom electrodes can not be arranged so satisfactorily as on furnaces without bottom electrodes, with the result that a considerable loss of energy in the leads must be counted with when running with a high load.

The Electrometal type has without doubt the greatest possibility of development. The largest furnace built up to date for electric production of pig iron is of this type, i.e., the furnace at Domnarfvet for 7,200 kw. From the designer's point of view it is, however, possible to build furnaces for 12,000 to 15,000 kw. provided electrodes of high quality are available.

FACTORS FOR SUCCESSFUL OPERATION WITH COKE

I am giving below the results I have obtained from operating the above-mentioned furnaces with coke, but will in this connection first point out that all the difficulties with coke operation which were experienced at the trial runs with the Electrometal furnace in Trollhättan and Hardanger, viz., bridging of the charge, cold iron, burnt roofs, etc., even the abnormally high current (with its corresponding low voltage) have occurred and occur occasionally not only in coke furnaces but also in charcoal furnaces and with all other types of furnaces. I know an electric furnace built for and operated with charcoal which exhibited the same irregular and impossible runs, as for instance the Hardanger furnace before it was rebuilt. This happened as late as 1915. It is surprising that anybody can imagine that the process will be improved only by pointing out these difficulties and consider them insurmountable; the cause ought to be ascertained in the first place and then the possibility of avoiding them discussed.

It has been shown from actual operations that the following factors are of great importance in order to obtain good results and to avoid the difficulties mentioned above:

1. The rate of melting.
2. The dimensions of the furnace hearth.
3. The shape and height of the furnace.
4. Voltage, current, current density and arrangement of the leads.
5. The composition of the charge.
6. The gas circulation (at the Electrometal furnace).

INFLUENCE OF MELTING RATE

In order to obtain a quiet and even run the melting rate is without doubt the most important factor, especially as far as the lower limit is concerned. The upper limit is not of the same great importance with furnaces without gas circulation. With furnaces of the Electrometal type, however, the highest efficiency is obtained when the gases leave the furnace at somewhat over 100 deg. C., in other words when the volume of the shaft is designed so that the melting rate is not too great.

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*Translation from *Teknisk Ukeblad*, vol. 66, pp. 151-3, Jan. 24, 1919.

[1]The writer has had practical experience with electric smelting of iron with coke as well as charcoal with furnaces mentioned below at Domnarfvet from 1911, or in other words from the time when this process was beginning to be used on a large scale. The following furnaces were in operation during this time:

Electrometal—Five furnaces, three of 2,800 kw., 7,200 kw. and 5,000 kw. respectively; one Helfenstein modification, of 4,000 kw.; one Kopparberg modification, of 5,000 kw.

Heroult-Haanel-Tinfos—Three furnaces, of 500 kw., 1,000 kw. and 1,000 kw. respectively.

When the melting rate is too low, short circuits and bridging of the charge often occur, and in this connection cold iron occasionally. My explanation for the occurrence of these irregularities is based on observations of a run with coke in Electrometal furnace with too large a shaft. The charge consisted exclusively of specular hematite which due to the relatively low melting rate was exposed to the reducing action of the CO gases for a very long time. During this preliminary reduction the hematite was disintegrated, and the charge descended to the crucible in the form of fine ore and coarse coke. The fines descended faster with the result that the coke accumulated in a charge between the electrodes. Now, when making artificial graphite from coke, for instance in electric furnaces, a little iron oxide is often added which acts as a catalyzer, facilitating the graphite reaction. It is therefore only natural to suppose that in the above mentioned case graphite was formed and as no more oxidizing material was added to the mass of graphite, it began to form a short circuit between the electrodes. The greater part of the fine ore descended directly to the iron and slag bath and caused a boil. It is therefore evident that bridging of the charge and cold iron may be caused simultaneously by too slow melting.

Coke Tends to Graphitize

It has been proven by electric measurements on the Domnarfvet and Söderfors electric furnaces made by the Electric Testing Bureau in Stockholm, that the electric current passes from one electrode to the nearest one and not, as had been previously assumed, to the one connected in series in a polyphase circuit; and, furthermore, that the drop in potential takes place principally in the electric arc and not in the charge. In consequence of this, the conductivity of the charge is of minor importance, a fact which has been confirmed in practice when melting, for instance, cast-iron borings.

From what has been said above, it appears probable that the difficulties are not caused by the high conductivity of the coke, but by its tendency to be transformed to graphite. It should be possible to avoid this by designing the furnace so that the charge arrives at the electrodes correctly proportioned. The factors which determine this are the dimensions of the furnace hearth, which, again, determine the possibility of running with an even load by means of regulating voltage only, without adjusting the electrodes.

Necessity of Adjusting Electrodes

This latter circumstance is of especial importance when smelting charges of low iron content in furnaces with relatively small hearths. Probably on account of this it has been found necessary at Tinfos to resort to regulation of the electrodes, because the amount of slag and iron is so large that the iron must be tapped frequently or else the electrodes raised. An even load may, however, be maintained by regulating the transformer voltage when operating this type of furnace in case the iron content of the charge is kept at about 60 per cent. Regulation of the electrodes, however, always causes a great loss of the rich gas which is one of the great assets of this furnace. It is easily possible to keep 20 to 30 tons of iron in an Electrometal furnace without experiencing any difficulty in keeping the power within normal limits by means of regulating the voltage.

The voltage, the current and the current density must be in a certain relation to one another in order to obtain a heating area of correct size around each electrode. This fact may be visualized by comparing the electric current and its power of melting with the stream of water from a hose. The pressure of the water corresponds to the voltage and the volume of water per second to the current. Coke requires a higher temperature than charcoal to become active chemically, and this is obtained preferably with a high load, i.e., high current density.

Uniform Gas Circulation Essential

The distinguishing characteristic of the Electrometal furnace is the gas circulation, which, apart from the fact that it increases the reduction by the gases, distributes about one-third of the energy to the shaft. A more even temperature is thereby insured in the whole furnace, contrasting it favorably with other electric furnaces where the heat is unnecessarily concentrated around the electrodes. It is of the greatest importance that the gas circulation is adequately carried out, and for this reason the largest Electrometal furnaces are now provided with positive blowers, i.e., blowers delivering a constant volume, instead of fans with a constant pressure.

Data on a Run With Coke

The only basis for comparison of results from furnaces of different types is the efficiency in utilization of electric energy. An Electrometal furnace, for instance, showed while operating with charcoal, an efficiency of over 80 per cent, and when operating with coke for four weeks, an efficiency of about 67 per cent. It is to be noted that the furnace in question was not designed for operation with coke, but was changed in such a way as experience had proved to be desirable for running with coke. The other types—Helfenstein, its modification Kopparberg, and Heroult-Haanel-Tinfos—did not reach a higher efficiency than about 50 per cent with the identical charge. However, the first two types can not be said to have passed the experimental stage, and the last mentioned furnace was operated with a load of about 500 kw.

The principal data from the run with coke in the Electrometal furnace are:

Average load, kw.	2,632
Voltage, volts	60
Current, amp.	14,000
Average production per day, metric tons.	23

After smelting was well under way the run was particularly quiet and even, without bridging of the charge or difficulties with the gas circulation, which facts also become evident from the following log:

Date	No. of Charges per Day	Date	No. of Charges per Day
17	52	23	52
18	52	24	63
19	58	25	57
20	57	26	51
21	55	27	55
22	52	28	52

Mixture of Coke and Charcoal Satisfactory

In connection with the main trial run with coke alone, the furnace was successfully run previously as well as subsequently with a mixture of coke and charcoal. The experience obtained naturally resulted in ideas regarding the use of coke alone; moreover, the test was important from an economic point of view. The substitution of 50 per cent charcoal corresponds to a lowering of the cost of the reducing agent of about 25 per cent (at peace-time figures).

The above-mentioned runs have, however, demonstrated that the Electrometal furnace is suitable for operation with coke, and I am of the opinion that a correctly designed furnace of this type at present should give the best results economically.

It is also my opinion that in order to obtain good results economically with smelting with coke, only large furnaces should be employed.

Conclusion

I have made this contribution to the discussion about electric smelting with coke, because I think that certain considerations have been lost sight of, especially when judging the suitability of operating the Electrometal furnaces with coke. This type has been judged only from the negative results, which have been obtained in Trollhattan and Hardanger without considering the fact that the same difficulties which were experienced there also occurred when running with charcoal, and that these were overcome by suitable changes.

Swedish Wood Pulp Industry in 1919

The last two years of the war, 1917 and 1918, were very trying for the Swedish sulphite cellulose industry, as production had to be reduced considerably owing to the shortage of certain important materials and lack of customers. With the advent of peace the industry looked forward to at least a renewal of normal output if not an increase in business.

For the first half of 1919, however, this hope was not fulfilled, as tonnage was scarce and buyers were waiting for lower prices. This resulted in sulphite mills decreasing their production and running at only 64 per cent of normal capacity. By the end of the year, however, business had picked up somewhat.

	Production, Metric Tons	Normal Capacity, Approximate, Metric Tons	Per Cent
1913	699,937	700,000	100
1914	714,747	750,000	95
1915	742,000	760,000	97
1916	771,302	790,000	98
1917	554,966	825,000	67
1918	476,307	850,000	56
1919	581,167	850,000	69

The above figures show that in 1919 production was larger than in either of the two preceding years but still represented only about 69 per cent of the full capacity of the mills.

Paper Market Disorganized During the War

During the last year of the war the paper market was disorganized both in Scandinavia and Canada. Paper, particularly in England and France, was offered freely in the first half of 1919 at prices so low that with the prevailing prices for cellulose the paper manufacturers in the countries named found it impossible to manufacture the corresponding sorts of paper at prices that would even approximate those at which the foreign paper was offered. Under such conditions it was not surprising that a restriction of imports was planned by the respective governments and that the impression grew abroad that Swedish quotations were unreasonably high.

Situation Explained to England and France

Because of the conditions, the Cellulose Association sent two of its representatives to England and France to explain the situation to the authorities as well as the customers, and point out the causes of the high cost of production and the difficulties under which the Swedish cellulose industry labored. The results of the work of this committee were apparently fruitful, as no measures were taken to regulate or ration the imports of pulp, although a proposal to such an end had already been formulated by the Allied Commission at a meeting in London. On the other hand, both England and France continued government control of the imports of paper in order to protect the domestic paper industry and enable it to resume operations on a large scale.

Supply of Paper Short and Demand Large

The summer brought a change in the paper market. The British paper manufacturers had obtained large orders under the protection of the restricted imports of paper, and had all their paper machines working again, and an increasing activity and a livelier demand were noticeable in the paper market of other countries also. By the end of the year it became evident that there was an acute shortage of paper and a veritable scramble for paper resulted.

During the latter half of 1919 the sulphite market developed along about the same lines as the paper market. In July the British paper manufacturers began to purchase paper pulp on a large scale and the sales increased until the end of the year. It was only during the end of the last month of the year that the paper manufacturers on the Continent commenced buying. They had been holding back in the hope that the promised shipments of Canadian pulp would ease the sulphite market in Europe. In the meantime it became evident that Canada could not deliver quantities of any importance, as the paper industry of the United States alone was able to absorb the entire Canadian surplus, and the Continental manufacturers then made haste to obtain supplies in Scandinavia. The rush of orders commencing in November, 1919, continued well into the first months of 1920, resulting in sharp increase in prices.

Factors Controlling Crude Oil Prices

A report on the causes of the advance in prices of gasoline, kerosene, fuel oil and other refined petroleum products, issued by the Federal Trade Commission June 1, states that the high price is due not because of a combination in restraint of trade, but to the varying conditions of supply and demand. The enormous demand for crude oil, the decline in stocks, the increased consumption of motor fuel by the ever-growing automobile industry, the increased cost of materials, labor and drilling, together with exportation to foreign countries and lack of transportation facilities in this country, have all been factors in the cost.

To conserve our supply of petroleum, which, although at present slightly on the increase, is estimated by geologists and oil experts as none too plentiful for our own growing needs, the Commission made the following recommendations to Congress:

1. Assurance of enough crude oil for home consumption in preference to exportation for foreign needs.
2. Further study in the wasteful methods of drilling and elimination by state legislation or otherwise of uneconomic methods of production.
3. A more extensive study in the possible utilization of shale oil.
4. Investigation regarding industrial and commercial conditions in the oil trade.

Legal Notes

By Wellington Gustin

Agreement With Promoters Not the Contract of the Corporation Subsequently Organized

The Circuit Court of Appeals, Fifth District, has affirmed judgment of the U. S. District Court for the Northern District of Georgia in the suit of George Beveridge against the Crawford Cotton Mills and others. This case involves the organization and promotion of the mills, and presents a lesson to organizers.

Beveridge alleged there was an agreement between himself and the co-defendants Ingle and Comer, for the formation of a corporation to take over and operate a cotton mill owned by Ingle, and likewise a mill on which Comer had an option. In pursuance of such alleged agreement the Crawford Cotton Mills was organized. Plaintiff claimed to be an expert in the handling and weaving of textile fabrics, and that, with certain other associates, he had in operation at Cedartown, Ga., a dyeing and finishing plant, and likewise a mill for the manufacture of duck; that, being desirous of forming a connection with other duck mills to supply material for his dyeing and finishing plant, he entered into an agreement with Ingle to form a corporation to take over the White City Manufacturing Co. plant, owned by the latter.

Details of the Agreement

This agreement, it is charged, was superseded by a new agreement, entered into with both Ingle and Comer, who held an option on two other mills, known as the Edwards mill and Edwards power plant. Under this agreement the Edwards properties were to be purchased for $135,000 by the proposed corporation and such properties, together with the White City Manufacturing plant, to be acquired from Ingle for $40,000, were to be bonded for $145,000, out of which the price of the Edwards properties was to be paid, less $20,000 cash to be advanced by Ingle and Comer. There was to be borrowed from a selling agent $35,000 for operation. An expert engineer was employed, and he appraised the three properties at $242,568.20.

Corporation to Be Formed

It was alleged that it was agreed to form a corporation, to be known as the Crawford Cotton Mills, with a capital stock of $250,000, $100,000 to be preferred stock and $150,000 common stock; Ingle and Comer should receive preferred stock for the $20,000 cash advanced by them, and that Ingle should receive $40,000 of preferred stock for the White City plant and machinery and all merchandise and products on hand; that the common stock should be issued one-third to each of the parties, and they in turn should then transfer back to the company, to be held as treasury stock, all but $45,000 of the common stock, each retaining $15,000 of common stock, for which each should execute his note to the corporation; that Beveridge should be president, Ingle vice president, and Comer manager, each at a salary of $10,000, out of which salaries their notes were to be paid at the rate of $5,000 a year.

The contemplated corporation was formed, it is alleged, but the stock was not issued as per agreement; on the contrary, Ingle and Comer demanded that Beveridge pay at once $15,000 in cash for his stock, which he refused to do, but for which amount he offered to execute his note as agreed previously. He further alleges that he was then presented with a subscription blank to be signed, subscribing for 150 shares of preferred stock, at $15,000, and 500 shares of common stock at $50,000, payment to be made on the call of the board of directors; that, being satisfied that this was a scheme to freeze him out, and that Ingle and Comer, constituting a majority of the board, would at once call upon him for the full amount of $65,000, he declined to sign the subscription blank, stating that he was willing to subscribe for the stock on the conditions and terms which had been previously agreed upon, whereupon the stock in full was subscribed by Ingle and Comer and another, O'Neal.

Frozen Out, Says Plaintiff

It appears that the White City Manufacturing plant and the Edwards properties were all taken over by the corporation and bonds were issued as originally contemplated. Beveridge claimed that the corporation refused to let him have anything to do with its management and refused to pay him the salary as president agreed upon between the promoters. Beveridge alleged that his damages would amount to $50,000, or other large sum, and prayed the court that Comer and Ingle be required to specifically perform the contract entered into, and that he be decreed the owner of 150 shares of the common stock upon payment of his note for the amount, and that he be declared the president of the corporation from the date of its organization at a salary of $10,000 a year; that Ingle and Comer be decreed owners of such stock only as may have been subscribed and paid for by them, and that he have judgment against them for $50,000 damages.

In an amendment to his petition for relief, Beveridge averred that he had made a trip to Philadelphia and New York, pursuant to the alleged agreement, and there secured the services of a competent selling agent, who advanced to the company $35,000.

No Relief, Declares Court

The Court of Appeals affirmed the lower court, holding that even if plaintiff had a valid contract, his remedy was not for specific performance, but was an action in damages for its breach. It said there was no ground for equitable relief in plaintiff's claims, and further that there was a misjoinder of parties and causes of action. The court had neither authority to decree Beveridge owner of 150 shares of the company's stock, nor to declare him president of the corporation. He had no contract whatever with the Crawford Cotton Mills, and the alleged agreement was between him and the promoters of the corporation prior to its organization. The only claim he could have against the corporation, which is a distinct legal entity or individual from its promoters, is one for services rendered to it in the purchase of looms and in acquiring the sales agent, said the court.

Whatever remedy plaintiff had under his alleged agreement, if any, was at law for breach of contract, and his rights at law appear too vague and indefinite to sustain a recovery.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, June 7, 1920.

THE advent of the holiday season is having the usual effect upon the chemical industry and the past month has been distinctly quiet, though the general position is considered to be very satisfactory. The somewhat sensational reductions in the prices of metals, cotton and wool, together with the tail end of the wave of labor unrest, have had a temporary depressing effect, but the strong latent demand for most technical chemicals had a stabilizing influence on prices, which remain practically unchanged. Quicksilver has been a notable exception, certain stocks having been thrown on the market at a considerable sacrifice.

A REPRESENTATIVE MERCHANTS' ASSOCIATION

Under the name of the British Chemical and Dyestuffs Trades Association, the new organization foreshadowed in these columns* has now been formed and has met with a somewhat mixed reception owing to the attitude of studied aloofness which it has taken toward the original and less influential British Chemical Trade Association. The latter was originally formed by a number of the smaller firms together with two of the larger East India merchants, partly for patriotic reasons and partly, it is thought, for self-protection in regard to government restrictions and a large number of pending arbitration cases. The American Chamber of Commerce gave its support at a later date and there is no question that the association carried out valuable work at a critical time. The threatened existence of two rival associations is universally deplored and it is to be hoped that fusion will ultimately take place and that steps will be taken to arrange for friendly co-operation with similar institutions in the United States and elsewhere.

CHEMISTS INAUGURATE MASONIC LODGE

The consecration of what is believed to be the first lodge composed of analytical and manufacturing chemists took place recently at the Freemasons' Hall, its title being Radium Lodge No. 4031. The leading spirits in its formation were A. Gordon Graig, N. J. Bluman and Prof. W. R. Hodgkinson, C.B.E., formerly of the Royal Academy, Woolwich. The latter was appointed secretary.

COMMERCIAL DEVELOPMENTS

Anglo Spanish Tartar Refineries, Ltd., has been formed with a capital of about $600,000 to develop the tartaric acid industry in Spain. Formed under the auspices of the Phoenix Chemical Co., which has successfully met part of the demand in this country, a new source of supply will presumably be available to meet next year's threatened shortage. In the nitrate field, the details of the Brunner Mond-Explosives Trades acquisition have now been announced. The capital of Synthetic Ammonia & Nitrates, Ltd., is about $20,000,000, or twice that of Atmospheric Nitrogen & Ammonia Products, Ltd. (Claude process), referred to in my last article. The projected output of the Billingham factory is 100 tons of ammonia per day, capable of rapid expansion to 300 tons per day. Interesting features are the safeguards against interference by the owners of the Haber patents—by means of compulsory licenses on a royalty basis—and for the maintenance of the company under British control. Explosives Trades, Ltd., is to erect the necessary plant for the oxidation of part of the company's ammonia to nitric acid for explosives manufacture and to the extent desired by the British Government. In view of the present great shortage of sulphate of ammonia, particularly for export account, these new developments of the synthetic process should be of far-reaching importance in stabilizing food supplies and incidentally in absorbing the surplus sulphuric acid production rendered available by the erection of war-time plants.

A British patent of considerable interest to the American chemical industry is that of Rossi, just published, No. 130,963, covering the extraction of potash compounds from leucites or feldspars, with simultaneous production of nitrogenous fertilizers. Rossi has found that the ordinary method of manufacturing cyanamide can be adapted to the treatment of potash-bearing rocks, the mixture of the finely ground rock with calcium carbide being heated in a stream of nitrogen in exactly the same way as in the cyanamide process, the heat of reaction being sufficient to enable considerable additions of potash-bearing rock, lime and carbon to be added to the raw mix. The potassium compounds may be either volatilized or left behind with the resulting complex nitrides to give compound fertilizers, and it is stated that the nitrogenous fertilizers are readily assimilable by the crops.

THE "POPE" OF THE BRITISH CHEMICAL INDUSTRY

The appointment of Sir William Pope to the presidency of the Society of Chemical Industry has been universally approved and the delay in making an announcement is comprehensible in view of the great responsibility attaching to the post at the present time. Sir William Pope is an ardent exponent of co-operation and federation among learned and scientific societies and has done valuable work during the war in regard to mustard gas and also in connection with various commercial developments. The Society of Chemical Industry had intended to hold its annual meeting next year in Canada, thus bringing before the whole body of its members the great developments in the chemical industrial field which have taken place during the war and since the armistice both in the United States and in the British Empire. Unfortunately it seems certain that this visit will have to be postponed and the appointment as president of the society of a man like Prof. R. F. Ruttan cannot materialize as yet. The reasons for this change in program are primarily financial, the society, in common with many other institutions of this kind, being faced with enormously enhanced charges for printing, salaries, etc., which are not adequately met by increased advertising revenue. A drastic increase in the subscription rates is probable and in the meanwhile the venue of the annual meeting next year will probably be in this country with a view to consolidating "the home front." Apart from his distinguished academic career, Sir William Pope is an ardent supporter of the new Chemical Industry Club. It may be apposite to mention here that members of the New York Chemists' Club visiting this country are *ipso facto* entitled to the privileges of membership of the Chemical Industry Club by notifying the secretary at 2, Whitehall Court, London S. W. 1. The shortage of hotel accommodation threatens to be very serious in London and American visitors should not overlook the residential facilities offered by this club.

*See CHEM. & MET. ENG., May 5, 1920, p. 828.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Alkali Cyanides.—In a process in which an alkali cyanide is made from nitrogen, alkali-metal compound and carbon, and the cyanide is then converted into ammonia and alkali carbonate, which is used again, the alkali carbonate, before being used again, is purified from silica, alumina, etc., by treating with carbonic acid or other acid containing no element other than carbon, hydrogen, oxygen and nitrogen, or with lime. (Br. Pat. 136,772—1919. C. T. THORSELL and H. L. R. LUNDREW, Gothenburg, Sweden, Feb. 11, 1920.)

Obtaining Textile Fibers.—Woody vegetable material, such as the stalks and other parts of plants having a hard bast, such as the rind of ramie, trees, etc., is treated successively with two liquids which tend to react within the material, generating gas. A 20 to 40 per cent alkali solution, boiling or not, may be used, and subsequently a saturated solution of an ammonium salt, such as the chloride, the material being boiled therein until the ammonia gas is completely discharged. The material is finally washed with water, which may be boiling, and dried. Ammonia gas generated within the fibers tends to split away the woody material, laying bare the fibers. (Br. Pat. 136,804—1919. M. HOFSTE, Amsterdam, Holland, Feb. 11, 1920.)

Treating Slag.—Water, with or without steam or other gases, is poured or forced into or upon molten slag so as to form a foam sufficiently liquid to be poured into molds, in which it is cooled so as to form porous bricks or insulating material. The product may be crushed or used as a filling for walls and the like. In an example, slag is heated in an electric furnace to a temperature of 1,400 deg. C. and poured in a continuous stream into a container lined with refractory material through an inlet formed in the lower part of the container. Above this inlet, one or more tuyeres are provided through which water is admitted, preferably under pressure, when the slag is on a level with or above the tuyeres. The water is added in a continuous stream, and is intimately mixed by means of a rotary stirrer mounted in the container, the stirrer being so constructed as to prevent an accumulation of solid slag on the tuyeres. The supply of water is regulated so that the temperature of the foam will be about 1,000 deg. C. At this temperature it is liquid and may be led through an overflow into molds. (Br. Pat. 136,818—1919. NORSKE AKTIESELSKALE FOR ELEKTROKEMISK INDUSTRI; Cristiania, Feb. 11, 1920.)

Alkali Valerates.—In the preparation of potassium valerate by the interaction of amyl alcohol with caustic potash according to the equation



$$C_4H_9CH_2OH + KOH = C_4H_9COOK + 4H,$$

the reaction is carried out in autoclave under such a pressure as will keep the amyl alcohol, which is employed in excess, in the liquid condition at the reaction temperature, a regulating device being provided for the escape of the hydrogen. Caustic soda may replace the caustic potash. In the example, a mixture of amyl alcohol is heated to a temperature of 235 to 240 deg. C. under a pressure of 18 atmospheres. (Br. Pat. 137,064—1919. SOC. DARRASSE FRÈRES ET CIE, Vincennes, Seine, France, Feb. 25, 1920.)

Ferro-Tungsten-Chromium Alloys—Ferro-tungsten-chromium alloys for use in high-speed steels are obtained from an aluminothermic mixture containing oxides or other compounds of tungsten and chromium in chemical combination with one another, or with compounds of another metal required in the alloy. Chromic di-tungstate for use in the process is prepared from a solution of sodium tungstate with chromium sulphate in the presence of soda ash. Additional tungsten required to increase the percentage in the alloy may be precipitated from the solution as ferrous tungstate, or it may be free from combination with another metal. The carbon may be added as carbide, or steel scrap, and the balance of the iron as forge scale. The high-speed steel may be produced in one operation, or the ferro-tungsten-chromium alloy may be separately produced and afterward added to the steel. (Br. Pat. 137,080—1919. H. L. SULMAN and W. B. BALLANTINE, London, Feb. 25, 1920.)

Preserving Yeast.—In order to preserve live yeast for use in the manufacture of fertilizers or cattle foods or for other purposes, without heating, desiccating or adding inorganic chemical compounds, it is mixed with peat or powdered peat moss or tanner's bark, wood fiber or fine sawdust, and vegetable charcoal, and the whole pressed. (Br. Pat. 137,131—1919. J. R. ROBINSON, Stockton-on-Tees, Durham, Feb. 25, 1920.)

Patassium Sulphate, etc.—Finely ground potassium bisulphate and potassium chloride are mixed intimately in theoretical proportions or with a small excess of bisulphate and heated to 300 to 350 deg. C., concentrated hydrochloric acid free from sulphuric acid, and potassium sulphate almost free from chloride being obtained. When a small excess of bisulphate is used, pure sulphate may be obtained, but some sulphuric acid is expelled and is condensed. For this modification, a second heating to 700 deg. C. is employed and the two operations may be effected in a salt cake furnace. The reagents may be treated with a little water, for instance by spraying, before the reaction, but the quantity should be such that the mass remains pulverulent. (Br. Pat. 137,296—1919. FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE, Thann, France, March 8. 1920.)

Acetic Anhydride.—Acetic anhydride is prepared by heating an intimate mixture of an acetate, such as sodium acetate, with a pyrosulphate, such as sodium pyrosulphate, preferably in the presence of a diluent, such as acetic anhydride or glacial acetic acid. The acetic anhydride is distilled off as formed. The sodium pyrosulphate used may be prepared by heating sodium bisulphate. (Br. Pat. 136,574—1919. H. DREYFUS, London, Feb. 11, 1920.)

Phthalic Anhydride.—Phthalic anhydride is produced by the treatment of nitronaphthalene with sulphuric acid, not necessarily the concentrated or fuming acid, in the presence of a metal such as iron or zinc commonly used for the reduction of nitro compounds. (Br. Pat. 140,051—1919. H. SASA, Tokyo, May 5, 1920.)

Synthetic Tanning Agents.—Synthetic tanning agents are prepared by condensing aromatic sulphochlorides with the alkali-soluble fractions of anthracene oil or soft pitch, and sulphonating the condensation products so obtained. According to an example, anthracene oil or a soft pitch distillate is extracted with dilute caustic soda lye, the extract is purified and condensed with toluene sulphochloride in benzene solution, the product is sulphonated with sulphuric acid monohydrate, and the sulphonic acid converted into its sodium salt. (Br. Pat. 137,323—1919. M. MELAMID, Breslau, Germany, March 3, 1920.)

Casting Aluminum and Its Alloys.—Metal molds for using in casting aluminum and its alloys are coated with a thin layer of aluminum preferably applied by painting or spraying with aluminum bronze, the mold being afterward slowly heated to 400 deg. C. to remove all traces of the medium. Prior to pouring, the mold is heated to from 550 to 700 deg. C. Cover may be similarly coated. (Br. Pat. 137,325—1919. METAL INDUSTRIE SCHIELE & BRUCHSALER, Hornberg, Baden, Germany, March 3, 1920.)

Production of Hydrogen.—In the production of hydrogen by passing gases containing carbon monoxide with steam over a catalyst and removing the carbon dioxide with lime, a series of alternate catalytic chambers and lime chambers is employed, the pipe connections and the absorption chambers being heat insulated, so that the process is effected without loss of temperature. Pressure may be employed. The gases may be passed through a heat exchanger at the beginning and at the end of the apparatus. (Br. Pat. 137,340—1919. H. E. F. ADAMS AND H. C. GREENWOOD, London, March 3, 1920.)

Extracting and Purifying Oils.—Oils, particularly cod-liver and other fish oils, are extracted and purified by water below 100 deg. C. in presence of a current of inactive gas, such as hydrogen, carbon dioxide, nitrogen, water vapor, or a mixture of these. The oil or material is boiled at about 75 deg. C. with water in a jacketed pan connected to a vacuum pump, so that the current of water vapor is produced within the charge; low temperature steam, mixed or not with inert gas, may be injected. The water used may be fresh, salt, acid or alkaline. (Br. Pat. 137,514—1919. P. M. HAYERDAHL, Bygdo, Norway, March 10, 1920.)

Recovering Volatile Solvents.—The vapors of volatile solvents are recovered from air with which they are merged, by absorption in "active" charcoal such as that used in respirators. The charcoal is afterward heated to drive off the solvent, and the vapors are led to a condenser. Duplicate absorption chambers are used to provide for continuous operation. (Br. Pat. 137,615—1919. L. A. LEVY, London, March 3, 1920.)

Treating Ores.—Iron sand or other fine ore is briquetted to facilitate subsequent smelting, by mixing it with bituminous matter and coking the mixture in shallow open trays divided into compartments of the size and shape of the required briquets. A weight is placed on top of each compartment, or a weight may be used which affects all the compartments simultaneously; or a power press may be applied to the material before or after the distillation is completed. Lime, salt, manganese, etc., may be mixed with the material before briquetting. (Br. Pat. 137,626—1919. H. G. HILLS and E. WHEELER, Cheshire, March 10, 1920.)

Acetic Anhydride.—In the manufacture of acetic anhydride by interaction between anhydrous sodium acetate and phosgene, acetic anhydride is employed as the medium into which the reacting bodies are simultaneously introduced. The sodium acetate is kept in slight excess, and the mixture is well cooled and agitated. When the reaction is complete, a portion of the reacting mixture is withdrawn and its acetic anhydride content removed by distillation in vacuo. The remainder of the reacting mixture is used to treat further quantities of sodium acetate and phosgene. (Br. Pat. 137,701—1919. E. P. LEACH and UNITED ALKALI Co., Liverpool, March 17, 1920.)

Cellulose.—In a process for the production of hemicellulose from highly lignified plants such as wood, and of cellulose or textile fibers that can be spun from slightly lignified plants, such as jute, manila, hemp, reed grass, typha, nettles, the materials are heated under pressure in a lye containing alkaline sulphite, and sulphides with or without easily decomposable alkalis, such as sodium carbonate or soaps of alkaline metals. (Br. Pat. 137,831—1919. C. A. BRAUN, Munich, Germany, Mar. 17, 1920.)

Purifying Sugar Juices.—In purifying thick beet and cane juices by means of sulphurous acid and lime, the thick juices are first treated to effect a separation of sugar by crystallization, and to obtain a sirup which contains more impurities and in which therefore the sulphurous acid has less tendency to produce inversion. Sulphurous acid may be passed into the sirup until it is acid. (Br. Pat. 137,849—1919. M. VON WIERNSZ-KOWALSKI, Leipzig, Germany, March 24, 1920.)

Phenol-Aldehyde Condensation Products. — Insoluble infusible products are obtained by the action of "pectinizing agents" upon phenol-aldehyde condensation products. According to examples, phenol is condensed with formaldehyde in the presence of slaked lime or sodium cyanide; baryta and strontia are also specified as suitable agents. The agent may be added in portions at the several stages of the condensation. The products may be used in the manufacture of varnishes, lacquers, paints, agglutinants, plastic materials, etc. (Br. Pat. 138,061—1919. L. JALOUSTRE, Z. KHEIFETZ and M. WARCHAWSKY, Paris, March 24, 1920.)

Cellulose Esters.—In the manufacture of solutions, varnishes and plastic masses from cellulose esters, for instance nitrocellulose, acetylcelluloses and nitro-acetylcellulose, the ester is dissolved or gelatinized by furfurol or a homologue or derivative thereof. The furfurol may be used alone or in conjunction with other solvents or diluents and softening or modifying agents may be added. In examples, plastic masses are obtained by kneading together acetylcellulose and alcohol; and a solution, by dissolving in furfurol, acetylcellulose soluble in tetrachlormethane, and diluting the solution, if desired, with alcohol, benzene, or even water. (Br. Pat. 138,078—1919. G. BONWITT, Berlin, March 24, 1920.)

Carbazol.—In the isolation of carbazol from mixtures containing it by conversion into alkali carbazol, hydroxide of the alkali metal is added in the presence of a neutral solvent and at a temperature below the melting point of the alkali carbazol. Naphthalene is an example of a solvent which can be used at ordinary pressure; solvents of lower boiling point, such as toluene, may be employed under pressure. (Br. Pat. 139,981. BURT, BOULTON & HAYWOOD and F. D. MILES, London, May 5, 1920.)

Current Events in the Chemical and Metallurgical Industries

Activities of the Manufacturing Chemists Association

At the recent annual meeting of the Manufacturing Chemists Association held in New York City, on June 9, Henry Howard, Chairman of the Executive Committee, submitted the report of his committee for the year.

The work of this committee during the last year has largely been connected with the chemical problems arising out of the war and the termination of hostilities, particularly the work of the Chemical Foundation, and reports on various bills.

Chemical Foundation Advisory Committee

The Executive Committee feeling that the work of the Foundation would be greatly aided by the co-operation on the part of chemical and other manufacturers offered their services to help bring this condition about, and suggested that this co-operation could best be obtained by the formation of an advisory committee.

Acting upon this advice the Chemical Foundation called a meeting of its stockholders, organized them into sections according to industries, each section choosing its committee, and this committee choosing its chairman. The chairman of the various section committees formed the advisory committee and met regularly once a month in the office of the Foundation. The committee considered the most important matter accomplished so far by the Chemical Foundation was the principal adopted that there will be no limitation as to who shall be given licenses under patents provided the licensees are bona-fide American concerns, and that the patents will be worked by them in good faith and not taken out for stock jobbing purposes.

In order to secure the widest distribution possible of stock holdings in the Foundation the holdings were distributed among 160 American manufacturers, and an effort is being made to increase this number, so that each stockholder will not hold over a thousand dollars worth of stock.

Of the various bills pertaining to the chemical industry introduced into Congress since the signing of the Armistice, the Committee considered the Longworth bill (H. R. 8078) by far the most important. This bill contained provisions for licensing the importation of dyestuffs in order to protect the dye industry in America from foreign competition, and the executive committee took active part in urging its passage. Representatives of the Association appeared before the Senate Finance Committee and presented oral arguments in favor of the bill. In addition a brief was prepared by a sub-committee, under the direction of the executive committee and submitted to the State Finance Committee.

The bill is still pending and with earnest effort it should be possible to have it advanced for consideration in the Senate in the next session of Congress. It is the general belief that a majority of the Senate are not unfavorable to the. bill.

The pyrites tariff bill (H. R. 5215) provided for a duty on the importation of pyrites and other crude iron sulphide minerals of 15c. per unit of sulphur content or a duty of more than 100 per cent. The committee felt that the passage of this law would be highly injurious to the chemical industry of this country and fought against it with a result that it now seems certain that the bill will not be brought up for action.

Patent Office Bill

The passage of the bill to increase the salaries of the personnel of the Patent Office was at first urged, until at the last moment a rider was tacked on incorporating the whole of another bill (S. 3223) which was opposed by the committee. At first sight, the bill had for its apparent object the rewarding of government employees who made inventions, but the proposed legislation actually provided that the Trade Commission might acquire and develop inventions, not only of Government employees, but of other individuals or agencies, which meant that the Commission could receive patents from any or all inventors throughout the United States. Having received the patents from any source, it could collect fees and royalties for licenses in such amounts and in such manner as the President should direct.

Through the National Industrial Conference Board the executive committee brought this matter before the manufacturing interests of this country with the result that the objectionable bill was amended and its enactment held up for this session.

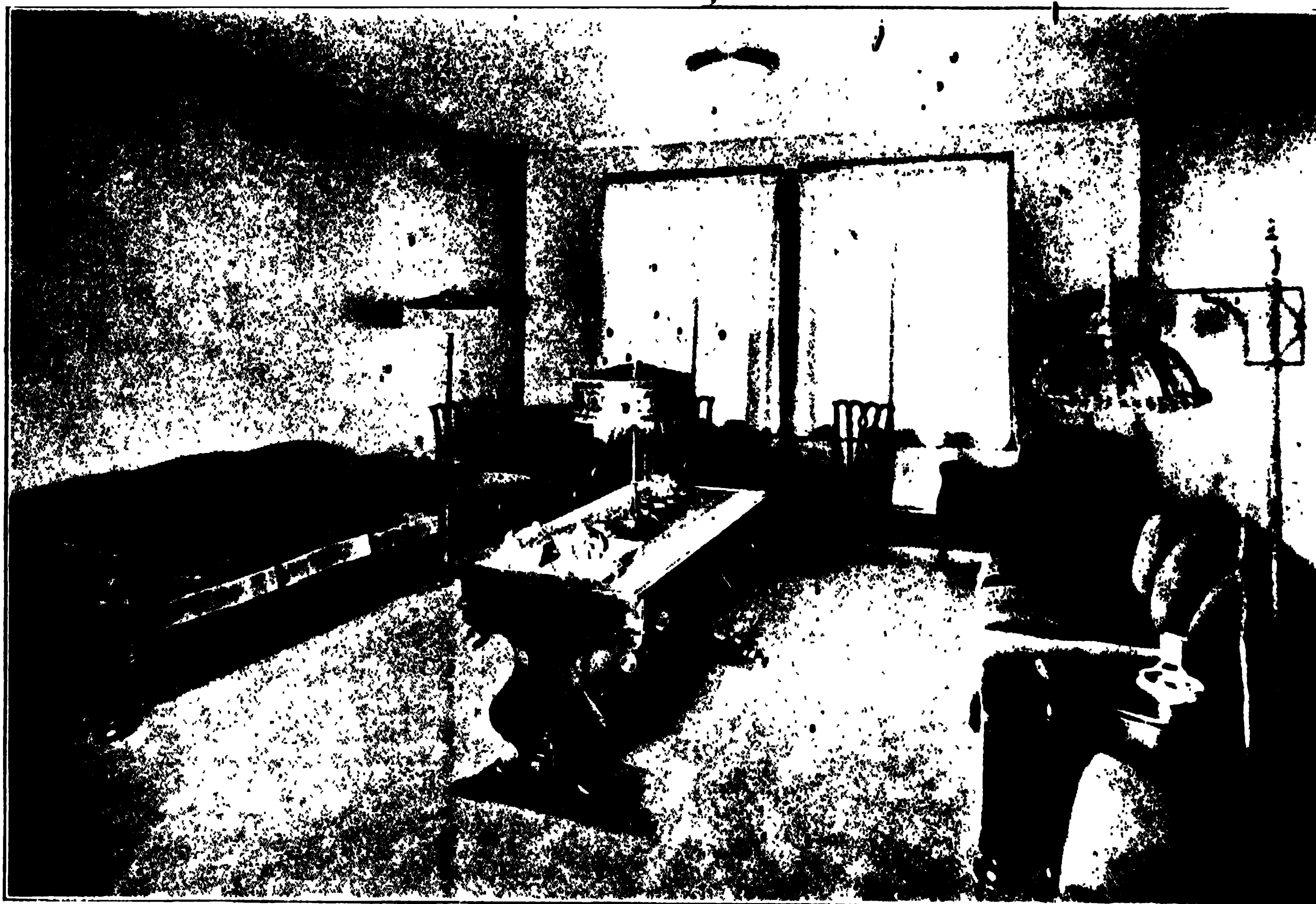
Other Activities

In addition to the above the committee has had prepared by counsel an analysis of the Peace Treaty, to bring out its effects on chemical industry. It has also prepared a statistical report on foreign trade, and kept in touch, through its membership in the National Foreign Trade Council, with trade conditions in European and other foreign countries.

The Association was represented in the International Trade Conference which was held October, 1919, at Atlantic City, by several members of the American Committee, which conferred with chemical representatives from France and Italy. The one tangible result of this conference was the decision to form an International Chamber of Commerce. The organization meeting has been called in Paris during the latter part of this month and C. Wilbur Miller of the Davison Chemical Co. will attend as a delegate.

And last but not least the committee has taken up with the Bureau of Explosives such matters as standard tests for carboys, welded drums, carboy neck protectors, new types of carboy stoppers, transportation of niter cake, hydrofluoric acid and mixed acids.

The Washington office is maintained jointly by the Manufacturing Chemists Association, the National Fertilizer Association, and the Chemical Alliance, Inc. This office has turned out to be an especially valuable adjunct to the Association.



THE CHICAGO CHEMISTS' CLUB LOUNGE

Chicago Chemists' Quarters Completed

The house warming and first "ladies night" held on the occasion of the opening of the newly-furnished lounge in the Chicago Chemists' quarters at 315 Plymouth Court on the evening of June 23 was a complete social success. Seldom are such gatherings effected and the program carried out with just the proper note of informality without loss of dignity as was manifest at this function.

Nearly one hundred members with ladies enjoyed an informal dinner and songfest in the main dining-room. After dinner the guests were introduced to the lounge, where President William Hoskins, Dr. W. Lee Lewis and Frank M. DeBeers with their ladies formed the receiving line. An excellent musical program followed by dancing completed the evening. The accompanying photograph will give some evidence of the quiet tone of refinement in this new home for Chicago Chemists.

The organization is founded for purely social purposes with a personnel composed of leaders in chemical science and industry of the Chicago district. While the success of any such body is assured through the high character of the individual members, the outward manifestation is found in the quarters they establish, just as we judge a man by the interior of his home. The atmosphere of this place cannot fail to impress the future visitor with the genial nature of the Western chemists, and leave with him a pleasurable feeling in having crossed the threshold.

Paul N. Leech, chairman, with J. A. Hynes, W. Lee Lewis and Carl S. Miner form the House Committee for the club.

Committees for Chicago Convention, A. C. S.

The following roster of committees and their respective chairmen for the fall meeting of the American Chemical Society at Chicago, Sept. 7 to 10 inclusive, was confirmed June 19 by the convention executive committee (W. Lee Lewis, chairman; R. J. Quinn, secretary):

Finance, A. M. Taylor; publicity, C. H. Jones; excursions, H. McCormack; registration and information, Glenn H. Pickard; hotels, S. L. Redman; transportation, A. E. Schaar; program, J. A. Hynes; banquet, D. K. French; men's entertainment, H. N. McCoy; ladies' entertainment, Ethel N. Terry; Relation to other scientific societies, William Hoskins.

Regulations Concerning the Chile Nitrate Industry

A cablegram received from the American Embassy at Santiago, Chile, June 10, 1920, states that at a recent session of the nitrate association it was decided to extend the date of session to June 30. The scale of prices agreed upon for delivery of nitrate were as follows: June and July, 15s. 5d. ($3.75) per Spanish quintal (101.4 lb); August, 15s. 11d. ($3.87); November, 16s. 10d. ($4.09); December to April, 17s. ($4.14). A clause protecting buyers was passed providing that in case of reduction of price the reduction rates will favor the buyer for all nitrate, not paid for, which he is under contract to receive. This agreement is valid until April 30, 1921. No sales less than fifty tons will be made for exportation, and a surcharge of 6d. will be placed upon certain amounts (not specified) up to 100 tons.

Annual Meeting of the Pacific Division, American Association for the Advancement of Science

The annual meeting of the Pacific Division, American Association for the Advancement of Science was held in Seattle, June 17, 18, 19 and brought together a large and distinguished gathering of the West's foremost scientists. The University of Washington was the scene of the many successful conferences, symposiums and sectional meetings of the affiliated societies while excursions and entertainment were provided throughout the adjoining territory.

Twenty-five societies were affiliated with the Pacific Division of the A. A. A. S., among which are included three sections of the American Chemical Society—the California, Intermountain and Puget Sound. At a very interesting joint meeting of these three sections the following program was presented:

Papers Presented at Sectional Meetings

"Ammonocarbonic Acid and Its Salts," by E. C. Franklin; "The Ratio of Invert Sugar to Sucrose in Relation to the Flavor of Storage Apples," by A. W. Barton; "Destructive Distillation in the Northwest, Including Low Temperature Distillation of Lignite and of Wood," by H. K. Benson; "Improvements in the Sand Test of Detonators," by W. M. Dehn; "Sympathetic Inks in Connection with the War," by F. H. Heath; "Selenium Mustard Gas," by W. L. Semon; "The Diffusion of Sea Water in the Seattle Canal System," by T. G. Thompson; "The Magnesite Industry in the Pacific Northwest," by G. E. Whitwell.

Dr. Franklin's paper was a discussion of one phase of the important work that he has been doing for many years at Stanford University in his study of the similarity between water and ammonia as solvents and between aqua and ammono acids, bases and salts.

Of particular interest to the chemical engineer were the discussions of destructive distillation. Dr. Benson has pointed the way to the Northwest in the utilization of low grade lignites through low temperature distillation.

Symposiums Presented at General Meeting

Of the general sessions the most important were: The symposium on the animal and plant resources of the North Pacific Ocean, in which it was pointed out that further control was necessary to insure to Alaska the continuation of its present valuable salmon and whaling industries; the research conferences in which Dr. A. O. Leuschner and Dr. F. M. Padelford, Deans of the Graduate Schools of the Universities of California and Washington, respectively, called attention to the imperative need of additional provisions necessary to keep research men in the University at this time when industry is making such successful inroads upon their number, and the symposium on the Einstein theory of relativity, in which was presented the remarkable work of the various astronomical expeditions and stations in endeavoring to experimentally determine some of the constants mathematically deduced.

Excursions

Among the excursions provided and enjoyed those of special interest were the visit to the Everett Pulp and Paper Co. where the soda process is used in the manufacture of paper from resinous mill waste; the American Nitrogen Products Co. at La Grande where 10,000 lb. of sodium nitrite is manufactured daily by arc fixation of atmospheric nitrogen and subsequent absorption of the gases by solution of soda ash; the Snoqualmie Falls, and the Snoqualmie Falls Lumber Co.

These falls, which have a depth of 268 ft., provide the hydro-electric power to operate the Snoqualmie Falls Lumber Co.'s mills. This company is unique in its application of electricity to its logging operations. It operates one mill exclusively for Douglas fir, another for hemlock and cedar, and also an electric shingle mill which has a total capacity of 500,000 ft. of lumber per day.

The 1921 meeting of the Pacific Division will be in or near San Francisco.

Accountants Association Formed

The Industrial Cost Accountants Association was organized in Chicago on the 18th of June by representatives of leading manufacturers in various lines of industry.

The object of the new association is the standardization of accounting and cost terminology and the adoption of standard governing principles; the promotion of active co-operation and interchange of average experiences between representatives of manufacturers engaged in similar activities; the education of the members and their business associates in the complex economic problems of industry; to assist standardization committees in each line of industry in establishing uniform accounting and cost practices; to act as a clearing house in distributing to all members the development in cost practices to the end that uniformity, once established, may be maintained.

Membership

Applicants for membership must be placed in nomination by an industrial firm or corporation, or trade organization, which must certify that the proposed member is either the owner, an officer, or a permanent employee actively engaged in the supervision of costs in such firm or corporation, or trade organization. Persons are not eligible to membership who are engaged professionally in the public practice of cost accounting on their own account, or in the employ of others so engaged. The annual dues are $25 payable in advance.

The industries represented in forming the association were the electrical, tanners (13 divisions), gear, brick, confectioners, concrete pipe, air brake, sand and gravel, farm operating equipment, cotton fabric, baking, concrete products, laundry, gas engine, and window glass manufacturers.

Officers

M. F. Simmons of Schenectady, N. Y., supervisor of costs for all General Electrical Company interests, was elected president of the association. C. H. Smith of Wilmerding, Pa., director of clerical operations of the Westinghouse Air Brake Company interests, was elected first vice-president. Roland H. Zinn of New York, chief of the cost accounting bureau of the Tanners' Council, was elected second vice-president. A. A. Alles, Jr., of Pittsburgh, secretary of the Fawcus Machine Company and treasurer of the Schaffer Engineering & Equipment Company, was elected secretary-treasurer of the new organization.

Headquarters of the association will be in Pittsburgh, at the office of the Secretary-Treasurer, 1501 Peoples Bank Building.

Boston University Establishes Branch in Havana, Cuba

The subject of foreign trade has received increasing attention since the war, and its problems are being met by numerous schools and colleges in their offering of courses which are intended to train the students for effective work in the commercial world. A recent important development in this field is the establishment in Havana, Cuba, of a Spanish-American branch, of the College of Business Administration incorporated in Boston University.

Dean Everett W. Lord states that the courses of the Havana branch parallel those given in Boston and lead to the same degree, bachelor of business administration. Courses are given in Spanish, with the use of textbooks prepared especially for Boston University classes. Students attending the College of Business Administration located in Boston may spend the sophomore or junior year in Havana without change of courses and without loss of time, thus having opportunity to perfect their knowledge of Spanish and to become intimately acquainted with Spanish-American life and customs. In the same way Cuban students, after a year or more at the Havana branch, may transfer to Boston to complete their course. A board of guarantors representing the leading banks and business houses of Cuba are lending their co-operation.

Endorsement of Federated American Engineering Societies by Engineering Council

At its regular meeting June 17, 1920, after hearing a report on the Organizing Conference, Engineering Council took the following actions:

Voted: that Engineering Council heartily endorse the plan of organization of the Federated American Engineering Societies and the American Engineering Council, adopted by the Organizing Conference of technical societies in Washington June 3 and 4, and authorize its Executive committee to proffer and perform on the part of Council such assistance as may be practicable in completing the work of the Organizing Conference and of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council.

Voted: that Engineering Council authorize its Executive Committee to deal with any question of co-operation with the Joint Conference Committee of the Founder Societies, relating to the permanent organization of the Federated American Engineering Societies, which may come up during the summer.

Voted: that the Secretary be instructed to invite to future meetings of Engineering Council delegates of the societies participating in the Organizing Conference in Washington, June 3 and 4, and editors of technical journals who may be interested.

Fall Meeting of the American Electrochemical Society

At the invitation of the members of the American Electrochemical Society residing at Cleveland, Ohio, supplemented by the cordial support of the local section of the American Chemical Society and the Engineers' Club, the Fall meeting of the American Electrochemical Society will be held in Cleveland, Thursday, Friday and Saturday, Sept. 30, Oct. 1 and 2. Headquarters will be at the Hotel Statler. The Engineers' Club will extend the courtesy of the use of its club rooms on the top floor of the hotel. Plans are under way which give promise of a meeting of exceptional interest. Dr. N. K. Chaney of the National Carbon Co., is in charge of local arrangements.

Personal

MARSTON T. BOGERT, professor of organic chemistry, Columbia University, New York, has declined President Wilson's appointment as a member of the U. S. Tariff Commission.

Prof. HENRY A. BUMSTEAD, director of the Sloane Physical Laboratory, Yale University, has been elected chairman of the National Research Council for the year beginning July 1.

FOSTER A. BURMINGHAM, formerly at the Pittsburgh station of the Bureau of Mines, is now a research chemist with The Brown Co., Berlin, N. H.

ARTHUR L. DAVIS, formerly of the Fixed Nitrogen Laboratory, American University, Washington, D. C., is now research chemist with the International Coal Products Corp., Newark, N. J.

E. P. DILLON, general manager of the Research Corporation, New York, has just recently returned from an extended Western trip in which he visited various Cottrell installations in the far West.

Dr. RUDOLF GAHL sailed on June 30 for Peru, where he will conduct some metallurgical investigations for the Cerro de Pasco Copper Co.

JAMES C. GRAY, senior member of the law firm of Gray, Thompson and Rose, Pittsburgh, Pa., has been elected president of the Standard Chemical Co.

J. C. INGRAM, of the American Cotton Oil Co., has been promoted to take charge of a new development department recently created by the American Cotton Oil Co. and associated corporations.

D. O. JONES, in charge of the research laboratory of the Armour Fertilizer Works, Chicago, has resigned to accept a position with the Newport Chemical Works, Carrollville, Wis.

PAUL KESTNER has been awarded the medal for the year 1920 by the Council of the Society of Chemical Industry, (London) in recognition of his distinguished services to the chemical industry. He was one of the chief founders and first president of the Société de Chimie Industrielle in France, which was established in 1917. Among his notable achievements are the use of forced draughts in acid towers, automatic acid elevators, the climbing film evaporator, the scaleless water-tube boiler and other inventions in connection with beet sugar manufacture.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, and Dr. DORSEY LYON, its supervisor of station, will leave in the near future for the South to look over the possibilities of several sites which have been suggested for the new non-metallic experiment station which is to be established by the Bureau of Mines.

IRVING E. MOULTROP of Boston, at the meeting of the Trustees of the United Engineering Society, was elected as a trustee of the American Society of Mechanical Engineers and a member of the Engineering Foundation Board, to fill the vacancy caused by the death of E. Gybbon Spilsbury.

PAUL S. NICE, consulting chemist of Denver, Col., has returned after spending a few weeks in the East on a business trip. He was recently appointed engineer of tests for the Denver and Rio Grande R.R.

G. G. SWARD, duPont scholar in chemistry 1919-1920, whose graduate work was done in physical chemistry and who received the degree of Master of Science at the June commencement, has been appointed to a fellowship in the U. S. Bureau of Standards, Washington, D. C., where he began on July 1.

H. M. TRUSLER has accepted an appointment as chemist with the Proctor and Gamble Co. in their Cincinnati laboratory.

R. C. WELLS, of the chemical division of the U. S. Geological Survey, will examine some of the deposits of natural soda in the Western states during the summer.

CHARLES SPENCER WILLIAMSON, dean of the Medical School, University of Illinois, spoke before the Chicago Chemists' Club, June 22, on "Some Phases of Modern Medicine."

Current Market Reports

The Non-Ferrous Metal Market

New York, July 5, 1920.—Copper consumers are buying from spot to the end of the year, sales amounting to some 20,000,000 lb. last week in the outside market, at 18@18.50c. Tin declined slightly, but lead and zinc remained firm.

	Cents per Lb.
Copper, electrolytic	18 00@19 00
Aluminum, 98 to 99 per cent	33 00
Antimony, wholesale lots	7.50@7.75
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48 00
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	7.75
Zinc, spot, New York	7.75
Zinc, spot, E. St. Louis	7.50

OTHER METALS

Silver (June 24)	oz.	$0.99¼
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@90
Iridium	oz.	300
Palladium	oz.	75@85
Mercury	75 lb.	90

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38 00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	14.25@14.75
Copper, light and bottoms	12.75@13.75
Copper, heavy cut and crucible	15.00@15.50
Brass, heavy	9.00@10.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.00
Lead, tea	4.50@ 5.00
Lead, heavy	6.50@ 7.00
Zinc, scrap	4.50@ 5.00

The Iron and Steel Market

Pittsburgh, July 2, 1920.

The coal car priority accorded the coal mines by the Interstate Commerce Commission order, which got into actual and general operation June 22 or 23, facilitates the production of pig iron and steel, but not its distribution. For the general good of the country the order is a good thing, but to the iron and steel producing industry it is not, directly at least, a good thing, for what the industry has needed of late is not heavier production but better facilities for shipping the product. The order increases the production and movement of coal, in which the iron and steel industry benefits, but it decreases the supplies of open top cars for shipping pig iron and steel products. As commonly applied the order includes high side gondolas in addition to drop bottom cars, which according to one definition are what are distinctly "coal cars," and as the steel industry ships fully 75 per cent of all its products in open top cars its supplies are naturally decreased. Even cars that are received by mills with loads are sometimes taken out empty, to go to the coal mines, the mills not being permitted to load them.

COAL MINES HAVE CAR PRIORITY

A common expectation is that within a week or so from this time the coal mines will be so well supplied with cars that the railroads can relax their efforts. While the order calls for a 100 per cent car supply to coal mines, it is well recognized that the average coal mine will be unable to load cars to the extent of 100 per cent of ratings, for eventually an increase in car supplies would uncover a labor shortage, or, if no labor shortage were uncovered then a lack of orders would be uncovered. The ratings are so high that shipments at rating would soon surfeit the country with coal.

Motor trucking of steel from mills in the Pittsburgh district has been increasing, and a rough estimate would be that at the present time from 2,000 to 4,000 tons of steel per working day is leaving mills in this district by truck. Most of the movement is to dealers and manufacturers in the Pittsburgh district, but there is some to railroad sidings removed from the mills, where cars may be had for loading to distant points, and there is a relatively small proportion of the steel that is being trucked long distances. The estimate just given refers only to the movement of steel to regular customers of mills having contracts and who in ordinary times get their steel by rail, and not to the trucking from warehouse that is customarily done.

DEPARTMENTS CLOSING

Not a few departments of large plants, and here and there a whole plant, either closed July 1 or will close at the end of this week, chiefly because of congestion of finished product. The disposition to close is in some instances emphasized by the moral effect the closing will have upon workmen who have been indisposed to show their normal or pre-war efficiency. In several instances departments are closed because other departments have fallen behind them, the object being to reduce the quantity of material in process. In other instances the object is to allow steel to accumulate in convenient form, as when finishing mills are closed and ingots, blooms, billets and sheet bars are accumulated, these forms admitting of convenient stocking with maximum tonnage for the space available. In some cases it is recognized that the piling of finished material at mill, against the orders of customers, has reached such a point that the customers may not want all the material at the later time at which it may become possible to ship it, there being no evidence that the consumptive requirements are increasing at this time.

There is no means of determining, or estimating with any closeness, the amount of finished steel that now lies at mill awaiting shipment. Probably 2,000,000 tons would be regarded as a low estimate, for some observers are disposed to place the total at 3,000,000 tons or more. In other terms, one might say that the accumulation is not less than one month's production at the average rate of production obtaining in 1912 and 1913, the two best tonnage years before the war, nor more than the equivalent of one month's full production at the present capacity, which is about 50 per cent greater than the capacity just before the war and about 70 per cent more than the actual production, on an average, in 1912 and 1913.

Obviously such an accumulation of steel is a serious matter. If it were shipped out suddenly, being cleared off in a period of say two months while current production were shipped at the same time, it would undoubtedly give some buyers altogether too much steel. Rail conditions are not at all likely to permit of the accumulation being moved off in any short period, but if so, then some of the steel will eventually reach customers too many months later than the time for which they specified it that it may be quite useless, the need having passed.

MARKETS QUIET

All branches of the general market are quiet, except for some insistent buying of small quantities of coke and pig iron, sending prices upwards again. Connellsville coke for spot shipment has brought as high as $18 per net ton at

ovens for both furnace and foundry grade, probably the record high in the history of the industry. Basic iron, which as noted in last report had advanced to $44, valley as minimum, has sold in a 2,000 ton lot for rather prompt shipment at $45, which possibly may now be found to be the minimum for any delivery. Bessemer remains quotable at $44 for large lots and $45 for small lots, while foundry stands at $45, valley, there being no demand except for small prompt lots.

The prices which several of the large independent steel interests have been quoting for three or four months past, including 3c. for bars, 3.10c. for shapes and 3.25c. for plates, are unchanged. There is little buying at these prices, but there is no particular pressure on the part of would-be buyers for reductions, since the common attitude of buyers is that they will buy only what they must have, paying the price asked, and will not buy any more on any terms. As long as the independents quote their higher prices the Steel Corporation experiences no difficulty in selling on contract the tonnage it is willing to allot to regular customers.

FERROALLOYS

Prompt ferromanganese continues easy at not much above the contract price of $200, delivered, still quoted for second half. Spiegeleisen is $72.50 to $75, furnace, for prompt or future. Electrolytic ferrosilicon is quite inactive, the market being nominally about $78 to $80, delivered, for 50 per cent, and about $150 for 75 per cent. Bessemer ferrosilicon remains at $62.50 for 10 per cent, $65.80 for 11 per cent and $69.10 for 12 per cent, f.o.b. furnaces at New Straitsville and Jackson, Ohio.

The Chemical and Allied Industrial Markets

New York, July 2, 1920.

The continued dullness in these markets remains unbroken. Buying interest on the whole has been indifferent except on some of the more desirable items the scarcity of which however prevents any activity worth mentioning. In investigating the *sodium salts* market it has been found that in general all grades are at least scarce and some unobtainable and that transportation difficulties are in a large part responsible for this condition. Producers are sold up on *sodium bicarbonate* and will not have any to offer for at least three months and the spot market is in the same condition with the average ranging between $2.50@$3.00 per cwt. for what little material that changed hands. The shortage of niter cake has held up the production of *sodium bisulphite* that quotations of 6c. per lb. are merely nominal as there is no material being offered.

Sodium chlorate and *cyanide* are probably in better condition than the other items in this class, *chlorate* being available on contract at 10@11c. per lb. while *cyanide* is being delivered at 25@26c. per lb. *Sodium nitrite*, which had such a sensational rise a few weeks ago, is quiet and very little demand is being exhibited; with the recent importations of this material there is now an adequate supply which is being sold around 17c. per lb. *Caustic soda, soda ash* and *sal soda* which have consistently been referred to as the "scarcer items," remain under that heading, although there have been some offerings of *caustic* made around 6c. per lb.; the present weather conditions are probably the reason back of this offering as this material cannot be stocked in warm weather.

COAL TAR PRODUCTS

No change has been noted in the weak position of the coal tar products market as reported last week. If an accurate list of sales of the two periods could be compared the latter probably would show more declines than rises in prices, but the volume of business is so small that a comparison of this kind would not sufficiently prove the point that this market is on the downward trend. *Aniline oil* is easier and sales have come down to 32@38c. per lb. against a previous level of 35@40c., and in sympathy the *salts* are lower also, being listed at 40@45c. compared with 42@50c. per lb. of the previous week. *Beta-naphthol* is the possible exception in this market and it is now hard to obtain the sublimed grade under 90c., while the average price is nearer $1 per lb. The technical grade is also scarcer with prevailing prices ranging from 70@90c. per lb.

NAVAL STORES

This branch is marking time with the buyer waiting for still lower prices, which will probably come as the past week has shown a still further decline. Supplies are in a much better condition and arrivals from the Southern market are ample to take care of the local trade, which at present is light. *Turpentine* is receding to its former level, reaching as low as $1.75 per gal., which was about the average price of six months ago. However, business has not resumed its former stride and exporting, which comprises a large part of this trade, is dull.

Baltimore, Md., June 30, 1920.

Fertilizer manufacturers in this section have been handicapped during the last week on account of an "outlaw" railroad strike resulting in an embargo not only on incoming but on outgoing shipments as well, and practically no complete fertilizer has been shipped out during the last week, although the season for wheat fertilizers is now on. It is with difficulty that the railroads are handling perishable food stuffs, but it is hoped this condition will be remedied in another week at the most.

Acid Phosphate.—The market continues firmer with practically no resale lots offering and producers well sold up for the summer months, and unable to take on but a very limited tonnage for movement by cars. The nominal quotation for 16 per cent grade, in bulk, is now $20 per ton f.o.b. cars, although some sales have been made during the past week as high as $22 per ton, in buyer's bags, f.o.b. cars Baltimore. Run of pile testing 17 to 18 per cent is quoted from $19 to $19.50, basis 16 per cent A.P.A., quantity and shipments subject to seller's approval and car supply permitting. Phosphate rock remains scarce, and there does not seem to be any relief in sight for some time to come, and even though shipments should come out from the mines in better volume during the next month or two, it is not anticipated that this will have any material bearing on the market, as an enormous tonnage will be required for next spring, and stocks of both acid phosphate and rock are running so low that the manufacturers will have to bend every effort to secure supplies of phosphate rock in order to enable them to take care of their trade next spring.

Blood and Tankage.—There has not been any change in conditions recently surrounding this material, but is is significant that producers are not pressing their packing house byproducts on the market, and are holding firm at their views ranging from $7.75 and 10c. to $8 and 10c. f.o.b. Eastern shipping points, according to test and condition of the material.

Nitrate of Soda.—The market continues firm and August to October arrivals are quoted at $3.90@$3.95, November to December, $4@$4.05, and January to April, $4.10@$4.15 ex vessels Baltimore, and sellers claim that based on the present sterling exchange rate these prices figure lower than cost of importation based on the market in Chile.

Potash.—There have been no recent arrivals, and on account of the sold-up condition of the domestic producers, spot stocks are held firmly at $2.65@$2.75 basis 80 per cent for muriate, $2.25@$2.30 per unit for manure salt, and $2.35@$2.50 for kainit. Even at these prices there is only a limited tonnage available, and with the prospect of no heavy arrivals during the summer months when the demand is comparatively light, it looks as though present quotations on spot stocks will be maintained. As yet no schedule of import prices on Alsatian potash has been announced, but these are expected momentarily. In the meantime, but few of the manufacturers have covered for their next season's requirements.

Fish Scrap.—Weather conditions during the past week have been unfavorable for the catch of menhaden fish in the Chesapeake Bay, and while quotations remain unchanged at $7.50 and 10c. for the machine dried unground scrap and $6.25 and 50c. for the acid scrap f.o.b. fish factories, some of the producers are not inclined to take on further business at these levels, anticipating a higher market will rule later on more in line with animal ammoniates.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	-	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.00 - 7.50	8.00 - 9.00
Acetic, glacial, 99½ per cent, carboy	cwt.	15.50 - 16.00	16.50 - 17.50
Boric, crystals	lb.	.15 - .15½	.15½ - .16½
Boric, powder	lb.	.15 - .15½	.15 - .16
Citric	lb.	1.05 - 1.12	1.17 - 1.18
Hydrochloric (nominal)	cwt.	2.00 - 3.00	3.10 - 3.25
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech.	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech.	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		-	-
Nitric, 40 deg.	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg.	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.60 - .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.25 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 19.00	-
Sulphuric, 60 deg., drums	ton	-	-
Sulphuric, 66 deg., tank cars	ton	23.00 - 24.00	25.00 - 26.00
Sulphuric, 66 deg., drums	ton	35.00 - 40.00	45.00 - 50.00
Sulphuric, 66 deg., carboys	ton	36.00 - 40.00	50.00 - 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 3[illegible].00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.60
Tannic (tech.)	lb.	-	.60 - .90
Tartaric, crystals	lb.	-	.80 - .85
Tungstic, per lb. of WO	lb.	-	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.	-	2.50 - 2.70
Alcohol, Methyl, pure	gal.	-	3.50 - 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	-	1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	-	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05	.05½ - .06
Alum, potash lump	lb.	.07½ - .08½	.09 - .09½
Alum, chrome lump	lb.	.15½ - .18	.19 - .20
Aluminum sulphate, commercial (nominal)	lb.	.02 - .03	.03½ - .04½
Aluminum sulphate, iron free	lb.	.03½ - .04	.04½ - .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ - .13½	.13½ - .14½
Ammonium nitrate	lb.	.08½ - .09½	.10 - .11
Ammonium sulphate	lb.	.07 - .07½	.08½ -
Amylacetate	gal.	-	5.00 -
Amylacetate tech.	gal.	-	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .23
Barium chloride	ton	150.00 - 160.00	170.00 - 200.00
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.09½ - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		-	-
Blue vitriol (see copper sulphate)		-	-
Borax (see sodium borate)		-	-
Brimstone (see sulphur, roll)		-	-
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3.55	-
Calcium carbide	lb.	.04½ - .04½	.04½ - .05½
Calcium chloride, fused, lump	ton	23.00 - 25.00	30.00 - 40.00
Calcium chloride, granulated	lb.	.01½ - .01½	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 - 4.25	4.50 - 6.50
Calcium peroxide	lb.	-	1.50 - 1.70
Calcium phosphate, monobasic	lb.	-	.75 - .80
Calcium sulphate, pure	lb.	-	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.12 - .13	.13½ - .15
Carbonyl chloride (phosgene)	lb.	-	.80 - 1.05
Caustic potash (see potassium hydroxide)		-	-
Caustic soda (see sodium hydroxide)		-	-
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.	-	2.00 - 2.05
Copperas (see iron sulphate)		-	-
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	-	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		-	-
Epsom salt (see magnesium sulphate)		-	-
Ethyl Acetate Com. 85%	gal.	1.35 -	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		-	1.75 -
Formaldehyde, 40 per cent (nominal)	lb.	.36 - .40	.57 - .65
Fusel oil, ref	gal.	-	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	-	-
Glauber's salt (see sodium sulphate)		-	-
Glycerine	lb.	-	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	-	.03 - .20
Iron sulphate (copperas)	cwt.	-	2.90 - 3.10
Lead acetate, normal	lb.	- .12	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .1	.13 - .17
Lead nitrate, crystals	lb.	-	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	-	1.50 -
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	-	3.25 - 3.60
Nickel salt, double	lb.	-	.14 - .16
Nickel salt, single	lb.	-	.16 - .18
Phosgene (see carbonyl chloride)		-	-
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	-	.35 - .37
Potassium bichromate	lb.	.35 - .37	.45 - .46
Potassium bitartrate (cream of Tartar)	lb.	.52 - .56	.57 - .58
Potassium bromide, granular	lb.	.80 - .85	.90 - .95
Potassium carbonate, U. S. P.	lb.	-	.85 - .88
Potassium carbonate, crude	lb.	.21 - .25	.26 - .28
Potassium chlorate, crystals	lb.	$0.15 - $0.16	$0.21 -
Potassium hydroxide (caustic potash)	lb.	.28 - .29	.31 - .35
Potassium iodide	lb.	-	3.35 - 3.60
Potassium nitrate	lb.	.15 - .17	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 -
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .36
Potassium sulphate (powdered)	ton	$225.00 - 240.00	-
Rochelle salts (see sodium potas. tartrate)		-	-
Salammoniac (see ammonium chloride)		-	-
Sal soda (see sodium carbonate)		-	-
Salt cake	ton	30.00 - 32.00	34.00 - 36.00
Silver cyanide (nominal)	oz.	-	1.25 -
Silver nitrate (nominal)	oz.	-	.74 - .76
Soda ash, light	100 lb.	-	3.50 - 3.60
Soda ash, dense	100 lb.	-	3.55 - 3.65
Sodium acetate	lb.	.08½ - .09	.09½ - .12
Sodium bicarbonate	100 lb.	2.45 - 2.60	2.75 - 3.50
Sodium bichromate	lb.	.30 - .33	.34 - .36
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 10.00
Sodium bisulphite Powered	lb.	.06 - .06½	.07 - .10½
Sodium borate (borax)	lb.	.09 - .10	.11 - .12
Sodium carbonate (sal soda)	100 lb.	1.60 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	.10 - .10½	.10½ - .11
Sodium cyanide, 96-98 per cent	lb.	.24 - .25	.26 - .27
Sodium fluoride	lb.	.18 -	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	4.25 - 6.00	6.25 - 6.50
Sodium hyposulphite	lb.	-	.03 .04
Sodium molybdate	lb.	2.50 -	3.25½ -
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	.16 - .18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 - 1.70	1.75 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09 - .10	.10½ - .11
Sodium sulphite, crystals	lb.	.03½ -	.04 - .06
Strontium nitrate, powdered	lb.	.17½ - .18½	.19 - .20
Sulphur chloride	lb.	.05½ -	.06 -
Sulphur, crude	ton	22.00 -	-
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.35 -	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 -	3.30 - 3.40
Tin bichloride (stannous)	lb.	.42½ -	.46 - .50
Tin oxide	lb.	.60 - .63	.65 -
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.13 - .13½	.13½ - .17
Zinc cyanide	lb.	.49 -	.50 - .60
Zinc dust	lb.	.12½ -	.13 - .15
Zinc oxide, U. S. P.	lb.	.18 - .19	.20 - .21
Zinc sulphate	lb.	.03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40 — $1.50
Alpha naphthol, refined	lb.	1.60 — 1.70
Alpha naphthylamine	lb.	.55 — .60
Aniline oil, drums extra	lb.	.32 — .38
Aniline salts	lb.	.40 — .45
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.35 — 1.40
Benzidine, sulphate	lb.	1.15 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.00
Benzoate of soda, U.S.P.	lb.	.80 — .90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .40
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech.	lb.	.25 — .35
Beta naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta naphthol, sublimed (nominal)	lb.	.90 — 1.10
Beta naphthol, tech (nominal)	lb.	.70 — .90
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 — 1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 — 1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.50 — 1.60
Dimethylaniline	lb.	1.35 — 1.55
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.30 — .35
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.40 — .45
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.80 — .85
H-acid (nominal)	lb.	2.25 — 2.50
Metaphenylenediamine	lb.	1.15 — 1.30
Monochlorbenzol	lb.	.18 — .20
Monoethylaniline	lb.	2.00 — 2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.17 —
Naphthaline, flake	lb.	.17 — .18
Naphthaline, balls	lb.	.16 — .18
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.18 — .25
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.35 — .45
Para-amidophenol, base	lb.	2.50 — 3.00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.50 — 1.55
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .20
Pyridin	gal.	2.00 — 3.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75

Item	Unit	Price	
Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0.50	— $0.52
Salicylic acid, U. S. P.	lb.	.50	— .60
Salol	lb.	.90	— 1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	— .31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	— .24
Sulphanilic acid, crude	lb.	.32	— .35
Toluidine	lb.	1.70	— 2.50
Toluidine, mixed	lb.	.45	— .55
Toluol, in tank cars	gal.	.28	— ....
Toluol, in drums	gal.	.29	— .32
Xylidine, drums, 100 gal.	lb.	.50	— .65
Xylol, pure, in drums	gal.	.37	— .45
Xylol, pure, in tank cars	gal.	.35	— ....
Xylol, commercial, in drums, 100 gal.	gal.	.37	— .45
Xylol, commercial, in tank cars	gal.	.23	— .27

Waxes

Prices based on original packages in large quantities.

Item	Unit	Price	
Beeswax, refined, dark	lb.	$0.36	— $0.39
Beeswax, refined, light	lb.	.39	— .40
Beeswax, white pure	lb.	.63	— .68
Carnauba, No. 1. (nominal)	lb.	1.00	— 1.95
Carnauba, No. 2, regular (nominal)	lb.	.85	— .88
Carnauba, No. 3, North Country (nominal)	lb.	.43	— .44
Japan	lb.	.21	— .22
Montan, crude	lb.	.23	— .25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	— .09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	— .10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	— .12½
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½	— .15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½	— .17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	— .18½
Stearic acid, single pressed	lb.	.25	— .26
Stearic acid, double pressed	lb.	.26	— .27
Stearic acid, triple pressed	lb.	.27	— .28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Item	Unit	Price
Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Item	Unit	Price	
Rosin B-D, bbl	280 lb.	$17.50	—$18.00
Rosin E-I	280 lb.	18.50	— 19.75
Rosin K-N	280 lb.	20.00	— 21.00
Rosin W. G.-W. W.	280 lb.	21.25	— 23.00
Wood rosin, bbl	280 lb.	17.00	— 17.00
Spirits of turpentine	gal.	1.75	—
Wood turpentine, steam dist	gal.	1.55	— 1.60
Wood turpentine, dest. dist	gal.	1.40	— 1.50
Pine tar pitch, bbl	200 lb.		— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	— 15.00
Retort tar, bbl	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.87	— .89
Rosin oil, second run	gal.	.89	— .92
Rosin oil, third run	gal.	1.04	— 1.05
Rosin oil, fourth run	gal.	1.12	— 1.12

Solvents

Item	Unit	Price
73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Item	Unit	Price	
Para—Upriver fine	lb.	$0.36½	— $0.37½
Upriver coarse	lb.	.26½	— .27½
Upriver caucho ball	lb.	.27½	— .28½
Plantation—First latex crepe	lb.	.36	— .37
Ribbed smoked sheets	lb.	.35	— .36
Brown crepe, thin, clean	lb.	.36	— .37
Amber crepe No. 1	lb.	....	— .40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Item	Unit	Price	
Castor oil, No. 3, in bbls	lb.	$0.18½	— $0.20
Castor oil, AA, in bbls	lb.	.20	— .22
China wood oil, in bbls	lb.	.18½	— .19½
Cocoanut oil, Ceylon grade, in bbls	lb.	.17½	— .18½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.18½	— .19½
Corn oil, crude, in bbls	lb.	.17½	— .18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15½	— .16
Cottonseed oil, summer yellow	lb.	.18½	— .19
Cottonseed oil, winter yellow	lb.	.21	— .22
Linseed oil, raw, car lots (domestic)	gal.	1.57	— 1.67
Linseed oil, raw, tank cars (domestic)	gal.	1.52	— 1.62
Linseed oil, boiled, car lots (domestic)	gal.	1.60	— 1.70
Olive oil, commercial	gal.	3.10	— 3.25
Palm, Lagos	lb.	.12½	— .13½
Palm, bright red	lb.	.13	— .13½
Palm, Niger	lb.	.11	— .12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.13	— .15
Peanut oil, refined, in bbls	lb.	.22	— .24
Rapeseed oil, refined in bbls	gal.	1.70	— 1.72
Rapeseed oil, blown, in bbls	gal.	1.80	— 1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	— .18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12½	— .13½

FISH

Item	Unit	Price	
Winter pressed Menhaden	gal.	$1.17	— $1.18
Yellow bleached Menhaden	gal.	1.20	— 1.22
White bleached Menhaden	gal.	1.23	— 1.24
Blown Menhaden	gal.	1.30	— 1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Item	Unit	Price	
Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	— $25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	— 20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	— 10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	— 25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	— 19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	— ....
Blanc fixe, dry	lb.	.05½	— .06
Blanc fixe, pulp	net ton	60.00	— 80.00½
Casein	lb.	.15	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb.	.04½	— .05
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	— 40.00
China clay (Kaolin), imported, lump	net ton	25.00	— 35.00
China clay (Kaolin), imported, powdered	net ton	30.00	— 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	— 8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	— 10.00
Feldspar, ground, f.o.b. Baltimore	net ton	22.00	— 25.00
Feldspar, ground, f.o.b. North Carolina	net ton	16.00	— 20.00
*Feldspar, ground, f.o.b. N. Y. State	net ton	16.00	— 20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00	— ....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	— ....
Fuller's earth, imported, powdered	net ton	35.00	— 40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	....	— .01
Graphite (dust facing grade 50%) Ashland, Ala	lb.	....	— .02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	....	— .05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	....	— .10
Graphite, crucible, 85% carbon	lb.	....	— .08
Graphite, crucible, 88% carbon	lb.	....	— .09½
Graphite, crucible, 90% carbon	lb.	....	— .10½
Pumice stone, imported, lump	lb.	.04	— .50
Pumice stone, domestic, lump	lb.	.06	— ....
Pumice stone, ground	lb.	.04	— .07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	....	— 10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	....	— 14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	— 17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7.50
Shellac, orange, fine ... nominal	lb.	1.35	— 1.40
Shellac, orange, superfine	lb.	1.45	— 1.50
Shellac, A. C. garnet	lb.	1.05	— 1.15
Shellac, T.N.	lb.	1.20	— 1.30
Soapstone	ton	15.00	— 25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50	— 14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00	— 9.00
Talc, rubber grades, f.o.b. Vermont	ton	9.00	— 15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	— 15.00
Talc, imported	ton	60.00	— 70.00
Talc, California Talcum Powder grade, f.o.b.	ton	20.00	— 35.00

Refractories

Item	Unit	Price
Bauxite brick, 56% alumina, f.o.b. Pittsburgh	1,000	$145
Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90- 100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	80- 90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45- 53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45-
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75-
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40-
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	1,000	90 100
Silica brick, 9-in. and 9-in. sizes, f.o.b. works, Chicago district	net ton	55-
Silica brick, f.o.b. Birmingham	1,000	51- 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50- 55

Ferro-Alloys

All f.o.b. Works

Item	Unit	Price	
Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.19	— .20
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	— .21
Ferro-manganese, 76-80% Mn	gross ton	200.00	— 250.00
Spiegeleisen, 18-22% Mn	gross ton	75.00	—
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.50	— 3.00
Ferro-silicon, 10-15%	gross ton	60.00	— 65.00
Ferro-silicon, 50%	gross ton	80.00	— 90.00
Ferro-silicon, 75%	gross ton	150.00	— 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	— 1.10
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	— ....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	— 7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Item	Unit	Price	
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.70	— .85
Coke, foundry, f.o.b. ovens	net ton	18.00	— 19.00
Coke, furnace, f.o.b. ovens	net ton	17.50	— 18.50
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	—
Fluor spar, standard, domestic washed gravel	net ton		— 25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02	— ....
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.85	— .90
Manganese ore, chemical (MnO_2)	gross ton	75.00	— 85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.85	—
Monazite, per unit of ThO_2	unit	42.00	— .....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	— .....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	—
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12	— .14
Pyrites, domestic, fines	unit	.12	— .14
Rutile, 95% TiO_2 per lb. ore	lb.	.20	— .25
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	— ..
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	— 7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	— 3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	— 3.00
Vanadium pentoxide, 99%	lb.	12.00	— 14.00
Vanadium ore per lb. of V contained	lb.	1.00	— 2.50
Zircon, washed, iron free	lb.	.10	— .....

*Nominal

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SACRAMENTO — The City Comrs. will receive bids about Aug. 15 for the construction of a filtration plant, cost, $1,618,000. Plans include an intake, pier and conduits, $155,000; filters, head house and pump, $225,000; filtered water basin, $115,000; coagulating basins, $190,000; coagulating house, $75,000, etc. M. J. Desmond, city clk. C. J. Hyde, engr.

Connecticut

BRIDGEPORT — The Cave Welding & Mfg. Co., 303 Center St., has awarded the contract for the construction of a 1-story, 42x93-ft. mill addition to welding plant on Center St., to Canning & Leary, Harris Bldg., New London. Estimated cost, $18,000.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., received the only bid for additions and alterations to the Aeronautical Engine Testing Laboratory, here, from Hyde & Baxter, 711—13th St., N. W., $14,990. Noted June 16.

Georgia

LA GRANGE — Swift & Co., United States Navy Yard, Chicago, has awarded the contract for the construction of a 1-story, 200x350-ft. fertilizer plant, to George Johnson & Son. Estimated cost, $250,000.

Indiana

VALPARAISO — The McGill Metal Co. plans to build a factory for the manufacture of bronze die castings. Estimated cost, $100,000. Charles Meier, engr.

Iowa

LAWLER—The Bd. Educ. plans to convert grade school into a high school. Chemical and physical laboratories will be installed in same. Estimated cost, $100,000. Frank Tustison, 355 Auditorium Bldg., Minneapolis, Minn., engr. Jacobson & Jacobson, Owatonna, Minn., archts.

Maryland

SPARROWS POINT — The Bethlehem Steel Co. is having plans prepared for the construction of a 2-story, 48x140-ft. hospital. Laboratory equipment will be installed in same. Estimated cost, $150,000. J. E. Sperry, 409 Calvert Bldg., Baltimore, archt.

Massachusetts

HOLYOKE—J. & W. Jolly, Inc., South East St., has awarded the contract for the construction of a 2-story, 100x100-ft. foundry to the Casper Ranger Constr. Co., Bond St. Estimated cost, $75,000.

LOWELL — The Saco-Lowell Shop, 77 Franklin St., Boston, has awarded the contract for the construction of a 1-story, 130 x 140-ft. foundry on Walker St., to D. H. Walker, 529 Dutton St. Estimated cost, $100,000.

WILLIMANSETT—The New England Tire & Rubber Co., Springfield, is having plans prepared for the construction of a large factory for the manufacture of tires and tubes, here. F. H. Callahan, pres.

Minnesota

JORDAN—The Bd. Educ. has awarded the contract for the construction of a 2-story, 67 x 110-ft. high school, to the Hracker Constr. Co., 638 Builders' Exch. Bldg., Minneapolis. A chemical laboratory will be installed in same. Estimated cost, $100,000. Noted May 19.

MINNEAPOLIS—The State Bd. of Control, State Capitol, St. Paul, received bids for the construction of a 3-story addition to the chemistry building at the University of Minnesota, from the Gauger-Korsmo Constr. Co., 301 Endicott Bldg., St. Paul, $225,994; James Peterson, 3152 Tenth Ave., S., $247,800; J. & W. A. Elliott, 906 Lumber Exch. Bldg., $254,725.

Missouri

ST. LOUIS — The St. Louis Malleable Casting Co., 7300 North Conduit Ave., is building additions and improvements to its present plant. Estimated cost, $500,000.

New York

FALCONER—The Jamestown Malleable Products Corp., Jamestown, plans to build a 400x400-ft. malleable iron foundry. Estimated cost, $300,000.

MARCY—The State Hospital Comn. will soon receive bids for the construction of a sewerage and water supply system including filter beds, chlorinating apparatus, settling tank, chlorinating building, etc., for the Utica State Hospital here.

SYRACUSE—The Atmospheric Nitrogen Corp., Milton Ave., has awarded the contract for the construction of a 1-story atmospheric nitrogen plant on Willis Ave., to the J. G. White Eng. Corp., 43 Exch. Pl., New York City. Estimated cost, $500,000.

North Dakota

HANKINSON—The Bd. Educ. plans to build a 2-story, 65x130-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $135,000. Terry Schulte Eng. Co., 484 Endicott Bldg., St. Paul, Minn., engr. Buechner & Orth, Shubert Bldg., St. Paul, Minn., archts. Noted April 14.

Ohio

AKRON—The S. & O. Engraving Co., 330 South High St., has awarded the contract for the construction of a 2-story, 40x150-ft. office and laboratory building on South High St., to the Carmichael Constr. Co., 524 Hamilton Bldg. Estimated cost, $75,000. Noted March 17.

CHAGRIN FALLS—The Adams Bag Co. is having plans prepared for the construction of a 3-story paper mill extension. Estimated cost, $100,000. Ernest McGeorge, 1900 Euclid Ave., Cleveland, archt. and engr.

CLEVELAND—The city has awarded the contract for 28 hydraulic operated sluice gates for the easterly sewage treatment plants, to the Coffin Valve Co., Wade Bldg., G. B. Gascoigne, City Hall, engr.

Pennsylvania

HORRELL (Canoe Creek P. O.) — The Standard Powder Co., Philadelphia, has purchased a 700 acre site here and will build twenty-five 1-story buildings, each to be used for one step in the manufacture of powder. Estimated cost, $1,000,000. Work will be done by day labor.

JEANETTE—The Amer. Window Glass Co., Farmers Bank Bldg., Pittsburgh, has awarded the contract for the construction of a 1- and 2-story furnace building, to the Hughes-Foulkrod Co., Oliver Bldg., Pittsburgh. Estimated cost, $300,000.

Tennessee

KINGSPORT—The Grant Leather Corp. is building a 2-story, 275x500-ft. factory. Estimated cost, $300,000.

Texas

PLANO—The city has awarded the contract for the construction of 2 sewage disposal plants equipped with chlorinators, etc., to Dalton & Campbell, 1915½ Main St., Dallas, at $31,254.

Virginia

RICHMOND—The Baughman Stationery Co., 1320 Broad St., West, is having plans prepared for the construction of a 2-story, 173x227-ft. factory on Marshall and Graham Sts. Estimated cost, $200,000. Carneal & Johnson, Chamber of Commerce Bldg., archts.

Washington

WENATCHEE — The city has awarded the contract for the construction of a filtration and pumping plant, to the California Filter Co., Spokane. Estimated cost, $60,000. Noted May 26.

Wisconsin

MILWAUKEE—The Amer. Metal Products Co., 671 Kinnickinnic Ave., will soon receive bids for the construction of a 1-story, 80x200-ft. machine shop and foundry on Burnham St. Noted June 30.

MILWAUKEE—Scott & Mayer, archts., Colby Abbott Bldg., will soon award the contract for the construction of a 2-story, 70x100-ft. varnish factory and a 60x112-ft. warehouse on Lake St., for the Patton Paint Co., 213 Lake St.

Quebec

THREE RIVERS—Lafour & McDougall, 107 St. James St., Montreal, will soon receive bids for the construction of a steel plant on Normand Blvd. Estimated cost, $750,000.

Ontario

TILLBURY—The Tillbury Brick & Tile Co. has awarded the contract for the construction of a 1-story brick plant, to the W. F. Sparling Co., 120 Bay St., Toronto. Estimated cost, $30,000.

TORONTO—The Sunlight Soap Co., Eastern Ave., will build a 3-story soap factory. Estimated cost, $350,000. Work will be done by day labor.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its Fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

FOREST PRODUCTS LABORATORY will hold its decennial celebration at Madison, Wis., July 22 and 23, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its midsummer meeting at Boston, July 15 and 16.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

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Modern and Ancient Canada

CONSIDERABLE contrast is to be found in the Canada as seen by our colonial grandfathers and the Dominion of today which cannot be ascribed to the natural flow of the sands of time alone. The territorial rivalries between the early settlers of the St. Lawrence and Mississippi river systems and the English Colonies were productive of neighborhood rows and fights that the French priests did not want ever to be buried and forgotten. Two centuries of prayers unanswered have no doubt dampened their passion. But ancient Quebec has given way in political prestige to Montreal, Ottawa, Toronto, peoples to the west, who wish no greater heritage than their present opportunities. Railway transportation, to be sure, has made their growth possible. They did not limit themselves to the use of the bateaux or canoes, but demanded and wrought better ways of transportation.

Those who were fortunate enough to attend the Canadian meeting of the American Institute of Chemical Engineers had the pleasure of seeing modern Canada teeming with ambition. The future city of Belleville may be taken as an example. There cannot be the slightest doubt that it will forge ahead, endowed as it is with creative citizens. Shawinigan Falls has accomplished most, and credit for it should not be of less pride to Canadians because they must share it with their neighbors the citizens of the States. For the very greatest heritages that are theirs also belong to these kinsmen of theirs to the south. The ownership of North America perhaps forms the greatest of all partnerships and the dividend of a greater language, a richer literature and a finer race of men shall be reared from North America, Inc. and Ltd. by the co-operating peoples who loyally love the Maple Leaf or American Eagle.

Strikes, Ammonia And Food Supplies

OCCASIONALLY it is possible to get such concrete evidence of the close interrelation of apparently unrelated matters that a good example is worth recording and pondering. We need an appreciation of the fact that "no man liveth to himself"; but the problem is to get the knowledge where it is most needed and will do the most good. Our present theme—strikes, ammonia and food supplies—may sound as incongruous as the classical "ships and shoes and sealing wax, and cabbages and kings," but the relation is very direct. There is an acute shortage of anhydrous ammonia in the country, and apparently it is a consequence of a series of labor strikes, first in the steel industry, then in the coal mines and finally on the railroads. The immediate effect is a crisis in some places in keeping cold-storage food from spoiling, and extreme measures have been adopted to obtain ammonia wherever possible, even to appealing to the Government.

The steel strike last year was planned far in advance and with great care; but no one imagines for a moment that the leaders calculated the full effect of their acts. But the steel strike closed byproduct coke ovens and diminished the supply of ammonia. The coal strike, likewise, restricted the output of raw material from which our ammonia is recovered. And finally the railroad strikes have made transportation slow and uncertain and have caused embargoes to be placed on such commodities as empty cylinders, thus giving the final touch to a series of events affecting the refrigeration of perishable food. In the face of such conditions the manufacturers of anhydrous ammonia are helpless, but they know the causes of their impotence and it would be well if the whole country could have as keen an appreciation of the situation. The strikes were an offense against society and a menace to the welfare of the people, as the present example shows.

The Education Of the Chemist

THERE is vigor and forceful expression in the last report to the Society for the Promotion of Engineering Education by its Committees on Chemistry. Six important items are discussed constructively: Courses of training for undergraduate degrees; industrial and vocational courses; fifth-year residence courses; conditions in the smaller institutions; aids to training in research; and the future supply of chemists. All are timely and vital.

In discussing instruction in industrial chemistry the committee shows a lively sense of the fitness of things when it says that "much of the time so frequently spent upon the processes given in the textbooks of general industrial chemistry may be better employed in a course which emphasizes the general chemical, engineering and economic problems and their solutions, and which deals with the surmounting of the difficulties encountered in as many of the industries as time will permit. Very little attempt should be made to deal with the technical details of any process." In other words, courses in industrial chemistry should be designed to ground the student in fundamentals rather than attempt to give him a finished technique which, after all, he can never obtain from books or laboratories. School years should be devoted to the study of those things which either cannot or will not be mastered after leaving school.

The committee represents the best thought of the day when it recognizes that "the amount of time necessary to fit a man fully for entering any branch of engineering cannot be crowded into four years." One

solution is "a fifth or graduate year of directed study" which should be spent in an intensive study of methods of chemical research. It is believed that this extra year of study might well be devoted to giving the student an insight into the manner of acquiring and applying chemical knowledge, including the methods of library research. By preference this fifth year should be spent at an institution of recognized advantages, and at some school other than the student's *alma mater*, even though the latter be well equipped.

A real menace to the industrial life of the nation is seen in the increasing difficulty with which young men of ability are attracted to the teaching profession. The business world is offering such high salaries that not only are young graduates deterred from entering educational work with its meager monetary reward, but the best of the younger members of the teaching profession are deserting the schools for industrial laboratories. This means a weakened teaching staff, with consequent deterioration in the product on which further teaching as well as industry must rely. Unless something is done to remedy the situation, we face the prospect of a constantly vanishing quality as well as diminishing quantity in our teaching forces. And since "poor teachers cannot possibly train such men as are needed to enable America to take her natural place among the great industrial nations," it is obvious that more money must be found somewhere for the better compensation of teachers so that the best men can be attracted and held.

The committee makes some very pointed and timely remarks on the subject of chemical research in our colleges, but comment will be reserved for a future time.

Super-Power And Chemistry

THE super-power investigation just beginning under the direction of the U. S. Geological Survey will, we trust, be made sufficiently comprehensive to include certain industrial chemical problems. We refer to the possibility of coking coal and augmenting the supply of byproduct gas in lieu of developing electric power and building transmission lines.

In central and western Pennsylvania, northern West Virginia and western Maryland there is a source of energy. Along the eastern seaboard there is a market clamoring for a supply of energy. The problem is to transfer the resource into useful public utility and transportation supply.

The problem is three-fold. What does it cost to generate the energy in a transportable form; what does it cost to transport this energy to the point of use; and how efficiently can the energy be applied at this destination? There are three forms in which the energy may move: As a solid, coal; as a gas, made either by the byproduct or by other variations of the distillation process; or as the intangible energy, electricity. If we generate electricity we must use it instantly, for it cannot be stored at all; that is, no appreciable percentage of the supply can be stored even by the most extensive use of storage batteries. If gas is the medium, we may store it up to 24 or 48 hours supply, but usually it is impracticable to store even as much as this in large operations. On the other hand, coal can be stored for an entire season or over into a succeeding season if we have a surplus of stock. These facts are so obvious as to have become almost trite in their significance, and yet they are the limiting factor in the swing from solid to gaseous and from gaseous to intangible energy supply.

It is, of course, for each municipality or district to determine which of the three means shall be used, but if proper thought is given to the matter the investigators of super-power possibilities will find that coking of coal and use of gas as one medium of energy transfer is a splendid supplement to the electrical possibilities which their work is certain to encourage. All of our chemical industries will be vitally affected if large-scale coke developments are thus to be considered. The nitrogen resources of the country will be augmented through ammonia production. Tar will afford additional liquid fuel, dyestuff raw materials, road-making material, roofing supplies, and numerous other commodities of large importance. The light oils which would be available from such developments would, of course, be most welcome in the field of gasoline substitutes; and they would also find numerous other applications, especially giving us very comfortable margins in toluol and xylol for military explosives in case of need. Altogether we can see a most attractive future for our industries if this subject receives that attention which we believe it fully deserves.

Technical Libraries An Asset to Industry

WE SOMETIMES wonder whether growing communities realize the value and importance of a technical library to the industrial concerns operating in their midst. Limited observation leads one to give a negative answer; for while libraries are now a common possession of even small towns, it is too often the case that the technical and scientific division suffers from neglect. The need, as we see it just now, is likely to be especially acute in the rapidly developing cities of the West. The East and Middle West are quite well supplied, at least in a few centers that are accessible to large areas; and the facility with which photostat copies and translations can be secured on short notice makes it possible for a few excellent libraries to give wide service. But the West is characterized by comparatively few large centers, separated by great distances. Scientific investigators in those cities are too remote from New York or Chicago to avail themselves quickly of the facilities offered, and they work at a consequent disadvantage.

The technical library is the first aid to industrial research. Investigation of a problem begins with a search of the literature in order to take advantage of past experience and knowledge, and this cannot be done with any degree of satisfaction unless a fairly complete library is available. Every large city in the Rocky Mountain and Pacific Coast region should have a well selected list of technical books and magazines specially suited to the industries already established there or likely to develop. San Francisco, we believe, has an advantage over some of the other cities in her Mechanics Institute library—an advantage which Los Angeles in her new pride as the largest city on the Coast should not allow to stand. Nor should the growing cities of the Northwest lag behind in this service to their technical men. It is a matter which local sections of the national scientific and engineering societies might well promote and support.

Efficient Use Of Railroad Equipment

WITH the closer interest that the public has been forced to take in railroad affairs on account of the freight moving difficulties of the past few months there has come a partial understanding of the real difficulties in the railroad situation, where previously there had been no understanding at all. Whether there had been an organized publicity campaign or not, the public had come to think that what the railroads needed was to buy more rails, cars and locomotives than available funds permitted. The public realizes now, what it could have realized earlier if the effort had been made, that the first requisite in railroading is to obtain maximum efficiency.

Cases have been cited without number of loaded freight cars being long periods in transit, nearly six months in some cases for a journey across the continent. These loaded cars were not held up by rails lacking in track or by roughness such as some highways offer to the progress of an automobile. The difficulties have been slow handling of the cars, particularly in classification yards and at junction points. If there were more cars, the congestion would simply be greater. If more men were engaged in laying rails the extra men would be withdrawn from work that might expedite the movement of freight.

While many things are needed for the future, at the present time the chief desideratum is greater efficiency in the utilization of existing physical equipment. It is a matter of men, the number of men and their efficiency. The railroads need more men, and they need more intelligent and efficient work on the part of all the men in employ, from the lowest group to the highest. The percentages in each group of men who are not doing their best work are not known, but it is a not uncommon view among those who have had excellent opportunities to observe that inefficiency does not stop at any group, but extends clear up to the highest circles.

It would be absurd to assume that in railroading men are not actuated more or less by self interest. It is the case with all other forms of human endeavor and there is no reason to suppose that railroading is totally different in this respect. Accordingly there are three events, set for the next sixty days, that promise very considerable measures of relief from the present inefficiency. The dates for these three events are: (1) July 20, when the Railroad Labor Board is expected to make its award, setting railroad wages on a competitive basis with those paid in the industries, and putting the men in a good humor, particularly on account of the increases awarded being retroactive to May 1; (2) August 1, when the Interstate Commerce Commission is expected to announce its decision in the freight rate cases whereby, whether the railroad managements are satisfied or not, they will be given all they can hope to secure at this time; (3) September 1, when the Government guarantee of railway earnings will cease and the railroads will be thrown upon their own resources and will have to make their money themselves.

The real experiment will then begin to determine what freight and passenger service can be gotten out of the present physical equipment by efficient use of the facilities. It is certain that there will be a very material improvement over present conditions. It will then be possible to determine, as it is not at present, where and in what manner the physical equipment should be improved. More terminal facilities, more second track, more automatic signaling, more cars and more locomotives are needed, but the proportions are not determined. In some cases additional automatic signaling will be more effective than additional cars or locomotives, while in other cases the latter will be found to be the desideratum, and thus as to all details of the problem that will then be presented, but the immediate need is better employment of existing physical facilities through more efficient functioning of the human element.

Fix the Mud-Hole

A NUMBER of prosperous farmers were compelled to haul all their produce to town over a road that in most places was in fair condition but in some parts was rendered almost impassable by deep mud-holes. In order to be able to pull through these mud-holes it was necessary to use four-horse teams, although two would have been ample if these unnecessary obstacles had not existed. One day the farmers took sufficient thought to realize that what they had been doing was not only inconvenient but a source of great expense to them. So they voted an increase in their taxes sufficient to permit the road commissioners to fix the mud-holes and keep the road in repair. To their gratification, they found that not only was the expense of keeping the road in good order much less than the cost of using four horses for a two-horse job, but they were now able to use automobiles, which proved to be a great convenience and economy. So they demonstrated to themselves that one of the ways to earn money is to spend it wisely.

Much the same situation exists in industry today and it remains to be seen whether manufacturers and the general public are as intelligent as the farmers. For three years there has existed, in varying acuteness, a coal problem. Except in the brief period in the winter of 1919-20, when stocks were probably being used up and there was little demand, the mud-hole in the road of industrial progress has always been the railroads, which are unable to transport the coal that is offered. To get the coal they require, consumers bid the price up until they bring enough economic pressure to bear so they can get coal that would be freely available at the normal price if the railroads could move all the coal that the mines offer. To be specific, coal that at Hampton Roads normally costs $5.50 per ton, of which $2 is the freight charge, is now eagerly snapped up at $11 a ton and buyers cannot get nearly as much as they need. Industry is using the four-horse team of doubled prices to pull it through the mud-hole of railroad disability. It is peculiarly inefficient because the premium paid by the buyer does not go to the railroads to induce them to move more coal, but to various others who take advantage of the situation to collect "all the traffic will bear."

The remedy is simple and obvious: increase the freight rate on coal. The increased earnings of the railroads will then enable them to purchase equipment and pay wages high enough to retain their men in competition with industry. An increase in freight rates sufficient to average $1 per ton on all the coal mined would give the railroads nearly $700,000,000 increase in annual earnings and would cost the public less than it is now paying to get coal across the morass of the railroads' inability to handle it.

Readers' Views and Comments

Copper and Magnetite in Copper Smelter Slags

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article, "Copper and Magnetite in Copper Smelter Slags," by Maier and Van Arsdale, CHEM. & MET. ENGINEERING, June 16 and June 23, is most interesting and is an excellent illustration of the valuable assistance which the metallurgist of today may obtain from skilled research investigation.

In considering this article the writer's thoughts go back to the 80's, in Colorado, when American lead-smelting practice was so largely being developed, and the metallurgist of those days was encountering difficulties which it now seems may have been due to such reactions taking place in the flowing furnace slag, and which became manifest upon the advent of the first small amounts of sulphides in the ores. These difficulties had not appeared in the smelting of wholly oxidized ores, which had previously constituted the furnace charge.

It was at a time when those who were the leaders in the metallurgical thought of the day, basing their opinion upon their earlier experience with the Nevada carbonate ores, were led to place practically their entire emphasis upon exact slag composition, even to the extent of asserting the attainment of chemical types as being the necessary requisite to obtain clean slags.

To one familiar with the method of slag analysis upon which the dictum of exact slag types was based, the methods discussed in this article offer an interesting comparison.

Even in those earlier days, however, there was a group of younger metallurgists who already had an appreciation of the fact of physical mixtures within the flowing slag, and realized that the chemical analysis should, to some extent at least, be questioned, as an indication of the form of the oxides present.

Iles, for example, in his paper written for "Mineral Resources of the United States," (See *E. & M. J.* Vol. 41, March 6, 1886, Page 169) expresses the opinion that nine-tenths of slag analyses were wrong.

In this same paper Iles refers to the magnetic properties of lead-furnace slags, stating that in December, 1879, it was discovered that the slags at the works of the old Grant Smelting Co. were all magnetic, and mentions an examination having been made of 108 samples of slag in an attempt to discover the "relation between intensity of magnetism and lead and silver losses." He states also that the slags produced in all of the prominent smelting works of the country show more or less magnetic property.

There is no suggestion, however, as to possible chemical reaction between the higher oxides of iron and the matte, such as that discussed by Maier and Van Arsdale. Iles indicates that there was in some way considered to be a relation between magnetic properties and losses. This is also shown by the proposal of Neill to subject pots containing molten slag to the action of a powerful magnetic field. (*Trans.* A. I. M. E. Vol. XXII, page 675).

A most convincing demonstration, in those earlier days, that mechanical suspension of matte was largely accountable for values contained in slags, and that such values could be mechanically removed, was that afforded by the experiment, carried out upon an operating scale, at the Omaha & Grant smelting works, in Denver, some time in the 80's, with a Peck centrifugal machine. The assay results clearly demonstrated that slags could be effectively cleaned by mechanically throwing out the suspended sulphides, but the operating difficulties involved in maintaining the necessarily high speed of rotation of the separating thimble, while at the same time pouring molten slag through the machine proved insurmountable. Thus through mechanical failure an important metallurgical fact was very largely lost sight of, although, with some of us, it had the effect of hastening the lead-furnace fore-hearth and reverberatory re-treatment of blast-furnace slags.

Although such reaction as is referred to by Maier and Van Arsdale, with the resulting "flotation" of matte prills, was not at all suspected, it was generally accepted as a fact that magnetite ores were unsuitable for lead-furnace smelting in that the iron content of such ores was carried into the slag without performing its share in the slag formation from silica. This was one of our problems in Mexico, in localities where magnetite was accessible and other iron ores not so attainable. It was known that the magnetite was not reduced in the furnace, and that we paid for iron "units" for which we did not get fluxing equivalent which was the real cause of their rejection.

These very interesting investigations of Maier and Van Arsdale clearly show that metallurgists should give careful consideration to the conditions indicated, not only in the smelting of converter slag, but where a similar suspension is likely to occur in slags flowing through blast furnace fore-hearths when ores having such higher oxides constitute, to any considerable extent, the blast-furnace charge.

R. C. CANBY.

Wallingford, Conn.

Nitrogen Fixation by the Haber Method

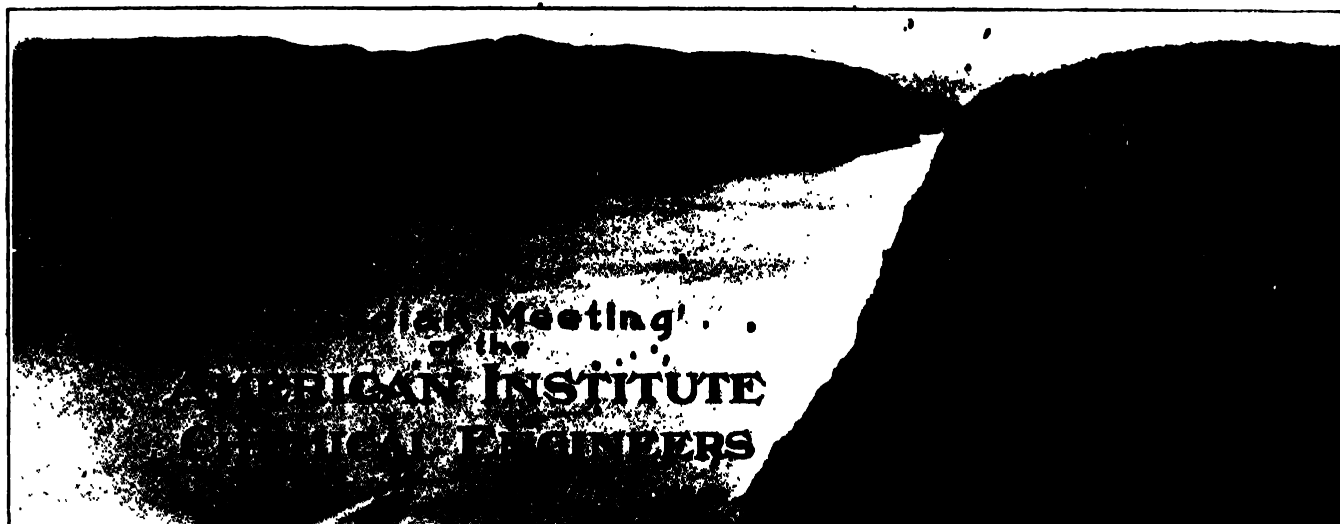
To the Editor of Chemical & Metallurgical Engineering:

SIR:—With reference to the article on the Haber process by Chester H. Jones in the June 9 number of CHEMICAL & METALLURGICAL ENGINEERING, a statement is made that one of the disadvantages of the Haber process is the "high royalty that would be demanded if the Government were to install and operate; and the inability to come to terms with the Badische company as to the use of its patents is reported to be the sole reason for the non-adoption of the method by two large American corporations," etc. A further disadvantage is, "Patents and processes controlled in America by one corporation."

It is true that the patents are owned by one corporation—The Chemical Foundation, Inc.; but we wish to take this opportunity to state that these patents are available to any qualified chemical manufacturer in this country at such a royalty as will not prove an obstacle to successful exploitation.

THE CHEMICAL FOUNDATION, INC.,
S. A. TUCKER, Chemist.

New York City.



Report of the Twelfth Semi-Annual Meeting Held at Montreal and of the Visits to the Leading Canadian Chemical Plants in the Vicinity of Montreal, Ottawa, Belleville, Shawinigan Falls and La Tuque

THE Canadian members of the American Institute of Chemical Engineers and their compatriot friends made the visit of the society to the Dominion from June 26 to July 5 an extremely pleasant one. The meeting as started in Montreal had few omens of the success that was coming, for the hall supplied by the Hotel Windsor was acoustically possessed by the carpenters' union, which was diligently turning adjacent large rooms into little ones to enable the hotel to house the great convention throngs to which every train from the States was constantly adding new recruits. The Engineers' Institute of Canada rescued the paper program by having the society move over to its commodius clubhouse.

The reports of council, officers and committees were received. The meeting committee reported that New Orleans and Detroit had invited the society and it was tentatively decided to hold the December meeting at the former city and the June meeting at the latter.

Mr. ROSS welcomed the society to the Dominion and spoke on the functions of the chemical engineer as being very old and in continuity with the work of all other engineers.

WHAT IS A CHEMICAL ENGINEER?

President DAVID WESSON spoke as follows on questions involving membership in the society:

"On occasions like this precedent seems to have decreed that your president should make some kind of an address. Personally it has been a matter of debate in my mind whether an address or a sermon was the better sedative.

"If it were proper for me to deliver a sermon, I would take for my text 2d Corinthians, 3d chapter, the last part of the 6th verse, which reads as follows: 'Not of the letter of the law, but of the spirit, for the letter killeth, but the spirit giveth life.' The reason for choosing this text was brought to my mind when discussing the proposed amendment, which has brought more or less discussion among our members, and not having received the necessary two-thirds vote of the members, has failed to pass. I am free to admit that there seemed to have been a good reason for the amendment when it was first proposed, but after going into the matter fully with the chairman of our membership committee, I have concluded the amendment is unnecessary.

WORK OF THE MEMBERSHIP COMMITTEE

"Those who have not served on the membership committee cannot fully realize its importance, and the great care its members take to do justice to all applicants and at the same time to see that the high standards of our membership are maintained. I have served on a jury and I have served on the membership committee, and between the two would choose the latter if I desired to obtain a thorough impartial sifting of evidence.

"No name is allowed to go on a ballot without a careful consideration by the committee of a man's qualifications and references. The greatest attention is paid to the applicant's character and ethics. Many cases come up where there is no question about the worth of a candidate and little time is lost in putting his name on the ballot. Other cases come up where the applicant obviously wants to use the Institute for selfish or advertising purposes, or is fully unqualified, and it takes no time to turn him down.

"The Institute owes its high standing to its membership committee, probably more than any other factor. It is an honor to be elected to the Institute and the membership committee tries to make it its business to see that applicants for membership will likewise add to its luster if elected.

QUALITY DESIRED RATHER THAN QUANTITY

"The Institute, as you know, was started in 1908—just twelve years ago. Our membership at present is about 400. Up to six months ago our growth was about 24 members a year. During the past six months we have added 40 or 50 members. It seems desirable that we should increase our membership to about 600, which would be nearly double what it was a year ago. We must bear in mind, however, that quality of membership is to be desired rather than quantity, and we must not lose sight of the fact that it is possible to have a society so large that it will defeat the object of sociability among its members and make delightful excursions such as we have had in the past and such as the present one impossible from mere weight of members.

It should be our object, therefore, in the future to try to secure for members those who will add to the prestige of the Institute.

Leaders of All Branches of Chemical Industry

"In the selection of new members, we should be governed by the text already quoted. There has been in the past more or less adverse criticism because the membership rules were sometimes too narrowly applied. It was some such feeling which probably started the proposed amendment which has just been rejected. I think the whole trouble has arisen from a misconception of what constitutes a chemical engineer.

"The Century Dictionary of 1909 says: 'Chemical Engineer—a degree given to graduates of a technical or engineering school for special knowledge of the scientific laws and rules of practice concerned with the manufacture of chemical products.' It is evident that if many of us applied this definition to ourselves we would find we had never taken the degree, although we were admitted to the Institute without it.

"The 1900 edition does not mention chemical engineers at all but gives as a third meaning of the word 'engineer,' 'One who carries through any scheme or enterprise by skill or artful contrivance—a manager.' The chemical engineer, therefore, is in the broadest sense of the word a chemical manager, that is, one who manages enterprises requiring the knowledge and application of chemistry. In a broad sense the head executive of a successful chemical enterprise, although not a trained chemist, might be a better chemical engineer than some man in his works who though holding the degree of chemical engineer would never rise above the position of foreman or superintendent of some small department.

"Again, the editor of a chemical engineering journal, though not practicing chemical engineering, so called, in its narrow sense, at the time of his application should, if possessed of the proper education and experience, be eligible to membership. The same rule would apply to a chemist who had turned his attention to patent law and was rendering great service to applied chemistry in securing patent protection to the industries.

"In conclusion I want to say that it is believed that the Institute should have in its membership the leaders of all branches of chemical industry; we should not wait for them to apply for membership, but should go after them. We need them and they need the Institute. The old theory that we should wait for men to apply is exploded. Naturally, many of those who apply are undesirables. We have it in our power to help the Institute by selecting the right sort of applicants ourselves and inducing them to join."

Views Presented in Discussion

In the discussion that followed Mr. Moore stated that the society was large enough and that increased membership would make it very difficult to obtain desirable plant visiting privileges. Dr. Olsen stated that there was some question as to the desirable number of members and estimated that there were only about 600 qualified men. Mr. Langmuir spoke of the difficulties encountered in connection with the large American Chemical Society meetings. Mr. Chute recommended that no limitations be set and that the society carefully select its candidates. Mr. Howard favored taking in all the able chemical engineers so as to make the Institute representative of the profession.

Prof. A. W. Smith reported for the committee on education and criticised the Mann report. He also gave a summary of Dr. W. J. Hale's recommendations on means by which industry can give support to the university staff by giving financial reward for the best publications on original investigations.

Symposium on Electrolytic Cells

Charles B. Baryon opened the program with personal reminiscences of the pioneer work done at Rumford Falls, Me., in 1894-98 by LeSueur, MacDonald and Mercer.

Hugh Kelsea Moore then discussed the fundamentals of the diaphragm cell, confining himself especially to the factors controlling current and decomposition efficiencies.

Albert H. Hooker made a notable contribution on cathode brine liquors, giving the equilibriums existing between NaOH and NaCl, from which considerable guidance is obtained in getting most economical caustic production.

L. D. Vorce's paper was then introduced, in which the space factors were especially dwelt upon, and the advantages of the cylindrical cell pointed out in this regard.

Time was not available for any generalizations on cell economics, but the three variable factors of heat of evaporization, current and space were brought out individually in an exceptionally competent manner. It is planned to publish the details of the symposium at an early date.

Chemical Lime Burning

Richard K. Meade gave an interesting account of lime burning technology, describing all types of kilns and ways of heating. The latest feature presented was the use of the kiln gases in tube boilers for the production of steam. Part of this steam was used in producing water gas, which is exceptionally efficient in lime burning because the heat of both the regenerating blast and the gas is utilized. The main factors of labor, fuel and equipment costs were taken up briefly for a few cases. An account of reburning spent sludges was given at the conclusion.

Research on Evaporators

W. L. Badger gave the initial contributions resulting from the work of the evaporator experiment station at the University of Michigan. In his first paper on the effect of temperature drop and level on heat transmission in vertical tube evaporators, it was shown that the coefficient of heat transmission was a function of several variables. It decreases with temperature drop and approaches zero for zero temperature drop. It increases with boiling point for a given temperature drop. When corrected for hydrostatic head it varies directly with temperature drop. As the liquor level is increased above the top tube sheet, the heat transmission falls off along a straight line. This change is only partially due to the effect of hydrostatic head. Changes in velocity or circulation are a very important factor.

The vapor pressures of salt solutions with varying concentrations and temperatures were given. An excellent bibliography on the subject was included also.

Corrosion of Iron and Steel

W. D. Richardson presented a voluminous paper entitled "Experiments on the Corrosion of Iron and

Steel," giving the results of many years' work on corrosion of several kinds of iron and steel in water and brine. A second paper on "Rates of Solution of Iron and Steel in Non-Oxidizing Acids" studied the action of H_2SO_4, HNO_3 and HCl on the same metal.

There is a certain resemblance between the corrosion which takes place when plates are submerged in water and brine when a minimum quantity of atmospheric oxygen is present and that which occurs when metals dissolve in the ordinary non-oxidizing acids such as sulphuric and hydrochloric. This resemblance, however, while characteristic in a general way, may not hold good at all points because of one essential difference in the two conditions compared. In water and brine respectively, at rest, there is always present a small amount of oxygen to influence the course of corrosion, whereas when the samples are submerged in a non-oxidizing acid, the latter is quickly relieved of its dissolved oxygen and henceforward the only gas present in solution is hydrogen resulting from the action of the metal on the acid and perhaps small quantities of other gases arising from impurities in the metal.

Relatively pure iron dissolves at a low rate in non-oxidizing acids. Less pure metals, such as cast iron, white cast iron and malleable irons, dissolve in H_2SO_4 at a relatively high rate, while cast steel dissolves at a rate between the two. On the other hand, in normal nitric acid, the relatively pure metals dissolve at a very high rate while the less pure metals, such as cast iron, white cast iron, malleable iron and semi-steel, dissolve at a much lower rate, and cast steel again occupies a position between the two extremes.

With these experimental figures at hand, Mr. RICHARDSON in a third paper presents a "Suggested Basis for an Index of Corrosion for Iron and Steel." His recommendation is to prepare a piece of 16-g. material 6 in. (15 cm.) square, by sanding each surface free of mill scale, then immersing one piece each in normal HNO_3 and H_2SO_4 at 16 deg. C. After immersion for one hour, they are carefully cleaned with a stiff bristle brush, dried, and the loss determined. The index of corrosion then is expressed by the ratio of loss per sq.cm. per hr. in HNO_3 to that in H_2SO_4. It should not be thought that the figures represent absolute ratios. Much more data would have to be accumulated and interpreted before any precise conclusions could be drawn, but since the rate of solution in non-oxidizing normal acid compared with the rate in normal oxidizing acid appears to run parallel to the rates of corrosion when an abundant supply of oxygen is present and when a limited supply is present respectively, it is thought that a rational opinion of the corrodibility of a given kind of metal can be formed from its behavior in the two acids.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, HOTEL WINDSOR, MONTREAL, CANADA

1. A. C. Langmuir
2. Richard K. Meade
4. Hugh K. Moore
5. J. R. M. Klotz
6. J. T. Baker
7. W. C. Bainbridge
8. Mrs. C. Sundstrom
9. P. F. McCleary
10. E. W. Wiggins
11. Mrs. A. B. Conner
12. Edgar Stansfield
13. J. F. Clark Carnell
14. J. V. N. Dorr
15. W. B. Campbell
16. Mrs. W. B. Carnell
17. W. C. Carnell
18. W. R. Clymer
19. Mrs. Ethel Takamine
20. G. H. Dorr
21. Earl Durfee
22. Jokichi Takamine
23. A. D. Chambers
24. E. W. Tucker
25. Mrs. E. Durfee
26. Benjamin T. Brooks
27. Clarke E. Davis
28. N. C. Ortved
29. Mrs. C. B. Clark
30. Arthur Wright
31. Parker C. McIlhiney
32. C. R. Bellamy
33. John C. Olsen, Secy.
34. Mrs. David Wesson
35. David Wesson, Pres.
36. Ralph H. McKee
37. Mrs. Benjamin T. Brooks
38. Mr. Bellamy, Sr.
39. E. C. Holton
40. D. H. Litter
41. Clarence W. Marsh
42. P. C. Kingsbury
43. C. B. Clark
44. B. R. Tunison
45. John B. Howard
46. Mrs. Henry Howard
47. Henry Howard
48. H. O. Chute
49. Mrs. J. H. Dunbar
50. Thomas C. Howard
51. J. H. Dunbar
52. Mrs. A. W. Smith
53. Charles S. Hollander
54. D. S. McAfee
55. A. W. Smith
56. Mrs A. D. Chambers
57. W. L. Badger
58. A. [illegible] Marshall
59. Joseph W. Richards
60. V. C. Edwards
61. S. L. Tyler
62. Mrs. G. M. Davidson
63. G. M. Davidson
64. R. S. Sherwin
65. Mrs. A. A. Barlow
66. A. Guillaudeu
67. E. B. Miller
68. J. D. Kerr
69. A. C. Houghton
70. S. F. Grove
71. Mrs. Beck
72. H. H. Meyers
73. W. H. Gesell
74. Mrs. A. M. Comey
75. A. M. Comey
76. Walter Laib
77. F. H. Garner
78. C. C. Ahlum
79. L. D. Simpkins
80. Mrs. A. H. Hooker
81. Louis J. Matos
82. W. W. Rhodes
83. F. C. Zeisberg
84. Mrs. W. C. Bainbridge
85. Samuel P. Sadtler
86. T. L. Lyster
87. Edward Bartow
88. Miss A. Seeker
89. Harlan S. Miner
90. Joseph Maudru
91. G. P. Hahlweg
92. Mrs. W. H. Gesell
93. E. F. Buchanan
94. R. W. Shafler
95. Mrs. G. A. Prochazka
96. S. P. Miller
97. C. A. Peterson
98. Miss Prochazka
99. George A. Richter
100. R. S. Weston
101. Mrs. Sherley P. Newton
102. J. S. Dean
103. James Morrison
104. Floyd F. White
105. Mrs. C. B. Morey
106. C. M. E. Schroeder
107. Robert W. Savidge
108. Mrs. W. L. Spalding
109. W. A. Hicks
110. Price Green
112. Sherley P. Newton
113. J. W. Rawlins
114. W. L. Spalding
115. H. E. Batsford
116. H. Rollins
117. W. L. Spalding
118. A. B. Conner
119. C. B. Morey
120. Henry Hess
121. Carl Sundstrom

Tour and Excursions

Tuesday afternoon was devoted to visiting the plant of Marx & Rawolle, where a crude sweet liquor is distilled producing dynamite, commercial and chemically pure glycerine. Two shifts of six men each operate the works, producing about 3,000,000 lb. of glycerine

per year. F. J. Wood designed the large multiple effect units, which are continuously charged with superheated concentrated sweet liquor.

A special train was provided by the Canadian National Railway containing five Pullmans with dining and baggage cars for the three-day tour. The beautiful capital city, Ottawa, was the first point of interest. Here the local members of the Society of Chemical Industry had provided an elaborate program. Luncheon was served, after which SIR GEORGE FOSTER, acting Premier, gave an after-dinner speech, which pointed out the great fuel problem confronting Canada. A small box containing a lignite briquet was set at each plate, that the society might have a souvenir of the occasion.

A quick tour was made over to Hull through the local pulp and lumber industry. The old Eddy mill was of exceptional historical interest, as it was operating with horizontal digesters on 24-hr. shifts, just as was the practice in 1889. After the industrial excursion, the entire party was taken around Lady Grey Drive in automobiles, where they obtained fine views of the lively Ottawa River and the stately edifices which house the various governmental departments.

Belleville Activities

The Institute special train pulled into Belleville just before midnight, but the town was not asleep. A full military band gave evidence to this effect and after a few commands from Captain Lucius E. Allen an excellent parade and street dance were staged.

In the morning cars were at hand for the tour through the picturesque roads of Hastings County. Deloro was reached at noon, luncheon was served, more speeches were heard, and the plant of the Deloro Smelting & Refining Co. was visited. Here the high cobalt ore concentrates are roasted to sublime the antimony, salted and heated to convert the silver salts to cyanide soluble forms, the residue of which is then dissolved in sulphuric acid. Fractional precipitation of pure cobaltic hydroxide, with the nickelic coming down with higher hydroxyl concentration, was obtained by the use of sodium hypochlorite. The cobalt hydroxide is heated to form the various oxides used in ceramics, or dissolved in acids to obtain various salts, or reduced to metal. A large amount of stellite is being produced at the plant for the Haynes company at Kokomo, Ind. The silver is removed by adding aluminum powder to the cyanide, filtering, and smelting. The antimony is resublimed and ground.

On the return trip to Belleville, the large talc grinding plant of S. H. Gillespie was visited. Then the plant of the Industrial Alcohol Co. at Corbyville was passed through. This company produces beverage alcohol about one-sixth of the time. The fermenting vats were open, but it is planned to remove the alcohol vapor from the CO_2 gas emission.

Institute Medal Awarded

Upon returning from the hundred mile tour, the party was agreeably surprised to find a banquet awaiting them at the Quinte. Captain ALLEN made a very excellent toastmaster and Colonel R. D. PONTON proved to be as able in commanding words as men. Dr. S. P. SADTLER gave added dignity to the occasion by reciting the extraordinary accomplishments of H. K. MOORE, whom the Institute chose to honor with its medal, because he had devoted unselfishly a liberal part of his time in writing scholarly papers of the greatest benefit to his fellow engineers.

Visit to Shawinigan Falls Plant

The Canada Carbide plant gave the visitors an excellent opportunity for seeing a three-phase carbide furnace in operation. The molten reduction product of burned lime and coke was drawn off at intervals in cast iron cars, where it cooled before being carried to the crushers. A large part of the carbide was packed in metal drums for shipment.

The electrode department was passed through enroute to the acetylene products plant. Coke was pulverized and bonded with hard pitch. The 16-in. electrodes were extruded and the volatile hydrocarbons removed by heating in kilns. Space will not be taken here for giving details on the acetic-acid-from-acetylene process, which was next inspected, as it has been recently described in this journal[1].

Buffet supper was served at the Cascade Inn. The piano was tuned up and everybody sang. Dancing was soon in order and the party did not break up until the conductor called "all aboard."

La Tuque Mills and Sorting Gap

Morning found the train sidetracked in front of the Brown Co.'s sulphate pulp plant at La Tuque. Here an opportunity was given to see digesters using the Morterude system of heating liquor, the spray process for burning the concentrated black liquors so as to recover their caustic content, a Cottrell precipitator and a new counter-current perforated drum pulp washing machine, in addition to all the usual equipment that constitutes a strictly modern pulp plant. The electric precipitator was being rebuilt at the time, as a large part of the soda vapors had not been caught by the first installation due to insufficient cooling and other causes.

The sorting gap on the St. Maurice River was exceedingly interesting, for SIMMONS BROWN had the camp cook prepare a Canadian lumberjack dinner, which was followed by an entertainment. The log rolling contest might have been enjoyed more if some of the chemical engineers had joined in and no doubt they would have done so, had they known the little joke Jupiter Pluvius had in store. None of them got back dry but they all seemed to be happy and put lots of force into "Alouette, je te plumerai la tête. le bec, le nez, le dos, les pattes, le cou, etc.

Saguenay River

The meeting closed amid the beautiful Laurentine mountains on the Saguenay river, the greatest of mountain streams. The grandeur of Cape Eternity towering almost one-third of a mile into the sky can not be described by words. It has been left to the art of photography to convey an impression of it in our heading.

Monday and Tuesday were spent sightseeing in the historical city of Quebec. The shrine of Sainte Anne de Beaupré was the most interesting of the churches, standing out from 1658 until the present as a center of intense religious activity of the old school. About 200,000 pilgrims flock to it annually owing to the supernatural curative influences with which it is believed by them to be endowed.

[1]"Synthetic Acetic Acid and Acetone," J. T. Rooney, CHEM. AND MET. ENG., vol. 22, p. 847; May 5, 1920.

The Future of Oxygen Enrichment of Air in Metallurgical Operations*

Apparent Possibilities of Applying Cheap Oxygen to Various Standardized Metallurgical Operations, Permitting Closer Economy of Blast Furnace Fuel, Reducing Atmospheres in the Open-Hearth, and Low-Silicon Iron to Converters

BY F. G. COTTRELL

ALTHOUGH oxygen is the commonest of all the chemical elements, making up nearly one-half of that portion of our globe which we have yet penetrated and is found in a perfectly free, that is, chemically uncombined state in the air, simply mixed with about four times its volume of inert nitrogen and very small amounts of other gases, still it has never yet been separated and used in any concentration above that of the atmosphere on a scale at all commensurate with its importance and industrial possibilities.

Not only is it the most common of all the elements, but it enters actively into more processes absolutely vital to human life and industry and to a far greater total tonnage than any other element. We have known of it and its striking properties ever since Priestley first prepared pure oxygen in 1774 and it has ever since been a potent reagent in the hands of the chemist for the special purposes of his laboratory. Still it has taken over a hundred years to bring it forward as a general industrial tool even to the comparatively limited extent it has already reached, while many other elements vastly rarer, inherently more difficult to extract and far less important in their practical applications, have outstripped it in the race.

This situation, in fact, presents almost an unique anomaly in our technical and economic development and can only be compared to those which ushered in the industrial application of the steam engine and later that of the electric dynamo and motor.

PROBLEM REQUIRES LARGE-SCALE TECHNICAL AND SCIENTIFIC CO-OPERATION

The reason that the possibilities and importance of very large scale applications of concentrated oxygen have not heretofore been fully appreciated and developed probably lies in the very magnitude of the project and the diversity of both technical and economic elements involved, rather than in any special difficulty inherent in any one of these individually. In other words, what is most fundamentally needed is the broad comprehensive grasp of the interrelation of these parts of the problem to one another and the ability to find, bring together and hold in active effective co-operation the specialists who can successfully deliver each element of the undertaking, be it technical, administrative or financial.

Turning to the history of commercial oxygen production we find the early industry based generally upon the decomposition of potassium chlorate by heat and the chief market for the gas in the oxyhydrogen or lime light for stereopticon and spectacular purposes with a smaller though important field for medical use. This process of manufacture held the field for practical purposes for many years. Later came the Brinn process substituting barium dioxide for the potassium chlorate and having the significant novel feature of regeneration of the residue of barium monoxide back again to barium dioxide by recombination of oxygen from the air through a change of either pressure or temperature, thus amounting on the whole to the use of barium compounds merely as a carrier to effect the fairly direct separation of oxygen from the air.

The Brinn process came very early, however, into active competition with the production of oxygen by the electrolysis of water, the growth of this latter from about 1895 being a natural consequence of the rapid general development and introduction of electric power into industry in general.

Since in the electrolytic process the determining factor of cost is the power consumption and it was relatively easy from the first to closely approximate in practice the theoretical efficiency possible by this process, the cost of oxygen soon became standardized to the cost of power on the open market and became almost as stable as that of power itself. Furthermore, electrolytic cells were relatively easy to build and operate in units of any size and there were no truly fundamental patents to affect the situation.

The last and most important innovation was the commercial development by Carl Linde, of Munich, and later by Georges Claude, of Paris, of air separation through liquefaction and distillation.

This it was that first vividly opened up to those in position to appreciate it the real vision of the ultimate possibilities for really cheap oxygen. It did not and has not to date, however, brought any significant lowering of the price of oxygen to the ultimate consumer and this is still practically determined as far as this country is concerned by the cost of production of the 25 per cent of our present supply still manufactured through the electrolytic process, plus the cost of bottling, freight on steel cylinders and overhead of the sales and administrative machinery required in such a business.

VIEW OF THE PRESENT OXYGEN INDUSTRY

Speaking in round figures, merely to give a birdseye view of the present oxygen industry in relation to what expansion and changes application to major metallurgical operations would mean, the United States' present production is about 3,000,000 cu.ft., or say, 130 tons, of oxygen per day, over 95 per cent of which is probably used in torches for cutting and welding purposes.

The one-quarter of this produced by electrolysis comes from several hundred privately owned plants, many of them quite small, and producing gas only for their

*Paper presented at the meeting of Iron and Steel Institute, New York, May 28, 1920.

owners' uses. The remaining three-fourths of the supply comes from about 50 air liquefaction plants owned and operated by the Linde Air Products Co., using the Linde process, and the Air Reduction Co., using, for the most part, the Claude process, but with still some production from the old Hildebrand process. The first of these two companies is the older and has somewhat the larger production. Practically the whole product from both companies is compressed into steel cylinders and sold to the trade.

The largest single installation for air separation ever erected was in connection with the cyanamide nitrogen fixation plant built for the Government at Muscle Shoals, Alabama, during the war. This consists of thirty of the largest size of Claude units. It was built primarily to secure nitrogen but if operated at full capacity for oxygen would be just about equal in output to this country's total production as given above, and this in turn is just about equal to 1/5 of the amount of oxygen contained in the air blown to one full sized iron blast furnace making approximately 500 tons of iron per day. The United States' average daily production of iron last year was equivalent to that of about 170 such furnaces running every day in the year.

Horsepower Required to Separate Oxygen From Water and From Air

Computed directly from its heat of formation water should theoretically be decomposable with a voltage of 1.48 and a current consumption of 3,032,000 amp. hr. per ton of oxygen; or in round numbers about 6,000 hp. hr., which even at 0.2. per hp. hr. would be $12 per ton of oxygen produced. This represents the energy of chemical combination of the oxygen with the hydrogen in the formation of water and must be supplied from without in the decomposition of the latter.

In the separation of air, on the other hand, there is no chemical combination to overcome. The oxygen and nitrogen simply dilute one another in a simple mixture of the two, and theoretically require no energy expenditure for their mere separation. Due to their mutual dilution, however, their partial pressures in the mixture are only 1/5 atmosphere for the oxygen, and 4/5 atmosphere for the nitrogen and as when finally separated they must both have been compressed up to one atmosphere, we must do at least this much work upon them which amounts, under assumption of isothermal compression to be about 60 hp. hr. per ton of oxygen produced, or only about 1 per cent of that theoretically required by the electrolytic process for producing the same quantity of oxygen, the byproducts being in the one case 3½ tons of nitrogen and in the other ⅛ ton of hydrogen. The values above given are, of course, the purely theoretical limits based on 100 per cent efficiency for every step of the process and piece of the apparatus employed and apply equally to any "reversible" process irrespective of whether it depends upon mechanical, physical or chemical steps. Thus, whether we try to centrifuge the gases apart, or liquefy and distill them, or dissolve them in water under pressure and re-liberate them in fractionated form from solution, or even combine the oxygen with barium oxide and re-liberate it, as in the old Brinn process, the theoretical limiting power requirements are the same and all that interests us from the power standpoint in any cyclic process is the measure in practice of its divergence from reversibility. The criteria of selection among these alternative processes from the side of power consumption must, therefore, be based upon losses of reversibility, i.e., on friction, mechanical leakage, leakage of heat, chemical inertia and losses of thermodynamic potential generally. In practice today the electrolytic process actually reaches an efficiency of from 80 to 85 per cent and probably only very small additional gains on this can be looked for without running up fixed charges proportionally.

Of all the proposed air separation processes, that of air liquefaction and distillation seems not only to have already outstripped all others in the race but to present naturally the most attractive features for large scale development.

Centrifugal Separation of Oxygen From Air

Under very high centrifugal force there is an appreciable tendency for air to stratify into layers of increasing oxygen content toward the periphery of the rotating mass, but the effect is rather small for the magnitude of centrifugal force we can expect to reach safely on a large scale with the strength of materials of construction now available. If we think of this as a continuous process with the air steadily flowing through the apparatus, very special precautions would apparently be necessary to prevent the current from disturbing the process of stratification, as there would be no sharp boundary between layers of different composition as there is between liquid and gas in the liquefaction process. There have been numerous patents taken out on the centrifugal separation of gases, but none of them as yet published seems to meet in comprehensive detail many of these fundamental difficulties, though one would be rash indeed to predict that human ingenuity may not yet produce something of practical value in this field. However oxygen and nitrogen, with a ratio of densities of only 7 to 8, present one of the most unfavorable pairs of gases which could be selected to which to apply the centrifugal method so that, if it ever is worked out in practice, it is apt to find its best competitive field elsewhere, at least at the outset, say for example, in separating hydrogen from water gas where the ratio of densities is from 50 to 100 times as favorable for this method.

Solution of air in water and re-liberation by drop in pressure also effects a concentration of the oxygen, as it is more soluble than the nitrogen. If high concentrations are desired, it becomes necessary as in the case of centrifugal treatment, to repeat the process several times. The process, while simple, would require, however, either very large equipment, or the use of very high pressure, or both, when compared to direct liquefaction.

The use of a chemical absorbent like the barium oxide of the Brinn process, would be much more practical and attractive if we could find some cheap and stable substance which had much the same properties as the hæmoglobin of the blood with respect to the absorbing and liberating of oxygen without waste of energy. Up to date, however, none of the many substances which have been suggested for the purpose have proved to combine these desirable qualities in sufficiently high degree to promise serious competition with the liquefaction process.

Expected Economies in Fractional Separation

The power efficiency in commercial air separation plants already reached on the other hand has probably not much exceeded if indeed it has reached 10 per cent

of the theoretical as above given. Here, however, there is a much more hopeful outlook for improvement, as there seems no fundamental reason why we should not multiply the present efficiency several fold by applying the same sort of good intelligent engineering which has brought the steam engine to where it stands today, as the elements of the problems are fundamentally almost identical.

Even with present equipment, the power cost item in air separation is of an order of magnitude comparable with the items of fixed charges, labor and other costs, in all of which further reduction can also reasonably be expected.

In considering items of cost, and especially as concerns installation and power, it is well to bear in mind that if the oxygen plant is included as an integral part when the metallurgical works are first built, a very considerable saving may probably be made through the reduction in size or the entire elimination of other structures, such as stoves, dust catchers, gas mains and the like and that a number of power savings might likewise probably be effected, though the detailed discussion of this belongs more properly under the later head of the metallurgical applications themselves. The development of this work is strictly an engineering project dealing with the handling of large masses of material and must be approached through practice at every point as contrasted with laboratory and experimental methods.

The possible effects to be expected from oxygen enrichment of the air stream must be rather carefully distinguished under several different heads.

Effect of Oxygen on Calorific Intensity

The effect which we are most apt to think of first is simply raising the temperature. This may be beneficial and important in some cases, but most of our present metallurgical processes are already standardized to pretty definite temperatures for very good reasons and, if enrichment of air is applied to them, the chief reasons will probably be other than for a temperature change per se. In fact, many temperatures in metallurgical operations are more definitely defined by the character of the charge than is always recognized even by those most familiar with practical operation. This is particularly so in blast furnace operations for, if more heat units are supplied or less taken away the furnace simply runs faster, but the temperature of the metal, and slag, can vary only slightly, as these are nearly though not quite completely determined by the composition and consequent melting point of the charge. The temperature of the coke and gas current in the furnace, especially in its lower position, may, of course, rise very considerably and this in turn slightly superheat the metal and slag as they fall through the lower part of the furnace filled chiefly with coke.

The most important way in which enrichment of blast may essentially influence blast furnace temperatures is indirectly by allowing variations in composition of charge, e.g., making of ferrosilicon or ferrochrome directly in the blast furnace. In the case of the open-hearth, and especially the converter, the temperature question is a more pertinent one, as their operation is not controlled by the melting and automatically flowing away of their charges.

On the other hand, the distribution of heat between the hearth and shaft of the blast furnace is tremendously influenced by enrichment of the blast with oxygen because of the diminution of the total amount of gases going up the shaft per unit of carbon burned. It must be remembered that the blast furnace is of all our metallurgical equipment the most complicated from the standpoint of interrelated mechanical and chemical processes going on inside of it and has reached its present state of development by very gradual and conservative steps over a long period. It may therefore not present the most favorable unit on which to commence the regular use of enriched air for standard and continuous operations.

In fact if we ever come to use highly enriched air in making ordinary pig iron the resulting furnace is apt to have very little resemblance to the blast furnace of today. Our experience in the meantime with electric furnaces should help greatly in this evolution, as the conditions to be fulfilled in an enriched air furnace may reasonably be expected to lie between those of the electric and the present blast furnace.

Attractive Use as Standby

As the blast furnace, however, is the piece of equipment requiring the most continuous and uninterrupted operation, it may be that the enrichment of air for it as an emergency measure in case of trouble such as a threatened freeze-up may prove of considerable importance. Not that freeze-ups really happen with the frequency which one would assume from their prominence in text books and discussions, but that this very infrequency may mean that blast furnace operators have come to work with so safe a margin of conditions to avoid them, that this insurance is costing daily in coke consumption and other requirements or results very much more than we realize, and if one could have a standby source of oxygen for enrichment purposes in case of emergency, even though it were not used at all in normal operations, it might permit of safely running on a very much closer margin in the heat allowance of the furnace and making important improvements in its general economy and efficiency.

Another important effect of the enrichment of the air would be the higher calorific value of the blast furnace gas obtained as a byproduct due to elimination of part of its nitrogen. This in turn should mean cheapening of gas engine and other equipment on which it may be used. Furthermore the removal of nitrogen from the blast air would tend to eliminate the necessity for hot blast stoves which at present consume about $\frac{1}{3}$ of the total heat value of the gas produced in the furnace.

Oxygen in Open-Hearth

The open-hearth presents some of the most interesting possibilities for the application of oxygen, particularly in those operations where the electric furnace has been the open-hearth's strongest competitor, e.g., where very high temperatures coupled with a reducing atmosphere are desired, as in the elimination of sulphur as calcium sulphide. With an open-hearth using ordinary air in order to reach the highest temperatures now attainable, a complete and carefully balanced combustion of the gases must be secured resulting in a neutral or slightly oxidizing atmosphere, whereas if part at least of the furnace's burden of inert nitrogen could be removed by the use of enriched air the same temperature could be reached while still leaving a residue of unburnt material in the gas, thus producing a strongly reducing atmosphere. By enriching the air the total

volume of gases passing through the furnace per unit of fuel burned and heat produced may be cut down enormously, since in the air there are four volumes of inert nitrogen to every volume of useful oxygen. This would greatly facilitate heat exchange and reduce mechanical difficulties such as dust losses, maintenance and control of draft and the like, or on the other hand permit of speeding up the furnace and thus increasing its daily output and correspondingly reduce fixed charges and labor per unit of product.

If we carry the application of oxygen back of the open-hearth to the gas producer we may still further extend the same principles and deliver to the furnace more thermal units per unit of primary fuel consumed; beside the actual saving of fuel which this represents, it may in some instances be still more important in cutting down the amount of impurities, especially sulphur, carried into the metal from the fuel. Aside from both of these considerations and viewing the gas producer simply as an isolated unit in connection with either heating or power operations, oxygen enrichment of its air supply will permit the use of fuels which could not otherwise be burned in it at all and thus vastly increase our available fuel resources.

CONVERTING PRACTICE

In the matter of possible application to the converter it is perhaps hazardous to speculate in advance of actual experimentation, but once an adequate supply of oxygen is available in the steel works such experimentation will almost inevitably produce useful results, some perhaps from directions we least expect. One of the conditions limiting what metal may go to the converter is the fuel value of the metalloids it contains and in many cases we are paying rather heavily through operating conditions of the blast furnace to put silicon into iron largely for its fuel value later in the converter. A good part of these heat requirements might be removed by abstracting part of the dead load of inert nitrogen from the converting air. Whether such a procedure might lead to a change in our practical classification of bessemer ores is an interesting question, but there seems to be so much difference of opinion at present and so many factors enter into the problem that all that can here be done is to merely mention the problem as suggestive of the wide and intensely interesting field of possibilities which cheap oxygen will open up.

In the copper blast furnace running on sulphides with its relatively short shaft and hot top, the advantage of oxygen enrichment is much less open to question than in the case of the iron furnace. Furthermore in all furnace treatments of sulphide ores the problem of disposal of the sulphur in the waste gases is one of ever increasing acuteness as our mining and smelting communities with increase in surrounding settlements meet with more and more exacting conditions with regard to fume and smoke abatement. One of the difficulties in the way of the successful economic treatment of many of these gases for the removal and utilization of the objectionable constituents has been the great dilution of the latter and consequent large volume of inert gases to be handled, a situation which may have quite a bearing on the interest manifested in the problem under discussion. In this connection the use of oxygen may also prove the key to the commercial recovery of sulphur in elementary form from sulphide ores which has been a very elusive and at times a very live problem ever since John Holway's classic work on pyritic smelting in 1878. Also in the roasting of difficultly burning sulphide ores such as those of zinc and very low grade copper ores and tailings preparatory to leaching, the availability of cheap oxygen will be very important especially where the resulting gases are to be further utilized for their sulphur dioxide content either for sulphuric acid manufacture or for other purposes.

Last but perhaps not least may also be mentioned the part that oxygen may play in some of the newest developments of general metallurgy, viz., volatilization processes, where in contrast to most of the older metallurgical processes high temperatures may in themselves play an important rôle. Aside from zinc, cadmium, and mercury it is only lately that we have seriously concerned ourselves with the primary recovery of metals by volatilizing them from their ores but just as hydrometallurgy after a long and discouraging struggle finally won a foothold through the successful application of the cyanide process to gold and silver ores, so now what we might term "gas-metallurgy" seems also struggling for recognition and finding encouraging applications to lead, copper, gold, and silver, to say nothing of potash and phosphorus.

But these last two carry us off again and still further into the field of applied chemistry, where besides the very important group of carbides and nitrides there are a host of other applications for cheap industrial oxygen, even the mention of which the limitations of time and the intended scope of this paper forbid.

Light Creosote Oils in Wood Preservation*

Service records have shown that light creosote oils properly injected into wood will prevent decay until the wood wears out or checks so badly that the untreated portions are exposed.

Creosotes used in ties from twenty-five to fifty years ago were for the most part oils having 50 per cent or more distilling below 235 deg. C., with a residue not to exceed 25 per cent at 315 deg. C. The ties so treated lasted fifteen to twenty years, and failure was traceable in most cases to mechanical wear, such as rail cutting and spike killing. In no case was failure found to be the fault of preservative.

Of 1,558 telegraph poles in the Montgomery-New Orleans line, which were pressure-treated with a light creosote oil, 1,049 poles were still sound after sixteen years. In 91 per cent of the cases of decay, the fungi had entered the wood through checks and shakes. Representative sections in the Norfolk-Washington line showed that after seventeen years' service, of the 1,614 poles inspected, 1,469 were sound, 92 decayed at the top, and 105 decayed at the ground line. The decay at the top was caused chiefly by cutting off the poles. In those decayed at the ground line, the causes of failure, as determined in 88 per cent of the cases, were checks or shakes. Here again, as in the ties, the preservative outlasted the mechanical life of the wood.

Unless some other factor than protection from decay is considered important, therefore, there is apparently no need to specify high-boiling oils. The important point is that any coal-tar creosote which is not extremely low boiling or extremely high boiling will satisfactorily prevent decay, and in the selection of an oil, factors such as price, penetrability and convenience in handling should receive greater consideration than moderate differences in volatility.

*From Forest Products Laboratory *Technical Notes*, June, 1920.

Czechoslovak Glass Situation

NOTWITHSTANDING constantly increasing production, Czechoslovak glass factories are oversold for some time to come. There are dealers who have accumulated fairly good stock from whom goods can be secured, but as a rule manufacturers cannot accept orders for early delivery. New concerns have been organized with large modern plants. Four establishments have been completed and the latest machinery is being installed. These, with sixty additional enterprises are expected to increase the normal pre-war capacity by 50 per cent. The present production in the Czechoslovak glass industry, according to Engineer Josef Soukup, secretary of the Czechoslovak Glass Syndicate, can be estimated from the quantities of coal needed in the industry and the number of tons actually allotted to it. In the month of March, 1920, the entire coal demand of the glass industry was 155,418 metric tons and the allotment was 83,445 tons. April, 1920, the demand was for 160,125 tons, and the allotment was 71,138 tons.

The following is a list of what is known as the hollow and cast glass section, which is said to operate at 60 per cent of its capacity:

Sixty-six ordinary hollow-glass factories.
Nineteen cast-glass factories.
Eleven machine cast-glass factories.
Fifty-two cut-glass factories.
Twenty-four factories manufacturing lighting fixtures, globes, shades, etc.
Eleven factories manufacturing glass rods and tubes.
Nineteen factories making crude glass for the Bor (Haida) fancy glass.
Seventeen colored composition and special glass factories.
Three watch-crystal glass factories.
Three chemical glass factories.

Before the war these products in the former Austro-Hungarian Empire were valued at 137,400,000 crowns (the normal value of the crown was $0.203 U. S. currency) whereof the share of factories located in the present territory of Czechoslovakia was 120,500,000 crowns. The present monthly production amounts to 25,000 metric tons, with prospects of its reaching in the near future 35,000 tons a month. Eighty per cent thereof, comprising principally glassware for household use, cut glass, chandeliers, lamp chimneys, bulbs for incandescent lamps, watch crystals, and chemical glass, has been exported.

Window, Mirror and Photographic Glass

The window-glass industry, which comprises twenty-nine factories, twenty-four of which are manufacturing window glass, three blown-mirror glass, and two photographic glass, are operating at 75 per cent of their capacity. A 25 per cent increase in production is in view on account of the intense demand and improvement in conditions generally. Eighty-five per cent of the output is exported, since 15 per cent of the output is sufficient for domestic needs. Photographic glass is manufactured almost entirely for foreign countries. Before the war the total Austro-Hungarian production of window glass was 12,060,000 sq.m., of which 10,900,000 sq.m. was manufactured in the present territory of Czechoslovakia. Fourcault machines are mostly used. Some concerns use window-glass machines under a license from an American firm, which machines are found very satisfactory.

During the war the inability to secure copping wire from America made their operation difficult because a substitute that was tried gave poor results. Six factories which manufacture cast smooth and ribbed glass for buildings and four factories making cast mirror glass are operating at 60 per cent of their capacity. Fifty per cent of the product is exported as mirror looking glass, and 30 per cent is exported partly manufactured, leaving 20 per cent for domestic needs.

Output of Bottles

Plants making all varieties of bottles, seventeen in number, are operating at 35 per cent of their capacity. During the year 1919 they were in a position to turn out 171,000,000 bottles. Since their output was limited by the quantity of coal, soda, potash, and other raw materials needed in their production, the actual production was only about 60,000,000 pieces. In pre-war time, in the territory of what is now known as Czechoslovakia, 165,000,000 bottles were manufactured annually, while in the rest of the Austro-Hungarian Empire only 15,000,000. In Czechoslovakia 49,500,000 bottles were consumed, leaving 115,500,000 for export. The factories have recently installed several American machines, so that their productive capacity has been increased to 240,000,000 pieces.

Factories Using Coal and Wood

In all there are 156 glass factories in Czechoslovakia. The oldest are located near forests because of the wood that was needed in glass production. But with the increase in the price of wood and owing to the discovery of factory production with the use of chemicals, soda, potash, and glauber salt, the factories have been gradually giving way to those using coal exclusively of which there are now 103; fifteen factories still use wood only, and twenty-one use both wood and coal. Five of the old plants have been abandoned and four are not in operation.

The seventeen special and colored composition glass factories are small concerns.

Other Glass Enterprises

In addition to the regular glass plants there are over 3,500 independent enterprises that finish partly manufactured glass products. Besides these there are thousands of homes where practically all the members of the family do work which cannot be done by machines. This is mostly in the Gablonz industry, which employs in all about 50,000 people. Until recently the Gablonz goods exports amounted to a value of about 90,000,000 Czechoslovak crowns a month. The climax was reached about the middle of April of this year, when the effect of the rising value of the crown was noticeable. Since then exports have fallen off about one-third. The increase by the Government of the export tax on Gablonz goods from ½ per cent to 5 per cent of the invoice price has had a deterrent effect.

While soda and potash are manufactured in Czechoslovakia, great quantities must be imported from Austria and Germany. About 1,000 metric tons of potash, it is said, would cover the needs of the glass industry for one year, and domestic production thereafter would be sufficient; fifty tons of saltpeter, 1,000 tons of glauber salt, twenty tons of boric acid, 100 kilos of selenium, and 20 kilos of gold must be imported monthly for the industry; 2,000 kilos of nickel and about the same quantity of cobalt are the annual requirements.

Chicago Section Meeting, A. C. S.

THE June meeting of the Chicago Section of the American Chemical Society was held on Friday, June 25, at the City Club.

Dr. L. V. Redman, in retiring from the chair spoke of the appreciation he felt toward the members of the society for the support they had given him during his regime. When he came into the chair he thought that the control of the section was sort of a closed ring or corporation, but found after two years' service that it was hard to get anyone into the ring, and that the corporation had to sell its stock on a poor market. He assured the new chairman, Dr. W. Lee Lewis, of the continued support, that he may be happy when he lays down the gavel of office.

Dr. Lewis, in taking the chair, said that by many political maneuvers he had now acquired the chairmanship, and that the Chicago Section must make the best of it. The chief concern of the section now is over the sixtieth convention of the American Chemical Society. The event places the Chicago Section as host in a most delicate position where vigor without violence is required. The mechanical work of the convention is progressing and the spiritual part is in the hands of the members of the section. While this convention is for the purpose of presenting papers, man is not essentially an intellectual animal, and the social side is therefore important. It is up to the Chicago Section to convince our visitors that we are democratic, friendly and genial. This lies in the hands of the members.

The Section committees for the coming year are as follows: Program committee, J. A. Hynes, chairman, David Klein, Frank DeBeers and Paul N. Leech; finance committee, Herbert N. McCoy, chairman, Robert J. Quinn and W. R. Smith.

Dr. Lewis spoke further of the splendid work done by the retiring chairman and group of quiet unselfish members back of this section. A rising vote of thanks was made to Dr. Redman for his service.

The paper of the evening was presented by Roy C. Coleman of the Essenkay Products Co., as follows:

Colloid Chemistry in Industry

There are certain well-founded criticisms against colloid chemistry to the effect that the colloid chemist generalizes too much. There is a divergence of opinion as to what colloid chemistry is and a review of the literature discloses the reason people think of it as a theoretical science. It is necessary to get away from usual theories to understand certain phenomena explained only by the colloidal theory.

In considering colloids, we first have a physical state of matter, and second, we have to do with the chemistry of material in that physical state. It is a state, not a kind, and an effect, not a cause.

We must not generalize, but define. Every phenomenon is not explained from a standpoint of colloid chemistry. What is the colloidal state? It is physically heterogeneous. Ostwald says: "It is the chemistry of neglected dimensions." Another writer calls it "dispersion chemistry" and another "the mathematics of chemistry." It is necessary, then, to have dispersion of one matter in another.

There are limits as to the size of the particles. The lower limits consist of mechanical mixtures with particles say 1 μ in diameter. The higher limits are molecular dispersions with the particles 0.1 μμ in diameter. The great field between these two limits contains particles said to be in colloidal state.

Emulsoids and Suspensoids

It is a state of matter, then, where one material is dispersed in another and this substance has the property of greater subdivision the nearer it approaches the mechanical solid and vice versa. It also possesses the property of great total surface of particles. We are not concerned as to why these matters disperse one within the other, but with the fact that they do disperse. If the particles are large they are called suspensoids and if smaller or approaching the upper limits they are called emulsoids. Emulsions may be either emulsoids or suspensoids.

Dispersion in Non-Aqueous Solutions

The literature deals largely with the dispersion of solids in aqueous liquids. The experience of the writer has been along lines of dispersions of solids or pigments in non-aqueous solutions like oils. We use certain things in the art because they have a definite physical state which is very often of greater importance than their chemical composition. Oils and varnishes, therefore, offer an excellent opportunity for the study of colloids.

Take for example oxidized linseed oil which is made a solid by heating or blowing air through the solution, or if it does not become solid it is at least very viscous. As these solids form, particle-surface increases. In suspensoids there is not much change in the viscosity of the solution but emulsoids will increase materially toward the solid state. There are many phases in these mixtures which depend upon the material and the dispersion medium.

This dispersion occurs without chemical action due to certain degrees of surface tension. The degree of dispersion depends on certain surface energy which causes the breaking up of the particles. This is particularly proven by placing pigments in oil. Certain liquids such as oils are of colloidal nature in themselves, and therefore tend to disperse the added solids more easily. Some of these colloidal liquids are in themselves of high viscosity.

Distinguishing Colloidal and Molecular Solutions

The application is found in the manufacture of oil cloth, where the solution is built up to a certain amount to get the rigid or solid material. The colloidal solution may be distinguished from molecular solutions by an observation of the action during this building up where viscosity is plotted against temperature. Molecular solutions show a straight line while colloidal solutions show a curve. There may even be a definite break in the curve were change occurs from the molecular to the colloidal state.

Solids may be dissolved in solids to get either colloidal or molecular solutions. Resins, gums, etc., are colloids themselves, and when mixed, may become either molecular or colloidal solutions in the fluid dispersion mediums. There are three different ways this works out with solids. Where the colloidal solid is soluble in the dispersion medium, molecular solution is formed, as when gums are dissolved in benzol or analogous compounds. If the solid disperses in the medium without breaking up we have the second state. Many gums do

this as a class in turpentine for dispersion medium, as the solid colloid is added.

The third class is where adsorption takes place to a certain limit, at which point the solid separates out from the solution. Shellac in alcohol is an illustration. If 6 lb. of shellac is dissolved in 1 gal. of alcohol, a viscous stable solution is formed. If more alcohol is added, for instance with a ratio of 5 lb. of shellac to 1 gal. of alcohol, a slight separation takes place and this will continue as more is added until all the shellac would separate out. Certain polymerides and varnishes act in a similar manner. This third condition, then, is a form of adsorption in which the solid is dissolving the liquid instead of the reverse. In practice this applies to many varnishes and protective coatings, and is of great importance in paint mixing.

Paints and Enamels

Colloidal oils may cause a very fine dispersion with zinc oxide, barytes, magnesium silicate, etc. Where a high colloidal viscosity is reached, a range of dispersion may be secured with zinc oxide in oil from 15 to 95 per cent, depending on the oil used. In the manufacture of body paints and fine enamels the dispersion must be very fine to secure proper smoothness on application.

In experiments with china clay, whiting, barytes, and silica as a class with a medium viscous oil, china clay was found to give a plastic paste, while with silica a viscous paste and liquid like molasses were obtained. This is caused entirely by a different degree of dispersion of materials. Solutions in rubber operate in the same manner as with oil. Hardness and elasticity are determined by the amount of dispersion.

We can, therefore, by a study of the viscosity of liquids and dispersion, find many things of practical importance. The practical laboratory tests for determining the colloidal condition or extent of viscosity due to colloidal condition may be determined by testing with adsorption of a certain strength of caustic soda. The word "absorption" is very much abused in this connection. Absorption is applied to any kind of taking up of material or liquid, as in the case of water in a sponge, while adsorption is a form of absorption like the taking up on the surface of the particles, as in a gel.

Chemists Studying Uses of Wool Waste

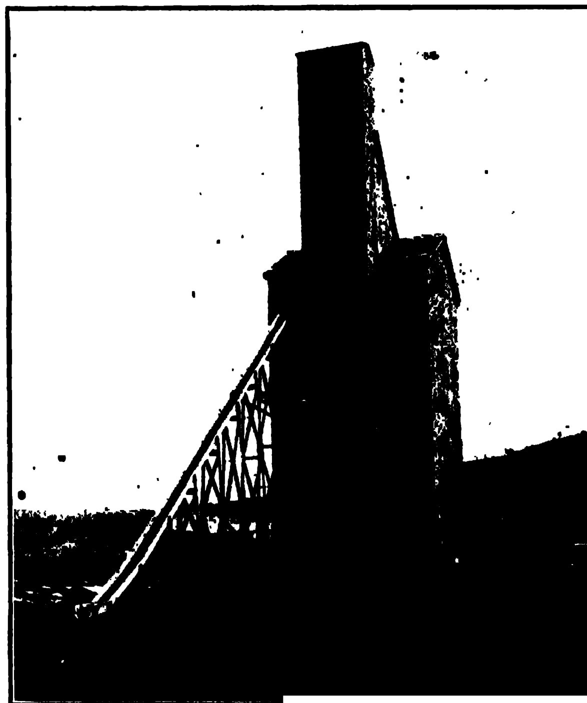
The Bureau of Chemistry, United States Department of Agriculture, has been carrying on experiments to determine profitable uses for the grease and other substances found in the scouring of wool.

Chemical analysis of a large number of samples of all grades and kinds of unscoured wool show that the percentage of grease varies widely even in the same grade or class, but is high in nearly all grades. In Ohio delaine, a very greasy wool, the grease varies from 17.8 per cent to 41.9 per cent. This means that in every hundred pounds of unscoured wool containing the highest percentage there is more than 41 lb. of grease. The profitable utilization of such an item is well worth the serious attention of the wool-scouring industry.

Tests of the suitability and adaptability of the grease to various uses, including leather dressing, waterproofing and manufacture of varnish and lanolin, are being made. There is a constant demand for lanolin for use in the manufacture of cosmetics and ointments. Methods for the economical recovery of potash, soapgrease and fertilizer are also being developed.

What Can Be Done With It?

A corporation recently organized to take over one of the large government powder plants for the purpose of selling the buildings and land in sections to new industries has found itself with several buildings of peculiar styles and construction apparently unsuited for peace time industrial purposes. Most of them, however, have been converted and utilized, with the exception of the building pictured herewith. The engineering and sales departments have racked their brains for an idea of what use this building can be adapted to, or what industry could utilize it, but without result. It seems ideally built for a concentrating plant but the fact that no minerals except soft coal are to be found



within several hundred miles does not make this seem feasible. A shot manufacturer might be interested were this field not already overfull. The owners have appealed for an idea and the problem is presented to our readers. Suggestions may be addressed to the editor.

There are five of these buildings in a row. The construction is frame with an elevator occupying the square offset. The dimensions are 40 x 40 x 80 ft. high to top of roof truss; to extreme top is 112 ft. The chute down in the foreground was to be used by the workmen as a fire escape, the building being used for blending gun powder. The interior is of tin construction.

Say "Flammable," Not "Inflammable"

The National Safety Council, the National Fire Protection Association and similar organizations have set out to discourage the use of the word "inflammable" and to encourage use of the word "flammable" instead. The reason for this change is that the meaning of "inflammable" has so often been misinterpreted. Some persons have thought of the first two letters of this word as the prefix "in," meaning "not," or "non-," as in "inactive" (not active) or "incontrollable" (not controllable). "Flammable" is shorter, more definite and cannot be misunderstood. The negative of "flammable" is "non-flammable."

Legal Notes

BY WELLINGTON GUSTIN

Correspondence and Telegrams Held to Constitute a Valid Contract

How a mass of correspondence, telegrams and such may, together, constitute an agreement or contract is shown in the suit of the National Smelting Corporation against Cutler Bros. and the Superior Metal Co. Action was brought to recover damages for breach of an alleged contract to sell and deliver to the smelting company, within a reasonable time, 25 long tons of Chinese No. 1 tin, minimum 99 per cent pure, at 82c. per pound c.i.f. Pacific Coast. It appears that prior to the time of delivery defendants gave notice that they would not fulfill their agreement, but would repudiate it, whereupon plaintiff was obliged to buy the tin in the open market and pay 91c. per pound. The case was discontinued as to the Superior Metal Co. upon the showing that it was only a broker in the transaction.

There were various letters and telegrams passed between the parties, beginning with the telegraphic offer of the Superior Metal Co., of New York, to Emar Goldberg, at San Francisco, on April 6, 1918, advising him that a firm bid would probably secure "25 Chinese" on steamship Canada, reported to have sailed on March 26 from the Far East, at 82c. per pound on the Pacific Coast. Goldberg replied that his party thought the price was high, but would accept confirmation at 82, and asked the broker to try to secure a price of 81 and wire confirmation to National Smelting Co., San Francisco, which he said was "O.K." On April 8 the broker telegraphed the National Smelting Co., confirming the purchase for it of "25 Chinese tin," as per telegram of April 6, at 82c., sellers Cutler Bros., and said, as its name was unknown in New York, it was requested to telegraph references. The smelting company did this, referring to the First National Bank in San Francisco. This was further confirmed by letter dated April 8. Now, on the same day, the broker (Superior Metal Co.) telegraphed the smelting company, asking it to have the bank telegraph a guarantee of payment on presentation of documents on arrival of the tin at the Pacific Coast, as it had no rating, and Cutler Bros. were becoming impatient, as they could sell the tin in New York at 86c.

More Letters and Telegrams

In the meantime the smelting company had written the broker confirming its telegram, giving its bank references and further confirming its purchase of the tin. On April 9, it sent the broker a telegram saying it was prepared to take care of the draft on arrival of the tin. Goldberg also telegraphed the broker that Cutler Bros. would be held to the contract if the tin was not delivered. The broker prepared contracts and sent them for acceptance of the smelting company. These were accepted and returned, but were never signed by Cutler Bros. On April 12, Cutler Bros. wired the First National Bank of San Francisco, asking if it would guarantee to pay their draft for twenty-five tons of Chinese tin sold National Smelting Co. On the same day Cutler Bros. wrote the broker, quoting this telegram, saying that unless they received answer from the bank that day, they would not sign the contract prepared by it, but would return such contract and consider same cancelled. The bank replied on April 13, accepting the order for payment of the draft, saying guaranty was unnecessary.

On April 17, the bank sent a telegram to Cutler Bros., advising them that the bank had opened a credit in their favor for $50,000 for the account of the smelting company to cover drafts as shown by the bills of lading attached, calling for the tin. On April 18, Cutler Bros. wired the bank that they would not accept the guaranty at that time. In the meantime, the smelting company had telegraphed the broker (on April 16) that the bank guarantee was no part of the contract, but, to avoid trouble, it had gotten guarantee.

Valid Contract Established, Says Court

The series of telegrams and letters was held by the trial court not to constitute a contract valid and existing between the parties, but the Supreme Court of New York, Appellate Division, thought otherwise, and reversed judgment of the lower court. It said all the necessary elements of a valid contract appear to have been understood to be present by the parties, and nothing was left to any future agreement. Cutler Bros. did not claim that the written contract, drawn up by the broker metal company, did not contain all the elements of a contract as agreed upon by the parties in conformity with the telegrams, and the refusal to carry out the contract by Cutler Bros. was due solely to the failure to furnish them with a bank guarantee, said the court.

When a valid and binding contract had been made between the parties, neither had the right to impose other conditions. The additional condition for a guarantee (and not a reference) was made by the sellers, Cutler Bros., apparently in the hope, says the court, that it might furnish a pretext to break the contract, as they desired to obtain a higher price for the tin on a rising market. They insisted on an immediate reply and claimed same came too late, though the buyer was under no obligation to do anything further, but yielded in its desire to receive the tin it had bought in good faith.

Delivery Delay Excused by Mandatory Order from Government Where Contract So Stipulates

The Supreme Court of New York, in Appellate Term, has ruled, on a case appealed to it, that the seller, having taken an order "subject to war hazards and to delays due to Government action over which the seller has no control," was not required to make delivery of the products within the time specified in the contract of purchase, where he was unable to do so because of a mandatory order from the Government for a large portion of his June product. (180 N. Y. S., 447.)

Where the seller brought an action to recover for buyer's refusal to accept goods, and the buyers defended on the ground that the goods were not delivered within the time specified in the contract, it was a question of fact, to be determined from evidence, whether the buyers had by their conduct led the seller to believe that delivery within the contract time had been waived.

Again, where the buyer's conduct had led the seller to believe that delivery within contract period was waived, the seller would be entitled to a reasonable time notice of a new delivery date before being held in default.

Properties and Constitution of Glues and Gelatines—II

The Effect of Electrolytes Upon Degree of Dispersion; and the Structure of Gelatine Sols—Action on Viscosity Not Regular—Protein Ions—Thread-like Structure—The Relation of Melting Point to Viscosity of Jell Strength*

BY ROBERT H. BOGUE, PH.D.

THERE is considerable evidence tending to indicate that viscosity is very greatly influenced by degree of dispersion, and many facts even suggest that many of the previously described factors[12] affecting viscosity do so through the medium of producing a change in the degree of dispersion.

The relation between viscosity and degree of dispersion does not, however, appear to be a simple one. Throughout the literature on the subject one finds the citations about equally divided between those who obtain a decrease in viscosity with a decrease in degree of dispersion, and those who find the ratio to vary inversely. Wo. Ostwald[13] arrives at the conclusion that "other conditions being constant, a dispersoid reaches its highest viscosity at a medium degree of dispersion," but adds that "the experimental verification of such a conclusion is a problem of the future." Results obtained in the present investigation not only confirm this point of view but perhaps may furnish a part of the "experimental verification" desired by Ostwald.

The structure of solutions of the proteins has long been a rife subject for speculation, and some of the work described herein has led to the presentation of a modification of the net-structure theory.

The Effect of Electrolytes Upon the Degree of Dispersion

In testing the effect of several electrolytes on jell strength, it was found[14] that in nearly every instance the presence of the electrolytes decreased the jell strength, there being in some cases a preliminary slight increase. There may conceivably be three ultimate reasons for such a depression:

The degree of dispersion may be increased. It is reasonable to assume that a molecularly dispersed system would be of more nearly a watery consistency and would not jell.

The degree of dispersion may be decreased. We have direct proof that the jell strength is considerably lowered and may even remain liquid, when the degree of dispersion is so far decreased as to result in visible flocculation.

The protein molecules may have undergone hydrolysis. This point was tested by precipitating the protein of a glue, after it had been in contact with different salts for some time, in a 35 per cent saturated solution of magnesium sulphate. The per cent of nitrogen thrown down in the precipitate was in each case greater than that of the control to which no salt was added, as is shown in Table XX.

In the light of the information obtained from a large number of experiments on the magnesium sulphate precipitation of the proteins of glue,[15] it becomes permissible to conclude that the added salts do not produce any cision or hydrolysis of the ultimate protein molecules themselves. We conclude, therefore, that the lowering of the jell strength may be due either to an increase or a decrease in the degree of dispersion.

Action on Viscosity Not Regular

The effect of the added substances on viscosity[16] is not so regular as the effect on jell strength. We find these substances arrange themselves into four groups with respect to their action on viscosity

Those which raise the viscosity constantly.

Those which lower the viscosity constantly.

Those which raise the viscosity to a maximum, beyond which they produce a drop.

Those which have no appreciable effect.

In studying the causes of this irregularity of action, we are especially aided by the third class, which produce first a rise followed by a decrease in viscosity. Sodium hydrate and acetic acid when added in regularly increasing amounts produce a noticeable increase in turbidity, a decided increase in viscosity and quite suddenly a sharp drop to a solution of water consistency. Very shortly after this drop begins visible flocculation occurs, which is reasonable evidence that the process has been accompanied throughout by a continuing decrease in degree of dispersion. But as the degree of dispersion decreases beyond a certain optimum size, the direction of the viscosity curve changes. This shows, therefore, that both an increase and a decrease in viscosity may

TABLE XX EFFECT OF ADDED SUBSTANCES ON HYDROLYSIS
35 Per Cent Saturated $MgSO_4$ ½ c c 1-4 H_2SO_4

Glue H_4	Per Cent of Total N	Glue H_3	Per Cent of Total N
Control	57 9	Control	72 5
33 per cent $MgCl_2$	67 2	33 per cent $MgCl_2$	74 1
33 per cent KI	65 5	33 per cent aluminum alum..	75 2
33 per cent CH_3COOH	60 9	33 per cent chrome alum.	75 1
33 per cent chloral hydrate	58 7	33 per cent formalin	74 1

accompany a continually decreasing degree of dispersion. It also shows that the degree of dispersion which is optimum for maximum viscosity is not the same as that which is optimum for maximum jell strength.

If the attempt is made to explain the action of those substances which constantly raise or constantly lower the viscosity, it may be expressed in the same terms. Magnesium chloride and chloral hydrate both increase the viscosity constantly. We may assume that the mechanism by which they do this is by decreasing the degree of dispersion. The reason why such high values are obtained with them in contrast to the much smaller maxima obtained by sodium hydrate and acetic acid is probably due to the great velocity of the change in the

*For Part I, see CHEM. & MET. ENG., vol. 23, No. 1, p. 5, July 7, 1920.

[12]See p. 11.

[13]Ostwald, "Handbook of Colloidal Chemistry," 1st Ed., (1915), p. 177.

[14]See p. 11.

[15]See Part III.

[16]See p 11

latter cases, which brings the viscosity past its maximum in a very brief interval of time, whereas with the former the change is gradual.

In the case of the nearly regular decreases in viscosity obtained on adding sulphuric and phosphoric acids, there are indications that they pass through a maximum point attained very rapidly on the addition of only traces of the acids, and that further additions produce further decreases in dispersion, but at a rate comparatively slow. Eventually, however, a visible separation of a flocculent precipitate occurs.

The action of potassium iodide appears to be different. In this case the solution resulting from its addition to a glue has a watery consistency, but does not, even on long standing, show any signs of precipitation. The solution becomes less turbid, it filters more readily, the "protective" action of the gelatine on preventing precipitation of insoluble salts becomes markedly less and, in general, it shows to a much greater degree than the control the properties of a molecularly dispersed system. It seems, therefore, reasonable to conclude that the addition of potassium iodide to a glue or gelatine results in an increased degree of dispersion, with the attendant decrease in both viscosity and jell strength.

The last class of substances, e.g., those which have no appreciable effect on viscosity, should, according to our argument, have no appreciable effect on jell strength. This conforms with the results obtained.

Structure of Gelatine Sols

As yet no attempt has been made to define the intramolecular mechanism by which a change in degree of dispersion is brought about, not to speculate upon the specific structure which the colloidal aggregates are assumed to possess. Considerable evidence has been presented in the literature[17] intending to show the presence of a net-structure in protein solutions. The presence of such a structure would unquestionably reveal itself in producing a high viscosity, for a net structure would offer a considerable resistance to any force involving the deformation of that structure, and viscosity, as it is usually determined, by pouring the liquid through a capillary tube, or by the rotation within it of a suspended disk, would involve such a deformation. This was shown by Garrett[18] who found that "the logarithmic decrement of a disk oscillating in a gelatine solution is not a constant, as it is in water or other homogeneous fluids, but, on the contrary, increases as a linear function of the time. This was traced to adhesion between the disk and the protein; if the disk was taken out of the fluid and washed the initial value of the decrement was always the same." He assumed that proteins of the net structure adhered to the oscillating disk.

The writer has shown[19] that mechanical agitation and preliminary heating also decrease the viscosity, and Garrett[20] found that in a solution of gelatine which had been boiled the logarithmic decrement of an oscillating disk did not increase with time, but remained constant. These all point to the fact that the net-structure may be more or less destroyed by mechanical agitation and heat, and conversely contribute toward the support of a theory of an extraordinary structure of some kind in the solutions of gelatine.

But as we are especially concerned here with the relations between viscosity and degree of dispersion, the questions should be considered: What is the internal mechanism by which a change in degree of dispersion, and consequently of viscosity, is brought about? How is one to regard a change in degree of dispersion when applied to a molecular net-structure? And if such a structure does not satisfy the conditions, what modifications to the theory are necessary?

J. van Bemmelen[21] has said: "The formation of flakes which are precipitated in a liquid is dependent on a change in the surface tension of the liquid membranes surrounding the colloid particles, of such type that these membranes between the particles are torn at some point, thus permitting the particles to form aggregates." And Wo. Ostwald[22] states that "the relation of positive to negative surface tension between the disperse phase and dispersion medium determines the degree of dispersion." It has been shown by W. Frei[23] that gelatine diminishes the surface tension of water; that the surface tension of a gelatine solution is increased by the addition of small quantities of alkali, and diminished by the addition of small quantities of acid; and that the addition of the anions SO_4, Cl and NO_3 and the cations Na, K, Mg and Ca increase the surface tension of a neutral gelatin solution in the order given. J. Loeb[24] has, however, recently shown that all such determinations are valueless unless performed either directly at the isoelectric point (for gelatin 2×10^{-5}N) or at an exactly determined hydrogen ion concentration above or below this point,[25] and in the absence of an excess of electrolyte.

Protein Ions

These investigations establish beyond any doubt the correlation between degree of dispersion and surface tension, but it has also been shown by many workers[26] that acids and bases combine with the proteins resulting in the formation of protein ions. The older belief was that these were formed only by the combination of the end $-NH_2$ and -COOH groups of the polypeptide chains, but an abundance of evidence has been brought to bear against this view, to the end that the -CONH-groups within the molecule are to a preponderant degree responsible for such combination. And not only acids and bases, but also neutral salts have been shown[27] to contribute to the formation of protein ions.

We are therefore led to the conclusion that *the addition of electrolytes to a gelatin solution may, and usually does, result in the formation of protein ions, and that the electrical condition resulting within the solution from this ionization produces a change in the relation of positive to negative surface tension between the disperce phase and the dispersion medium, and that this change, in turn, affects directly the degree of dispersion of the disperce phase, or gelatin molecules. The alteration of the degree of dispersion reveals itself*

[17]Garrett, *Phil. Mag.*, 6th Ser., vol. 6 (1903), p. 374. Wo. Ostwald, "Handbook of Colloidal Chemistry," 1st ed., (1915). Sutherland, *Proc. Roy. Soc. London*, vol. 79B (1907), p. 130. Hardy, *Am. J. Physiol.*, vol. 24 (1899), p. 158.

[18]*Loc. cit.*, cited after Robertson "The Physical Chemistry of the Proteins," 1st ed. (1918), p. 327.

[19]See p. 6.

[20]*Loc. cit.*

[21]"Die Absorption" Gesammelte Abhandl., Dresden (1910), p. 22. Cited after Ostwald, *op. cit.*, p. 88.

[22]*Op. cit.*, p. 181.

[23]"Zur Theorie der Haemolyse," *Diss.*, Zurich (1907).

[24]*J. Gen. Physiol.*, vol. 1 (1918-19), pp. 39, 237, 363, 483, 559.

[25]The determinations upon which this discussion is based were performed at the "neutral point," as determined by litmus (H^+ ion concentration = 0.0_61).

[26]Blasel and Matula, *Biochem. Z.*, vol. 58 (1914), p. 417. Pauli and Hirschfeld, *idem*, vol. 62 (1914), p. 245. Robertson, *op. cit.*, p. 20. Loeb, J., *loc. cit.*, pp. 483, 559.

[27]Pfeiffer and van Modelski, *Z. physiol. Chem.*, vol. 81 (1912), 239; and vol. 85 (1913), p. 1. Loeb, J., *loc. cit.*

then in a change in the physical properties, as melting point, viscosity, and jell strength.

In the light of this rather broad generalization we may speculate upon the probable structure of the colloid aggregates of the protein molecules. There seem to be some difficulties in the net-structure conception. If the molecules are considered as forming only the intersections of this hypothetical "net," and the "connecting threads" being merely lines of force which tend to bring the molecules together, touching each other at certain points, with perhaps a thin film of the dispersion medium between, then, according to W. N. and W. L. Bragg,[28] the conditions would be met for the formation of a crystalline structure. But no such homogeneously built product results. Again, if the molecules be represented as forming both the intersection points and also the connecting threads of the "net," one is put to some trouble to visualize the phenomena attending an alteration in degree of dispersion. If a decrease in degree of dispersion is conceived of as a coalescence, then wherefore should the process become discontinuous with the formation of flakes? If the process consists only of aggregation, then the surface tension phenomena, coming into play, would eventually result in a separation of the dispersion medium from the disperse phase, leaving the system composed of two liquid phases, or a solid and liquid phase, with a clear line of demarcation between. The occurrence of syneresis with solid jells is of course well known, but it is not known to generally occur in the liquid sols.

Thread-like Structure

But, as has already been pointed out, there is an abundance of evidence pointing toward some kind of an extraordinary structure in protein solutions, so that we are not permitted to regard them as consisting of discrete particles, of the same nature as true solutions. It seems altogether probable to the writer that the disparities between the behavior of protein solutions and the proposed theories of structure may be to a great extent harmonized by conceiving the colloid aggregate as of a thread-like, or streptococcal, structure. The latter similus seems especially to give a clear picture of the situation. The protein molecules may be regarded as the individual cocci, the colloid aggregate as the streptococcic thread. An alteration in the degree of dispersion could now easily be interpreted as consisting of a change in the length of these threads, many uniting to form one, or one breaking into several. If the force tending to unite them were great, cohesiveness[29] might also become a factor, and as the surface energies between the solute and solvent becomes less,[30] a flocculent precipitate may result. Indeed Bordet[31] and Arkwright[32] both have pointed out that acid agglutination of bacteria belongs to the same class of reactions as the coagulation by hydrogen ions, or electrolytes, of amproteric colloids. The behavior of the proteins which led to the belief of the existence of a net-structure in their solutions may be explained with equal ease by the streptococcic structure hypothesis, while, in the congealed state, the maze of intermingled threads would readily account for an apparent net-structure. A deformation of this thread-structure would reveal itself similarly in producing an abnormally high viscosity, and Garrett's[33] findings that the logarithmetic decrement of a disk oscillating in a gelatine solution was not a constant would be explained by an entirely similar manner.

The conception of ionization is especially benefited by the thread-structure conception. Robertson[34] has pointed our a serious inconsistency in the net-structure theory. He recalls that the viscosity is said to be due to a net-structure, and that it is also attributable, primarily, to the protein ions. This also conforms precisely to the findings of Loeb.[35] Therefore, the net-structure within the protein solution must be built up of protein ions. But, he goes on to say, "such a conclusion is totally out of harmony with the prevailing view that ions, in solutions of electrolytes, are mutually independent and physically discrete bodies, and would appear to invite a distinction between the mode of ionization of ordinary electrolytes and that of protein salts." But if we regard a neutral "streptococcic thread" of protein molecules as capable, by a chemical reaction, of forming a protein salt, and this salt, in turn, of ionization, the identity of the "streptococcic thread" need not be lost, and it is still an independent and physically discrete body, capable of developing osmotic pressure, of conducting the electric current, and, in general, of carrying out the reactions associated with ions in electrolytes.

It should be added that these threads need not be considered as of great length, except in special cases. A small number of such molecules or ions combined in this manner is sufficient to account for the experimental facts. It is of especial interest to note that Loeb,[36] in accounting for the ratio of 1 : 3 in the osmotic pressure of calcium gelatinate and sodium gelatinate states, "It is in reality only necessary to assume the existence of compounds of the form Ca (gelatin)$_2$, the two anions of which form one aggregate of two gelatin anions, and to assume further that two, three or more such aggregates of two gelatin anions join to form larger aggregates of four, six, or eight gelatin anions, every one of which keeps its original charge. This would account for all the phenomena observed." Bayliss[37] offered a somewhat similar explanation in accounting for abnormal osmotic pressures with respect to the electric dissociation of solutions of Congo red, namely, "the possibility of aggregated simple ions carrying the sum of the charges of their components."

It is well known, however, that the viscosity of gelatin solutions increases by standing at low temperatures, and, from our knowledge that heating breaks up whatever structure exists, it seems reasonable to expect that this protracted standing at low temperatures may produce the opposite effect, and produce exceptionally long threads, which formation, in turn, is revealed by the high viscosities obtained.

In the light of these reflections it seems reasonable, therefore, to conclude that a modification of the net-structure theory, to the end that the colloid aggregates of protein molecules be considered as united into a "streptococcic thread," accounts somewhat more adequately than the older theories for the several phenomena attendant upon ionization, changes in surface tension, degree of dispersion, viscosity, etc.

[28] "X-Rays and Crystal Structure," London, 1915.
[29] Wood and Hardy, *Proc. Roy. Soc. London*, vol. 81B (1909), p. 38.
[30] See W. Ostwald, *op. cit.*, p. 83.
[31] *Cent. Bakt.*, vol. 54 (1910), p. 150.
[32] *Z. Immunitat.*, vol. 22 (1914), p. 396.
[33] *Loc. cit.*
[34] *Op. cit.*, p. 325.
[35] *Loc. cit.*
[36] *Loc. cit.*, vol. 1 (1919), p. 496.
[37] *Proc. Roy. Soc. London*, Series B, vol. 84 (1911), p. 253.

To summarize upon the effect of electrolytes on degree of dispersion; and the structure of gelatine sols, it has been shown that:

Glues in general are at their optimum degree of dispersion for maximum jell strength.

Glues are below their optimum degree of dispersion for maximum viscosity.

Whenever a substance is added to a glue which produces a decrease in the degree of dispersion, this change is accompanied by an increase in viscosity until a certain optimum size of molecule has been reached, beyond which point the viscosity falls rapidly.

Whenever a substance is added to a glue which produces an increase in the degree of dispersion, this change is accomplished by a decrease in viscosity.

Electrolytes in general produce a decrease in the degree of dispersion: The hydrogen ion acts very rapidly, the hydroxyl ion acts more slowly, and salts in general act slowly.

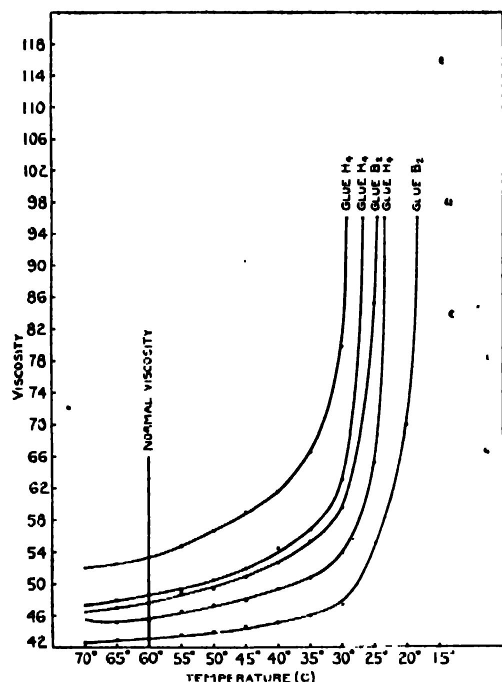


FIG. 11. THE RELATION OF NORMAL VISCOSITY TO MELTING POINT

Some salts, e.g., potassium iodide, may produce an increase in the degree of dispersion.

The internal mechanism by which these changes are brought about in the solution is shown to involve ionization of the protein, an alteration in surface tension, and a change in degree of dispersion.

Inconsistencies in the net-structure theory are pointed out, and a modification in favor of a "streptococcic structure" is proposed.

Many methods have been suggested for the determination of the melting point of viscous substances, but few of these appear to have any value in their application to glues and gelatines. Indeed, the change from a firm solid through varying degrees of hydration and phases of viscid semi-mobility to a true colloidal solution are so gradual and uniform that it becomes difficult to apply the term melting *point* at all, even theoretically. In the present paper an attempt is made to establish a satisfactory method for the measurement of *relative* melting points of glues and gelatines, and to determine the relation which exists between this value and the jell strength and viscosity in these substances.

If one may assume as a *measure* of melting point that degree of viscidity at which a glue will no longer flow through the narrow orifice of a viscosimeter tube, then it becomes an easy matter by taking a series of viscosity readings at decreasing temperatures to plot the point at which the rate of flow would be zero. For comparative purposes, however, it should suffice only to plot the values actually obtained and note the relative rates at which the curves tend to approach the vertical (time of flow = infinity). Thus, if the curve of one glue tends to approach the vertical more rapidly than another, as both are reduced through equal intervals of temperature, then the former has the higher melting point.

Working on this principle, two series of glues were selected, those within each series being of the same jell strength but of different normal viscosity. These were examined for viscosity at 5 deg. temperature intervals between 70 and 15 deg. C.

Relation of Viscosity to Melting Point

The data obtained, when plotted, show unmistakably that the higher the normal viscosity (at 60 deg. C.) of a glue, the more rapidly does it approach the vertical (infinite slowness of flow) with reduction in temperature, which means in the terms of our experiment that the melting point varies directly as the viscosity, or that the viscosity is a function of the melting point.

TABLE XXI RELATION OF VISCOSITY TO MELTING POINT

Concentration, 30 g. glue to 180 g. total weight

Temperature	Grade H_4			Grade B_2	
Deg. C.	1	4	7	8	11
70	45.8	47.4	52.0	42.6	46.4
65	45.4	48.0	52.6	43.0	47.0
60	45.8	48.8	53.8	43.2	47.8
55	46.6	49.4	54.8	43.8	49.0
50	47.4	50.6	56.8	44.0	49.6
45	48.0	52.0	59.0	44.8	51.0
40	49.6	54.4	61.8	45.2	52.8
35	50 8	56.8	66.6	46.0	55.4
30	54 0	63.0	79.8	47.6	59.8
25	65.2	139.6	Set	55.2	85.4
20	140.0	Set	....	70.0	Set
15	Set	.....	....	Set	....

Graphical representations of the above are shown in Fig. 11.

In order to determine if the jell strength was also related in any way to the melting point, another series consisting of five glues of uniform normal viscosity but varying jell strength was run in the same manner as above. If the melting point was concerned only with the viscosity at 60 deg. C. and not with jell strength, then the viscosity runs should remain practically constant throughout the changes in temperature and set at the same temperature.

The data obtained show that from 70 deg. to 35 deg. the viscosity remained practically constant throughout the series. At 30 deg., there began to be some divergence, which at 25 deg. became very pronounced, the glues varying in their viscosities at this temperature as their jell strength. At 20 deg. all were too thick to run except the glue with the lowest jell strength.

Jell Strength

It seems, therefore, that the jell strength is also a function of the melting point, but it should be pointed out that the variation due to differences in jell strength at a uniform normal viscosity are not so great as the variations due to differences in viscosity at a uniform jell strength.

A method described by A. Wayne Clark and Louis

Du Bois[38] has as its object the determination of "jelly value" in terms of the minimum percentage of glue or gelatine which will remain in solid phase when, after putting into solution and cooling to well below 10 deg. C., it is brought gradually up to 10 deg. C. This appeared to be more of a determination of melting point than of any other physical constant, and so was tried out in an attempt to corroborate the above conclusions.

TABLE XXII. EFFECT OF JELL STRENGTH ON MELTING POINT

Concentration, 30 g. glue to 180 g. total weight

Number.	1	2	3	4	5
Jell Strength, Deg. C.	63	64	66	68	70
70	45.8	45.0	45.2	45.2	45.2
60	46.0	45.6	46.2	46.8	46.2
50	47.8	47.4	48.0	48.0	48.0
45	48.8	48.4	49.2	49.0	49.0
40	50.4	49.8	50.8	50.6	50.2
35	52.4	51.4	42.8	53.0	52.6
30	56.0	56.8	58.4	61.0	58.6
25	64.8	71.0	72.8	92.2	96.6
20	105.4	Set	Set	Set	Set

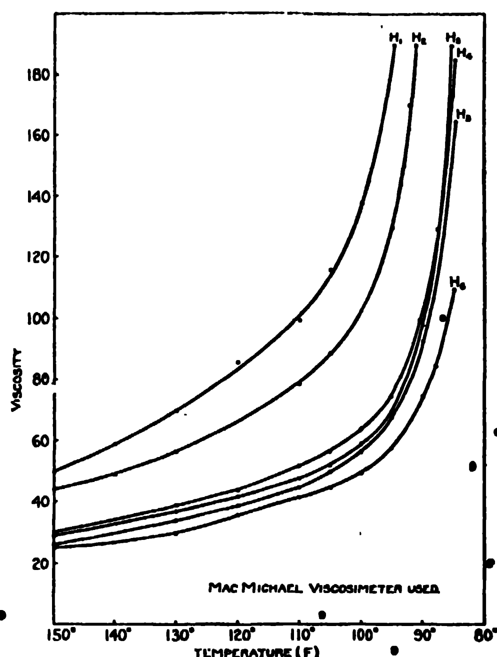


FIG. 12. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF HIDE GLUES

Three sets were run by this method: 1—the standard glues of Grades H_2, H_3, H_4 and H_5; 2—three glues which were of uniform jell strength but varying viscosities; 3—five glues which were of uniform viscosity and varying jell strength.

TABLE XXIII. RELATION OF "PER CENT JELLY VALUE" TO VISCOSITY AND JELL STRENGTH

	No.	Grade	Viscosity	Percentage Glue Added 2	3	4	5	Per Cent Jelly Value
Standard Grades	2	H_2	54.0	s	s	s	s	2
	3	H_3	50.8	ss	s	s	s	2½
	4	H_4	49.4	l	l	s	s	4
	5	H_5	48.0	l	l	l	s	5
Uniform jell strength, varying viscosity	1	H_4	45.6	l	l	ss	s	4½
	4	H_4	49.0	l	l	s	s	4
	7	H_4	55.0	l	ss	s	s	3¾
Uniform viscosity, varying jell strength	1	63	46.2	l	l	l	ss	5½
	2	64	45.8	l	l	ss	s	4½
	3	66	46.0	l	l	ss	s	4½
	4	68	45.8	l	ss	s	s	3½
	5	70	46.2	l	s	s	s	3

Note: s=solid; l=liquid; ss=semi-solid

The results show the "per cent jelly value" to vary inversely with the jell strength in the standard grades, but in the glues of uniform jell strength and varying viscosity there was also a uniform variation, the glue with the highest viscosity remaining solid with the lowest percentage of glue. The glues of uniform viscosity and varying jell strength also varied, the "per cent jelly value" being in inverse ratio to the jell strength.

These results are in every way identical to those obtained by the first method described, and lend additional evidence to the conclusions derived from that set of experiments.

Another method described by C. Frank Sammet[39] has as its object the determination of jell strength by the direct observation of the comparative melting points of the granulated glues. These are soaked in cold water for 1 min., then small amounts placed near the end of a brass strip and the tip of the latter held in water at 40 deg. C. The comparative melting points are noted by observing the order in which the glues melt under these conditions. In order to obtain further confirmation of our conclusions, this method was tried out. The same three series of glues were used as in the previous experiment. The standard grades melted regularly in order of their grade, beginning with the lowest. The glues of equal jell strength and varying viscosities also varied, and regularly, the glues melting in the order of increasing viscosities. But among those glues of equal normal viscosities and varying jell strength, no regular variation could be noted by the method described. Flakes of each glue were then allowed to soak over night in water at 10 deg. C., and small portions of the resulting jell treated as described. The same results were obtained as before. A jelly was then made in 1 to 5 solution and portions of this treated as described.

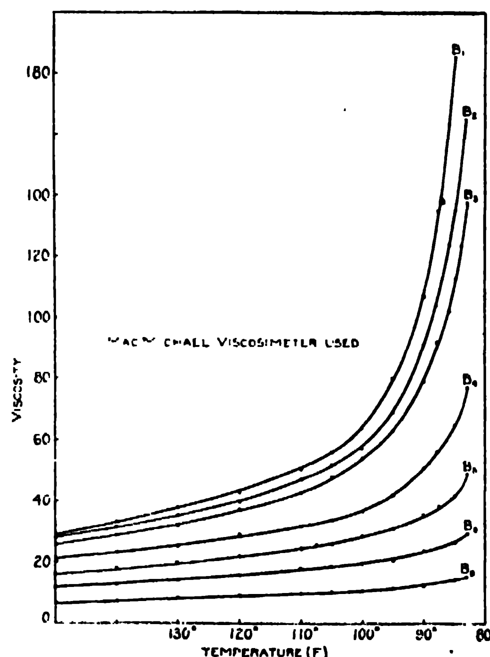


FIG 13. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF BONE GLUES

This time the melting point varied regularly in order of increasing jell strength, but this variation was very slight. The reason of failure to obtain a uniform variation in the first two trials was probably due to differences in the thickness and hardness of the par-

[38] *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 707.

[39] *Idem*, vol. 10 (1918), p. 595.

ticles and the ease of hydration. No. 4, which melted first, was very thin cut and produced a clear transparent jelly. The others were more firm and opaque.

The final results on this set of experiments are entirely analogous to those obtained by the other methods.

TABLE XXIV. RELATION OF JELL STRENGTH AND VISCOSITY TO MELTING POINT

		Grade	Jell	Visc.	Order of Melting		
Standard grades	2	H_2	..	54.0	4th		
	3	H_3	..	50.8	3rd		
	4	H_4	..	49.4	2nd		
	5	H_5	..	48.0	1st		
Uniform jell strength, varying viscosity	1	H_4	65	45.6	1st		
	2	H_4	65	47.2	2nd		
	3	H_4	66	48.0	3rd		
	4	H_4	66	49.0	4th		
	5	H_4	66	50.2	5th		
	6	H_4	64	51.0	6th		
	7	H_4	64	55.0	7th		
	8	B_3	68	43.2	1st		
	9	B_2	70	45.8	2nd		
	10	B_3	70	47.0	3rd		
	11	B_3	70	48.0	4th		
					Granulated	Cold Water Jell	1-5 Jelly
	1	H_5	63	46.2	2nd	2nd	1st
	2	H_5+	64	45.8	4th	4th	2nd
	3	H_4	66	46.0	3rd	3rd	3rd
	4	H_5+	68	45.8	1st	1st	4th
	5	H_3	70	46.2	5th	5th	5th

VISCOSITY AND TEMPERATURE

In order to ascertain if the viscosity increased proportionately to the decrease in temperature for all glues, all grades of both hide and bone glues were measured for viscosity at temperatures from 150 to 83 deg. F. in the MacMichael viscosimeter.[40]

An examination of these results, shown in Table XXV, and expressed graphically in Figs. 12 and 13, reveals that in the bone glues the viscosity varies regularly from the highest to the lowest grade at every temperature. In other words, the viscosities are all normal. In the hide glues, however, there is one exception to this, e.g., glue H_3 is of abnormally low viscosity, lower at most temperatures than glue H_4, which it should normally exceed. It will be seen, however, that as the temperature of setting, or melting point, is approached, e.g., at 86 deg. and below, the viscosity of glue H_3 is greater than that of glue H_4, which is what one would expect if jell strength is a function of melting point, as seems to be the evidence of the previous experiments. In all other cases in this series the viscosities are normal at all temperatures.

TABLE XXV. VISCOSITIES OF STANDARD GLUES AT VARYING TEMPERATURES (MacMICHAEL VISCOSIMETER USED)

Temperature Deg. F.	Hide Glues H_1	H_2	H_3	H_4	H_5	H_6	Bone Glues B_1	B_2	B_3	B_4	B_5	B_6	B_7
150	50	44	29	29	26	25	29	28	26	21	16	12	7
140	59	49	33	33	30	28	33	32	29	23	18	13	8
130	70	57	37	39	34	30	38	35	32	25	20	14	9
120	86	68	42	44	39	36	43	40	37	29	22	16	9
110	100	79	48	52	45	42	51	47	43	32	25	18	10
105	116	89	52	57	50	45	56	52	48	34	26	19	11
100	138	103	59	64	57	50	64	57	54	37	29	20	11
95	188	130	70	75	68	58	80	69	63	42	31	21	12
90	...	210	100	100	93	75	107	91	79	51	36	24	13
88	...	...	120	122	112	85	133	104	92	56	38	..	..
86	...	...	162	155	143	100	165	124	102	..	..	..	..
85	...	...	205	185	165	110	186	136	113	65	42	27	15
83	...	...	...	...	...	...	...	165	138	77	49	30	16

Many further runs were made of sets having uniform jell strengths and varying viscosities, and of sets having uniform normal viscosities and varying jell strengths, but as these all point to the same conclusions and only corroborate data already obtained they will not be tabulated.

From these several experiments it seems pertinent to draw the following conclusions upon the relation of melting point to viscosity and jell strength:

If the jell strength remain constant, the viscosity will vary as the melting point.

If the normal viscosity be constant, the jell strength will vary as the melting point.

In normal glues wherein the viscosity varies as the jell strength, the so-called "grade," which is nearly always based primarily upon jell strength, will of course vary as the melting point, but in many glues wherein the viscosity is abnormal to the jell strength the melting point will represent the resultant of those factors which control the viscosity and jell strength, and a "grade" based upon melting point methods would in such cases presumably represent a closer approximation of the true value of the glue than is usually obtained by the present methods."[41]

Inasmuch as it has been shown herein that jell strength and viscosity are *both* functions of the melting point,[42] it is suggested that melting point methods be substituted for the customary examinations of jell strength and viscosity in the grading of glues.

As it has further been shown that a measurement of the viscosity at low temperatures[43] is in effect a measurement of melting point, it is suggested that this method be used, and the MacMichael viscosimeter is recommended as an instrument by which such measurements may be carried out with the greatest degree of speed and accuracy. Such a procedure will also eliminate the necessity of maintaining a set of standard grade glues in the laboratory, as the instrument may be standardized against any common viscid substance.[44] There is thus obtained a decided saving in time, space and labor, a better control of conditions, greater accuracy, and a truer evaluation of product than by the use of the old and time-honored methods.

(Part III, on The Relations Between Physical Properties and Chemical Constitution, and The Influence of Size of Molecule Upon Physical Constants, will be printed in a subsequent issue.)

Use of Sulphur Dioxide in Candy Prohibited in Pennsylvania

Chocolate-covered cherries containing sulphur dioxide have been found offered for sale in the Pennsylvania market. As this is in direct violation of the law pertaining to adulteration and use of preservatives in food, Director Foust of the Pennsylvania Department of Agriculture, Bureau of Foods has taken the matter up with the confectioners' organization in the state and the trade papers calling attention to the fact that the Pennsylvania food laws specifically prohibit the sale of any confectionery containing sulphur dioxide regardless of the quantity.

The majority of the manufacturers have announced that they will use no sulphur dioxide in confectionery sold in this state. The dealers who have not taken this stand will be prosecuted to the limit of the law.

[40] The viscosity is here measured directly in degrees of angular deflection, and is produced by the torque exerted upon a steel wire supporting a disk suspended in the rotating liquid. See Herschel, *J. Ind. Eng. Chem.*, vol. 12 (1920), p. 282.

[41] The final criterion for "grade" must be the strength of the glue in service. For the consideration of this phase of the subject see Part V.

[42] A discussion of the causes of variation in melting point will be presented in Part III.

[43] From considerations developed in Part V a temperature of about 90 deg. F., or 32 deg. C., is recommended.

[44] A 65 per cent solution of cane sugar at 90 deg. F. answers very well.

The Problem of the World's Supply of Energy*

Early Exhaustion of Fossil Fuels Will Require Use of Other Sources; Water, Wind and Sun Power. Continual Increase of CO_2 in Atmosphere Will Reforestate Temperate Zones and Drive Civilization Back to Its Birthplace: Mesopotamia, the Mediterranean, Central America and Peru

BY SVANTE ARRHENIUS, PH.D., M.D., D.SC., LL.D.

SINCE the days of Watt the physical well-being of mankind has become more and more dependent on fossil fuels. The life of today would be impossible without the enormous supply of coal necessary to industrial establishments, for railways and steamships, in the metallurgical arts and for the heating and lighting of our houses. The demand for fossil coal has increased very rapidly, about doubling every ten years during the last century, and is now some 1,200 millions of metric tons per year. It is clear to those who have studied the matter that our coal fields will be exhausted after a certain time. When this calamity will happen, and the probability of the discovery of substitute sources of energy are questions of vital importance.

Estimated Life of Coal Fields

One of these questions was answered by the Geological Congress in Canada in 1913. The quantity of fossil coal down to a depth of 1,800 m. would suffice for 6,000 years, at the present rate of consumption, if it were all recoverable, but a very great deal of this coal occurs in beds too thin for profitable working, a considerable part is lost as dust, or left in the mines as pillars, and further, the use of coal will probably increase in the future just as it has done in the past. It is, therefore, necessary to reduce the indicated time considerably, probably to one-fourth, or about 1,500 years.

Of the different countries the United States, in the matter of coal, has the best position, as it has in the matter of other natural resources. The coal treasures there will probably suffice for about two thousand years. The worst situation among the great coal-producing countries is that of England, where the coals will be exhausted within a little less than two hundred years. Germany will be able to meet its demands during a little more than a thousand years.

This time of some few hundreds or thousands of years is very short compared with the time estimate made at the Geological Congress referred to, and only about 1 per cent of the period of man's existence, which probably lies between the thousandth and ten-thousandth part of the time during which life has existed on our earth. It is quite clear that we must soon ration our coal, and substitute as far as possible for fossil fuel other sources of energy.

Substitution by Mineral Oils Improbable

It is often suggested that we might use mineral oils as fuel instead of coals. This advice rather reminds one of the words of Marie Antoinette: "If the people complain that they have no bread to eat, why do they not eat cakes." Petroleum is a far more valuable fuel than coal, because it is much easier to transport and to use effectively. The world's yearly production of mineral oils represents not quite 3 per cent of the energy contained in the yearly production of coal. Petroleum ought, therefore, to be reserved for better purposes, e.g., production of light and lubricants. Further, the recent failure of many oil fields indicates that we must economize this valuable material. According to David T. Day, U. S. Geological Survey, the production per well in the Appalachian oil field decreased from 207 barrels in 1861 to 1.73 barrels in 1907. The production of West Virginia had, in 1910, declined 56 per cent from its maximum output. The oil obtained from the New York and Pennsylvania oil fields fell to 50 per cent from the year 1891 to 1898. If we suppose the present fields of the United States and the present rate of exploration should continue, petroleum would be exhausted by about 1935, and if the present production goes on with no increase, the product would be exhausted in about ninety years, said Charles R. van Hise in 1910, who has done so much to warn against waste in the expenditure of our natural resources. The output of mineral oil has been kept up through an enormous increase in the number of oil wells in each field, and by opening up new fields, e.g., in Oklahoma and California. There are very rich new oil fields in the world which are still not used, or only in a small degree, e.g., in Mexico and Mesopotamia and Turkestan, but certainly they will not last as long as the coal fields, even if the production of this fuel is restrained to but 3 per cent of the simultaneous production of the latter.

Still much less is the hope that sources of natural gas may deliver more than a small fraction of the fuel value of the oil fields. Even peat, although an important fuel, can by no means compete with coal. Thus, for instance, in the United States the available peat is less than one-half of one per cent of the estimated coal. Probably the relative value of the European peat bogs is about the same as compared with the European coal fields. For heating purposes petroleum and peat cannot play an important rôle as compared with fossil coal.

Water Power as Substitute for Coal

It is very often said that for coal should be substituted the water power of our rivers, often called the "white coal." According to an estimate of Engler, the energy which might be economically taken out from these waterfalls amounts to about 60 per cent of the energy of the present output of coal. But even this figure seems too high, for many of the waterfalls are located in rather inaccessible parts of the world, where no industry is likely to be developed for a long time. So it seems wise to reduce the figure of Engler about 50 per cent. If this is done, it is evident that there is little hope that white coal will be able to substitute for black, except in a small degree. For heating purposes water power

*Delivered through Dr. Allerton S. Cushman in Philadelphia, May 19, 1920, on being awarded the Franklin Medal by the Franklin Institute.

will probably not be used in a noteworthy degree, because used directly for the production of mechanical or electrical energy it is at least three times as valuable as the equivalent quantity of heat. Further, the well-situated waterfalls are already developed in greatest part, at least, in Europe. Thus, for instance, in Switzerland nearly all the waterfalls which have a commercial value are developed, and in a little less degree the same is true in all the other industrial countries of Europe.

Estimated Water Power Resources

During the unhappy situation created by the World War, when there was a great scarcity of fuel, and even now, when fuel is extremely expensive, waterfalls were and rapidly are being put to use. Within a short time, therefore, this source of energy will be taken into the service of man, not sensibly diminishing the demand for coal. An estimate of the power of the waterfalls has been made by Koehn and by Keplan, and is of much interest. Although the figures are only approximate, I give them in the accompanying table, with some later corrections. The power is given in millions of horsepower and horsepower per inhabitant:

TABLE. WATER POWER RESOURCES OF THE WORLD

Country:	Hp. in Millions	Hp. per Inhabitant
Asia	236	0.27
Africa	160	1.14
North America	160	1.17
South America	94	5.25
Europe	65	0.13
Australia	30	3.75
Total	745	Average 0.45
Canada	26	4
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan Countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

These figures are not altogether reliable. Thus, for instance, Leighton gives for the United States 200 millions, and van Hise says: "Others regard this estimate as too high, and say 100 million horsepower is nearer to truth." I think this latter figure is more to be depended on. Van Hise is of the opinion that even it will meet the needs of a population of 250,000,000. Since his estimate made in 1910 the demands for power have greatly increased, and probably only about one-half of the energy given in the table above is available at present without excessive initial expenditures. We may, therefore, assume 0.5 hp. per inhabitant as adequate to present needs. We find then that Europe and Asia are the only parts of the world where water power is really scanty—in Asia the demand is still so small that even this power per inhabitant is more than sufficient. Especially fortunate are those countries, such as South American Republics, and Australia, where water power per unit of population is well beyond this figure, and may be developed at a moderate cost. The United States is among the great powers very well endowed in this regard, as in most other natural sources of wealth, such as metal, ores and coal. In Europe, Iceland ranks first, because of its small population, and the old Saga Island may yet know a new and flourishing era. Then come the Scandinavian countries, the first being Norway, which has already greatly profited through its cheap power, and is destined to be one of the leading industrial countries of the future. Sweden and Finland possess enough power for their needs. Their waterfalls are not high, and in general are far from established lines of communication, especially from those of the ocean. Denmark has scarcely any water power, as also Holland. Among the other countries of Europe the Balkan States have more power than their industrial needs require. Switzerland may also be regarded as having a nearly sufficient supply of water power, which is the more fortunate, as this highly industrial country does not own any coal deposits. The same is true of the new Austria, which has lost its old coal districts but has retained by far the greater part of the waterfalls of the old Austria, so that it now probably ranks with Switzerland in this respect. Spain is also a relatively well situated state, but which up to the present has not made much use of its resources. In general, the waterfalls in the Alps, Spain, Italy and the Balkans are high and of great value. For the industries of France and Italy water power is of the greatest importance, although it must be regarded as insufficient for nations so highly developed. At the end of the list come the three great powers of Great Britain, Germany and Russia, with only a fiftieth horsepower per inhabitant. Russia is an agricultural country, with a very small demand for power, and agriculture will probably remain its chief industry because of its small power resources, both in coal and water. England and Germany, now the most highly developed industrial countries in the world, will undoubtedly also, in the future have agriculture for their chief industry. Probably a great part of these countries will again be covered by forests, as they were in the time of Tacitus.

It is often asserted that the power of tidal waves should be utilized. Of course, this is possible, but doing so on a large scale would involve an initial investment not justified by prices likely ever to be obtained for power. The energy of the tidal wave is so widely distributed along the shores of the oceans that it is impossible to commercially collect a sensible part of it. It is quite in contrast to the energy of fossil fuel and waterfalls.

Solar Energy Accumulated in Plants

All available energy on the earth has its origin in solar radiation. Of this energy a small part, 0.12 per cent, is accumulated in vegetation, which, however, is great as compared with the energy of the coal burned in the industries. A detailed calculation, made by Prof. Schroeder, of Kiel, shows that about twenty-two times as much energy is yearly accumulated in plants as is represented by the coal consumed in the same time. Of this energy in vegetation 67 per cent is taken up by the forests, 24 per cent in cultivated plants, 7 per cent in the grass of the steppes and 2 per cent on desert lands. The energy collected by forests may be used for heating purposes, and exceeds every year that of the coals burnt by about fourteen times. But, unhappily, the greater part of this energy is collected in tropical areas, and the highly cultivated countries are so nearly deforested that their production of wood is not nearly sufficient as fuel for their industries. Further, the wood produced in civilized countries is needed for the production of paper, pulp and lumber. In forest lands the refuse from the woods may be sufficient for domestic purposes, and during the war even the industrial needs of certain countries for combustibles were met by wood, where the importation of coal was hindered by the

blockade. The costs, however, were very high, due to the expensive transport from the forests to the industrial centers. The transport of wood from the immense forests in the tropics to industrial countries seems impossible on economic grounds. The forest lands possess, therefore, an advantageous position in this regard. Before other industrialized countries will be able to substitute wood for coal an economic solution of the transportation problem is necessary, which at present seems fraught with exceedingly great difficulties.

Power From Windmills

Two other sources of energy, greatly dispersed in form, remain to be considered, namely, those of the winds and of sunshine. They are extremely great, and exceed that of simultaneous burnt coal from 5,000 to 70,000 times, respectively. The energy of the winds is taken up by windmills, which have been in use in Europe since the eleventh century. The great objection to wind as a source of power is its variability, and the high installation costs per unit of power continuously deliverable. It has been proposed to store the energy of the wind by means of accumulators, charged from windmills, and to use these accumulators during times of calm. But even in windy countries, e.g., Denmark, this method is extremely uneconomical, as compared with coal or wood at their present price. Windmills are widely used for pumping water, both in the New and the Old World.

Solar Energy

The radiation of the sun may be concentrated by means of mirrors on a boiler, and this connected to a steam engine. The best known of these solar engines was constructed by John Ericsson, and described in *Nature* in 1888. It was an improvement of an earlier machine constructed in 1860. In his experiments in New York, John Ericsson obtained an effect of one horsepower with a mirror of 10 sq.m. opening. Later, his experiments were taken up on a commercial scale by Mr. Shuman, of Philadelphia, who installed a solar engine, with mirror of 1,200 sq.m. in all, at Meads, 10 km. south of Cairo, in Egypt. The machine was of the Ericsson type, with some small modifications, and auxiliary apparatus. Shuman did not obtain more than half the effect of that obtained by Ericsson, namely 1 hp. per 20 sq.m. mirror opening. After an inspection of Mr. Shuman's plant, Mr. Ackerman thought it possible to introduce improvements which would give as good results as those obtained by Ericsson.

Future of Solar Engines

After improvements the solar engine seems likely to play an important rôle in the opening up for cultivation of great arid districts in tropical countries, as Ericsson maintained with great energy it would do. In these parts of the world are great deserts, such as Sahara, the Arabian desert, the Syrian desert, and those in Mesopotamia, which have in historical times been the seat of flourishing culture. but are now the home of wandering tribes. The decay of these regions resulted from the destruction of their aqueducts and irrigation plants, which the present wandering population is unable to restore. With the aid of the solar machine it would be possible to re-establish the old agriculture and horticulture of these districts, and industrial works founded on its use might also be looked forward to. It is not only in the deserts that the sun in shining nearly continuously during the greatest part of the year, but extensive provinces in Spain, Greece and North America possess such a climate that they would profit by the introduction of the solar engine. In other parts of the world. where the sky is covered for the greatest part of the year, as in the Congo or the Amazons, or which lie nearer to the poles, as the temperate regions, the solar machine will be of very little use.

Probable Results of Total Consumption of Coal

It seems very probable that when fossil fuel has been consumed, civilization and culture will return to its birthplace about the Mediterranean and in Mesopotamia in the Old World, and to Central America and the land of the Incas in the new.

According to some calculations made by me an increase of the carbonic acid in the atmosphere will give the whole earth a more uniform and warmer climate. Therefore, we may suppose that the burning of coal will cause our climate to approach to that of the tertiary age. Furthermore, vegetation is highly stimulated through absorption of carbonic acid in the soil, augmented through an increase of the carbonic acid in the air. It is, therefore, probable, as I have tried to show in my book, "World's in the Making," that the total consumption of the available coal by the industries will, in a high degree, favor agriculture and the growing of forests in the temperate regions now the chief seat of culture. These regions will then know not only harmful, but some useful consequences as the result of the present waste of our fuel resources.

Stockholm, Nobel Institute.

Thermo-Electricity Progress

Prof. C. A. F. Benedicks, of Stockholm University, delivered a lecture on "Recent Progress in Thermo-Electricity" before the Institute of Metals, June 10, 1920. He first gave a short summary of his theoretical views upon the metallic conduction of electricity which explained many matters not made clear by the former electron theory. A consequence of this new theory was that one has to conclude that even in a single homogeneous metal thermo-electric currents do occur; hitherto such currents were believed to be produced only when two different metals were present. Prof. Benedicks gave a concise demonstration of the most important experimental evidence of the truth of this conclusion, utilizing for this purpose various metals.

In liquid mercury it had been possible for him definitely to prove the existence of thermo-electric currents, thus disproving the negative results of previous workers. A consequence of what the lecturer termed his "homogeneous *thermo-electric* effect" was that there must exist the *reverse* effect, the "homogeneous *electro-thermic* effect," including as a special case the well-known Thomson effect. The reality of this effect was duly made clear. A specially interesting demonstration was of a new rotating thermo-electric apparatus made entirely of copper and rotating in a magnetic field, the driving force originating solely from unequal heating (by means of a tiny gas jet) of thin strips of copper.

The point at which the new knowledge brought forward by Prof. Benedicks might have some practical interest lay in the possibility of reducing the thermal conductivity of metals by insulated subdivision into fine wires without impairing the electrical conductivity. The demonstrations were carried out with the aid of a galvanometer provided by the Cambridge & Paul Instrument Co.

Characteristics of Primary Low-Temperature Tar

By Franz Fischer*

IT IS desirable to have an easy method of distinguishing light, primary tar from ordinary tar. Today many wholly useless products are given out as genuine primary tar which in reality have nothing to do with the true low-temperature tar. It is possible, however, that with the characteristics of this tar which we now give, not all of the numerous points of difference are established finally, through which a high-grade primary tar passes from a useless, thick, pitch-like, ordinary tar of the vertical retorts, generators, cokeries and ovens. It is possible too, that a further definition of the given conditions for primary tar may be necessary.

The following characteristics must be required of a good quality of the genuine tar in general:

1. It must be liquid at room temperature; at the most a separation of small amounts of paraffine may influence its ready fluidity.
2. Its specific gravity at 25 deg. C. must correspond to 0.95-1.06.
3. On a thin layer it is a golden red to port wine colored oil.
4. In the fresh state it smells nearly always of sulphuretted hydrogen or sulphide of ammonium. In no case should it smell of naphthalene.

Naphthalene Test

Low-temperature tar, if rightly prepared at moderate temperatures, contains no naphthalene. Naphthalene is a secondary product obtained first at 750 deg. C. and above. A tar, therefore, which contains naphthalene has been heated to a higher temperature than that employed for the production of primary tar. The simplest method of distinguishing them is based upon these facts. At the high temperature at which naphthalene is obtained primary tar is altered in constitution. It contains, as we know, among its constituents paraffine, olefines, naphthalene, phenols, and, only in small proportion, aromatic hydrocarbons. To the first four constituents it owes its low specific gravity, and these four constituents are converted at temperatures higher than 550 deg. C., in great measure, into aromatic compounds by which a rise in specific gravity is caused. Upon these facts is grounded a second method of distinguishing primary tar from ordinary tar.

Thickening Power

If naphthalene is not found, a finer method is required. On the one hand, naphthalene-free tar is not always primary tar, since overheating is not always carried to such a degree that naphthalene is formed; then a naphthalene-free tar may be overheated. A process to distinguish between them is based upon the solubility power of the individual constituents of the tar and their specific gravity.

The hydrocarbons afford a suitable means of following this process, since the phenols are not adapted for the purpose, because the quantity of phenols in the tar is subject to great variations, according to the kind of coal used. We propose, in the next place, to shake up the tar in petroleum spirit, and then separate the pitch and asphalt constituents; the petroleum spirit solution is then freed from acid compounds by alkali and distilled at 200 deg. C. The oil which goes over at temperatures from 200 to 300 deg. C. is separated and taken up, and from the distillate and residue the specific gravity is determined. With primary tar the distillate of 200-300 deg. C. is below 0.90 at 20 deg. C. With other tars, it is nearly 1 or over. The residue obtained by boiling at 300 deg. C., is, in the case of primary tar, thick, like paste, owing to the separation of paraffine; it is completely soluble in petroleum spirit and ether, and at 50 deg. C. has a sp cific gravity below 1. The residue obtained in a similar manner by boiling overheated tar at 300 deg. C. dissolves, after distillation of the 200-300 fractions, only partially in cold petroleum spirit, leaving a residue of solid matter. This residue, also, is not completely soluble in ether, and has at 50 deg. C. a specific gravity of over 1—that is, it sinks in water at 50 deg. C.

*Translated from *Zeitschrift für angewandte Chemie*, 1920.

Sampling

Technical primary tar to the amount of 300 c.c. was thoroughly shaken in a flask for several minutes with 300 c.c. of petroleum spirit. The brownish-yellow red solution was then poured off from the separated dark viscous mass, and shaken up with 200 c.c. of 5N (20 per cent) soda lye in a glass arm. The soda lye was then drawn off, replaced by an equal quantity of fresh lye, shaken up again, and separated. The petroleum ether solution was washed with an equal quantity of water and separated. To remove all traces of water, it was filtered, the petroleum spirit evaporated from a small flask over the water bath until no more went over. The residue was then freed from all fractions boiling at 200 deg. C. or over, in a flask over an asbestos plate, and after filling up a still smaller flask of about 100 c.c. capacity, it was distilled off in a flame at 300 deg. C. The distillate of 200-300 deg. C. then corresponded to about 20 per cent of the residue.

The values thus obtained are given in the following table:

	Technical Tar	Vertical Retort Tar	Mond's Gas Tar
Sp.gr. (20 deg. C.) of fraction 200-300...	0.9100	0.9850	0.9306
Sp.gr. (50 deg. C.) of the residue boiling above 300 deg. C..................	0.9606	1.0931	0.9713

The residues obtained by distillation of the primary tar and Mond's or oven gas tar were thickened to a soapy character by separation of the paraffine. Both were readily dissolved in ether and petroleum spirit in the cold. By rubbing up a sample with an equal volume of acetone the paraffine could be separated in the form of white flakes. The residue of vertical retort tar showed, in comparison with primary tar, a quite minimal separation of paraffine in the form of a thin film and left behind after rubbing up with petroleum spirit the greater part of its substance in the form of a brown, insoluble mass. Ether left a very dark, flocculent mass undissolved.

We examined such a product. The sample failed to show the characteristics No. 3, as the tar remained wholly black. But the naphthalene test showed that it contained no naphthalene. Specific gravity, however, proved that it belonged to primary tar, in which only the lower fractions were wanting.

A sample was obtained from a Breslau gas works. Externally this tar resembled a good quality of primary tar, showed a relatively great fluidity, no smell of naphthalene and the golden red so characteristic of primary tar. But the sp.gr. of 1.084 distinguished it from primary tar as did the positive naphthalene test, its behavior to petroleum spirit.

Permeability of Rubber to Gases—II

Relative Permeabilities to Hydrogen of Oxygen, Nitrogen, Argon, Air, Carbon Dioxide, Helium, Ammonia, Ethyl Chloride, Methyl Chloride and Water Vapor—Factors Summarized and Data Tabulated*

BY JUNIUS D. EDWARDS AND S. F. PICKERING

ON DETERMINING the permeability of rubber to different gases it is preferable to refer the values to some standard rather than attempt to express the permeability in absolute units. In this work, the permeability to hydrogen has been adopted as the standard rate because hydrogen is so generally used for filling balloon envelopes and because the greatest part of our knowledge of the permeability of rubber to gases concerns hydrogen. Accordingly, the permeability to hydrogen of any sample of rubber has been set equal to unity; its permeability to any other gas is given as the ratio of its permeability to that gas to its permeability to hydrogen. In order to secure the required precision it has been necessary to determine the permeability of every test piece, both to hydrogen and to the gas in question.

The hydrogen used in all this work was made in a Kipp generator from a very pure lot of zinc and from c.p. hydrochloric acid. It was purified by passage over soda-lime and anhydrous granular calcium chloride. Conclusive tests made in another connection, on hydrogen generated in this way, showed it to contain not more than 3 or 4 parts in 10,000 of impurity when the generator was properly swept out.[7]

It was found that the ratio of permeabilities for different gases with different samples of rubber was fairly constant—sufficiently so to make the results of interest and value. In all probability the ratio varies somewhat with different samples of rubber; the extent of this variation is indicated roughly by the concordance of the results secured with different samples. In a preceding section a first approximation to the specific permeability of rubber to hydrogen was given; this value multiplied by the ratio of permeabilities of different gases will give approximately the specific permeabilities of those gases.

Permeability of Rubber to Oxygen

It is an interesting fact, first pointed out by Graham, that rubber is more permeable to oxygen than to nitrogen. As a result, air which has passed through rubber contains a higher percentage of oxygen than normal air. The significance of this fact in connection with the use of rubber-coated balloon fabrics has already been discussed by one of us.[8]

The permeability of rubber to oxygen was determined with the apparatus of Fig. 1 with some appropriate minor changes. A current of oxygen was passed over one side of the fabric and hydrogen over the other side. The oxygen passing into the hydrogen was determined with the interferometer, using hydrogen from the same source as the standard of comparison. The oxygen was analyzed volumetrically. The results were corrected to a partial pressure of 100 per cent; the existing partial pressure of oxygen was 99.55 per cent.

The results of a series of tests are shown in Table I. The average ratio of permeabilities, oxygen to hydrogen,

TABLE I. PERMEABILITY OF RUBBER TO OXYGEN AND HYDROGEN

Fabric No.	Permeability to Oxygen Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Oxygen: Hydrogen
50,313	5.09	11.83	0.430
50,313	5.16	11.91	0.433
50,313	4.84	10.81	0.448
50,313	4.97	10.77	0.461
50,313	4.82	11.06	0.435
50,313	5.30	11.52	0.460
Average			0.445

is about 0.45. For this ratio Graham found the value 0.466 and Dewar's[9] curves show a value of 0.500 at 25 deg. C.

Permeability of Rubber to Nitrogen

The permeability of rubber to nitrogen was determined in the same way as the permeability to oxygen except that nitrogen was used in place of oxygen. The results of these experiments are given in Table II: the

TABLE II. PERMEABILITY OF RUBBER TO NITROGEN AND HYDROGEN

Fabric No.	Permeability to Nitrogen Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Nitrogen: Hydrogen
50,313	1.48	8.77	0.169
50,313	1.53	9.47	0.162
50,313	1.45	9.14	0.159
50,313	1.38	9.10	0.152
50,313	1.51	8.76	0.172
50,313	1.27	9.08	0.140
50,313	1.44	9.41	0.153
50,313	1.52	8.73	0.174
Average			0.160

average ratio of permeabilities, nitrogen: hydrogen is 0.16. Graham[10] gives the value 0.18 and Dewar's[11] value is 0.12 (at 15 deg. C.).

Permeability of Rubber to Argon

No experiments with argon were made in the course of the present work because a satisfactory sample of argon was not available. For the sake of completeness, reference will be made to the work of Dewar[12] and of Rayleigh[13] with argon. Dewar found the ratio of the permeabilities to argon and to hydrogen to be $\frac{1.28}{15.6}$ = 0.23 at 15 deg. C. Rayleigh found that in a sample of "air" which had diffused through rubber there was 1.93 per cent argon in the nitrogen after removing

*This paper, of which part I was published in CHEM. & MET. ENG., vol. 23, No. 1, July 7, 1920, is a condensation of a comprehensive report to be issued by the U. S. Bureau of Standards.

[7]Edwards, "Preparation and Testing of Hydrogen of High Purity," *J. Ind. Eng. Chem.*, vol. 11, p. 961; 1919.

[8]Edwards and Ledig, "Significance of Oxygen in Balloon Gas," *Aviation and Aeronautical Eng.*, vol. 6, p. 325; 1919.

[9]*Proc. Roy. Inst.*, vol. 21, p. 813; 1915.

[10]*Loc. cit.*

[11]*Loc. cit.*

[12]*Loc. cit.*

[13]*Phil. Mag.*, vol. 49, p. 220; 1900.

the oxygen. Atmospheric nitrogen contains $\frac{0.94}{78.12}$ = 1.20 per cent argon. He therefore concluded that rubber was somewhat more permeable to argon than to nitrogen. The ratio of permeabilities, argon : nitrogen, calculated from his original data is 1.6. Using the value we have found for the ratio nitrogen : hydrogen, the ratio argon : hydrogen would be 0.26.

Permeability of Rubber to Air

The permeability of rubber to air can be calculated from its permeability to oxygen and nitrogen by means of the proportionality between permeability and partial pressure. According to Sir William Ramsay the composition of air is as follows: Nitrogen, 78.12 per cent; oxygen, 20.94 per cent, and argon, 0.94 per cent. The permeability of rubber to air (referred to hydrogen) would then be

$$P = (0.7812 \times 0.16) + (0.2094 \times 0.45) + (0.0094 \times 0.26) = 0.22$$

In confirmation of this value, the permeability to air was determined directly by the same method used in the case of oxygen and nitrogen. The refractivity of the air which had diffused through the rubber was calculated from the composition as determined by typical analyses. The influence of any probable variation in composition is negligible. The results are given in Table III. Though the data are few in number and not very concordant, the average ratio, 0.23, is in close agreement with the value (0.22) which was just calculated.

TABLE III. PERMEABILITY OF RUBBER TO AIR AND HYDROGEN

Fabric No.	Permeability to Air Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Air: Hydrogen
50,313	2.21	9.45	0.234
50,313	2.14	8.73	0.245
50,313	1.97	9.40	0.210
Average			0.230

The composition of air which has diffused through rubber is a matter of interest. This may be calculated from the permeability to nitrogen, oxygen and argon and their partial pressures. The composition thus calculated is as follows:

	Per Cent		Per Cent
Nitrogen	56.8	Argon	0.9
Oxygen	42.3		100.0

Graham found as much as 41.6 per cent oxygen in air which had diffused through rubber; Edwards and Ledig[14] found 41 per cent.

These facts are of obvious practical importance in many instances.

Permeability of Rubber to Carbon Dioxide

In determining the permeability to carbon dioxide, the regular method with the interferometer was employed. The carbon dioxide was generated from marble and hydrochloric acid and passed over anhydrous sodium carbonate and calcium chloride. Volumetric analysis showed the presence of 99.9 per cent carbon dioxide. The results of a series of these tests are shown in Table IV. Each permeability value recorded in the table is the average of three to six separate observations on the same test piece.

[14]"Significance of Oxygen in Balloon Gas," *Aviation and Aeronautical Eng.*, vol. 6, p. 325; 1919.

TABLE IV. PERMEABILITY OF RUBBER TO CARBON DIOXIDE AND HYDROGEN

Fabric No.	Permeability to Carbon Dioxide Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Carbon Dioxide: Hydrogen
50,313	27.3	9.6	2.84
50,313	28.6	9.7	2.95
Dental dam	42.4	14.0	3.03
26,293	27.0	9.2	2.94
26,293	26.6	9.5	2.80
Average			2.91

The values obtained for the permeability of fabric No. 50,313 to hydrogen and carbon dioxide in the partial pressure experiments recorded in a previous section may be used to obtain a value for this ratio, even though the determinations with hydrogen and carbon dioxide were not made with the same test pieces. The average of seven determinations with hydrogen was 9.71 liters and the average of seven determinations with carbon dioxide was 27.86; the ratio is 2.87, which is in substantial agreement with the ratio 2.91 found in Table IV. It may be concluded that rubber is approximately 2.9 times as permeable to carbon dioxide as to hydrogen.

Values found by other experimenters for this ratio are of interest. Graham[15] gives 2.47 as the ratio (temperature not specified). Kayser[16] gives equations for the variation of permeability with temperature; the ratio of the permeabilities of rubber to carbon dioxide and hydrogen at 25 deg. C., as calculated from these equations, is 2.48. Dewar,[17] using thin films of rubber under tension and having a thickness of about 0.01 mm., found a value of 2.5 for this ratio at 15 deg. C. In another series of experiments at "ordinary temperatures" Dewar found, for the same film, a relative rate of $\frac{30.0}{8.4}$ = 2.8.[18]

Permeability of Rubber to Helium

A knowledge of the permeability of rubber to helium is of great importance at the present time because of the recent development by the U. S. Government of a supply of helium for filling airships. The investigation of the permeability of balloon fabrics to helium was made for the Bureau of Steam Engineering of the Navy Department. The helium employed was furnished by that Bureau and was contained in a steel cylinder under 1,800-lb. pressure. Its composition, as determined by our analysis, was as follows:

	Per Cent		Per Cent
Helium	94.6	Methane	0.2
Nitrogen	5.2		100.0

The methane in the gas was determined by combustion with oxygen. The density of the gas was then determined with the Edwards gas density balance and the composition calculated on the assumption that the residue was nitrogen and helium. Oxygen was tested for and shown to be absent. To confirm the analysis a direct determination of nitrogen was made by absorption with metallic calcium. This method showed approximately 5 per cent nitrogen. When the gas was examined spectroscopically, neon and argon were found to be either absent or present in such small amounts as to be masked by the other gases present. Accordingly, it is thought that no appreciable error was

[15]*Phil. Mag.*, vol. 32, p. 401; 1866.
[16]*Wied. Ann.*, vol. 43, p. 544; 1891.
[17]*Proc. Roy. Inst.*, vol. 21, p. 813; 1916.
[18]*Proc. Roy. Inst.*, vol. 21, p. 559; 1915.

introduced by the assumption that the residue consisted of helium and nitrogen. The refractivity of the mixture as determined with a Zeiss-Rayleigh interferometer indicated an amount of helium within 0.3 per cent of the value shown by the above analysis.

The amount of helium penetrating the fabric was determined with the interferometer in the usual way. Because of the large difference in the refractivities of air and helium, $(2917 - 342) \times 10^{-7}$, the interferometer furnished a very sensitive means of determining helium. Each scale division indicated about 0.004 per cent helium in air; the total amount present could be determined with that precision.

The observed permeability obtained with the gas containing 94.6 per cent helium was corrected to the standard condition; that is, a difference in partial pressure of 100 per cent helium on the two sides of the fabric. This was done by multiplying the observed permeability by the ratio $\frac{100}{94.6 - x}$ where x is the percentage of helium (usually about 0.4 per cent) on the "air side" of the fabric.

In Table V are given the permeabilities to helium and hydrogen of a number of samples of different fabrics. The fabrics tested are from three different manufacturers and include both envelope and ballonet fabrics. Although there was considerable variation in the relative permeabilities, this variation could not be entirely ascribed to experimental error. It seems probable that part of this variation is due to differences in the relative permeabilities of different fabrics to these gases. The average ratio of 0.65 appears satisfactory for present purposes.

TABLE V. PERMEABILITY OF RUBBER TO HELIUM AND HYDROGEN

Fabric No.	Observed Permeability to Helium Liters per sq. m. per 24 hr.	Permeability Corrected for 100% Helium Liters per sq. m. per 24 hr.	Observed Permeability to Hydrogen Liters per sq. m. per 24 hr.	Ratio of Permeabilities Helium : Hydrogen
27,145	9.6	10.2	16.1	0.63
45,847	9.8	10.3	15.7	0.66
45,835	7.6	8.0	14.0	0.57
45,838	7.4	7.9	13.7	0.58
36,827	6.4	6.8	10 0	0.68
36,827	6.7	7.0	10.6	0.66
36,827	6.5	6.9	10.7	0.64
36,823	6.2	6.6	10.0	0.66
36,827	6.6	7.0	10.6	0.66
36,827	6.1	6.4	9.5	0.67
36,827	6.3	6.7	9.3	0.72
36,827	6.5	6.9	9.4	0.73
26,293	5.7	6.1	9.8	0.62
24,579	4.8	5.1	8.7	0.59
Average				0.65

The other values for this ratio which appear in the literature are those of Dewar[19] and Barr[20]. Dewar found a ratio of $\frac{1.75}{5.6} = 0.31$.

No information is given regarding the helium used. Barr estimated two-thirds of the permeability to hydrogen—a value which is in agreement with ours.

Permeability of Rubber to Ammonia

Ammonia has been considered as a filling gas for balloons. Its specific gravity is only 0.596 and it offers advantages from the standpoint of freedom from fire hazard and the fact that it can be transported in the liquid form. However, the fact that rubber is quite permeable to ammonia would necessitate the use of a different type of fabric for the balloon envelope.

[19] *Loc. cit.*

[20] Barr. British Advisory Comm. for Aeronautics, 1915.

In determining the permeability of rubber to ammonia it was necessary to use a special permeability cell made of steel, which would be unattacked by the ammonia. All connecting tubes coming in contact with the ammonia were either steel or glass. The ammonia which passed through the fabric into the air stream was absorbed in a measured volume of tenth-normal sulphuric acid and the excess acid determined by titration. Two small wash bottles were always used in series but never more than a negligible amount of ammonia escaped absorption in the first wash bottle. Two sets of wash bottles were used and they were connected to the cell alternately through a three-way cock. They were attached to the system by a mercury seal so that they could be easily detached. Each value recorded in the table is the average of a number of observations each covering a half-hour period.

TABLE VI. PERMEABILITY OF RUBBER TO AMMONIA AND HYDROGEN

Fabric No.	Permeability to Ammonia Liters per sq. m. per 24 Hr.		Permeability to Hydrogen Liters per sq. m. per 24 Hr.		Ratio of Permeabilities Ammonia : Hydrogen
50,313	71.9		9 0		7.99
	59.3 61.1	a			
50,313	71.8 74.2	73 0	9.1		8.02
50,313	80.0 80.9	80.4	10 0		8.04
Dental dam	119 6 119.8	119 7	15.4 14 8	15 1	7.93
Average					8.00

a These two results which were obtained on two succeeding days indicated that some change had occurred in the sample and they are omitted from the average.

The ammonia was taken from a small steel cylinder, which had been evacuated to a very low pressure before filling with liquid ammonia. The gas can be considered to be free from air and water vapor; in fact, the total amount of impurity in this sample, which was carefully purified by fractionation, was shown by tests of C. S. Taylor of this Bureau to be less than 1 part per 100,000. The results of a series of experiments is given in Table VI. The average ratio of the permeability to ammonia and hydrogen is probably very close to 8.0.

Permeability of Rubber to Ethyl Chloride

An interferometer of the portable type was used for determining the percentage of ethyl chloride passing through the fabric into the air stream. The ethyl chloride was contained in a glass flask fitted with a steel valve and the vapor could be readily withdrawn under its own pressure. It was prepared by C. S. Taylor of the Bureau of Standards, from very pure materials, and further purified by fractionation. The total impurity in the vapor phase was undoubtedly less than 1 part in 10,000, a purity far beyond that required for the present work.

TABLE VII. PERMEABILITY TO ETHYL CHLORIDE AND TO HYDROGEN

Fabric No.	Permeability to Ethyl Chloride Liters per sq. m. per 24 Hr.	Permeability to Hydrogen Liters per sq. m. per 24 Hr.	Ratio of Permeabilities Ethyl Chloride: Hydrogen
50,313	1,717	8 80	195
50,313	1,851	9 76	190
50,313	1,810	8 31	218
50,313	1,763	9 44	187
Average			198

The permeability of rubber to ethyl chloride, as shown by these few tests, is approximately 190 to 200 times its permeability to hydrogen.

PERMEABILITY OF RUBBER TO METHYL CHLORIDE

For the purpose of comparison with ethyl chloride, the permeability of rubber to methyl chloride (CH_3Cl) was also determined. The interferometer was employed in estimating the percentage of methyl chloride in the same maner as with ethyl chloride. The sample of methyl chloride used had been carefully purified by fractionation by C. S. Taylor. Three tests were also made with a sample of methyl chloride the purity of which was unknown. These gave a ratio of permeabilities, methyl chloride to hydrogen, of 16.8, 17.6 and 17.8, but they are not included in the average. The other results are given in Table VIII. The permeability of rubber to methyl chloride is approximately 18.5 times its permeability to hydrogen.

TABLE VIII. PERMEABILITY OF RUBBER TO METHYL CHLORIDE AND HYDROGEN

Fabric No.	Permeability to Methyl Chloride Liters per sq. m. per 24 Hr.	Permeability to Hydrogen Liters per sq. m. per 24 Hr.	Ratio of Permeabilities Methyl Chloride Hydrogen
50,313	173.8	9.43	18.4
50,313	185.8	9.58	19.4
50,313	174.8	9.68	18.1
50,313	180.3	9.86	18.3
Average			18.5

PERMEABILITY OF RUBBER TO WATER VAPOR

The permeability of rubber to water vapor is interesting for a number of reasons. In view of the popular conception of rubber as a "waterproof" material it might be thought that it was quite impermeable to water vapor whereas the opposite is true—its permeability is relatively high. This fact is of great importance in many instances where rubber is used as a gas container, such as, for example, the use of rubber tubing in chemical and physical work. The use of rubber connections in any apparatus where the water content of the gas is important may introduce errors.

TABLE IX. PERMEABILITY OF RUBBER TO WATER VAPOR AND HYDROGEN

(Air Partially Saturated With Water Vapor in Contact With Rubber)

Sample No.	Permeability to Water Vapor (100 per Cent Partial Pressure.) Liters per sq.m. per 24 Hr.	Permeability to Hydrogen. Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Water Vapor: Hydrogen
A 17	953	....	....
Thickness	969	....	....
0.18 mm.	1,270	....	....
	1,001	....	....
	1,108	....	....
	978	....	....
	1,130	....	....
	1,174	....	....
	975	....	....
	920	....	....
	1,021	....	....
	875	....	....
	970	....	....
	890	....	....
	1,030	....	....
	1,019	....	....
	1,262	....	....
	1,075	....	....
Average	1,034	22 0	47.0
A 19	905	....	....
Thickness	905	....	....
0.25 mm.	726	....	....
	1,118	....	....
	860	....	....
	765	....	....
	905	....	....
	930	....	....
Average	888	14.3	62.0

The high permeability of rubber to water vapor renders its determination rather difficult. The first method employed in its determination was to pass a current of air saturated with water vapor at a temperature slightly below 25 deg. C. over the fabric, which was maintained in the cell at 25 deg. C. A stream of air, previously dried over phosphorus pentoxide, was passed over the other face of the fabric and thence through an absorption tube filled with phosphorus pentoxide in which the water vapor could be absorbed and weighed. The results were very erratic, probably because of the low partial pressure of the water vapor in the air (about 3 per cent) and the large effect on the difference in partial pressure produced by small variations in the rate of passage of the dry air. The results, however, are confirmatory of those secured by the following method:

TABLE X. PERMEABILITY OF RUBBER TO WATER VAPOR

(Liquid in Contact With Rubber)

Sample No.	Permeability to Water Vapor, Liters per sq.m. per 24 Hr.	Permeability to Hydrogen. Liters per sq.m. per 24 Hr.	Ratio of Permeabilities. Water Vapor: Hydrogen
A-18	1,526	....	
Thickness	1,700	....	
0.21 mm.	1,846	....	
	1,918	....	
Average	1,748	18.4	95.0
A-19	1,510	....	
Thickness	1,752	....	
0.25 mm.	1,740	....	
	1,581	....	
	1,638	....	
	1,712	....	
	1,562	....	
Average	1,642	14.3	115.0

A shallow crystallizing dish, 8 cm. in diameter, was partly filled with phosphorus pentoxide and the top closed by a sheet of rubber, such as dental dam, which was fastened at the edge with rubber cement. The dish was then placed in an atmosphere saturated with water vapor and the rate of increase in weight determined. The results are shown in Table IX; obviously, they only give an approximate figure and no claim of accuracy is made for them. Lack of time prevented carrying this phase of the work farther. In connection with this table and the succeeding one, attention should be called to the fact that the permeability to water vapor is calculated for the assumed case of a difference in partial pressure of water vapor of 760 mm. This is done to make the results comparable with the hydrogen value. In any test the partial pressure of water vapor was about 20 mm.

A few experiments were also made with liquid water in contact with the rubber film. In these tests, instead of cementing the rubber to the dish containing the phosphorus pentoxide, the rubber was cemented to the top of another exactly similar dish from which the bottom had been removed. The edges of both dishes were ground plane. The dish with the rubber film across the bottom was partially filled with water and placed on top of the dish containing the phosphorus pentoxide. When it was desired to weigh the lower dish, the upper dish was replaced by a watch glass. The results of these tests are shown in Table X. In calculating the results the partial pressure of water vapor used was that corresponding to the temperature of the water in contact with the rubber.

According to these few tests the permeability of rubber to water vapor is about fifty times the permeability to hydrogen when saturated air is in contact with the rubber and about 100 times when liquid water is in contact with the rubber. In these methods diffusion processes were depended on to bring the water vapor into contact with the rubber and from the rubber to the phosphorus pentoxide. This factor should tend to give low values. The accidental errors of handling and weighing would probably be in the opposite direction.

THEORY OF PERMEABILITY

One object of this investigation was to establish, if possible, a quantitative relationship between the permeability of a film of rubber to any particular gas and the various factors on which it is dependent. Only the part of the program detailed in the preceding pages was completed, however, before it became necessary to discontinue the work.

A simple and satisfactory picture of the process is one of dynamic equilibrium in which the gas is dissolved at one side of the rubber at a rate proportional to its solubility and partial pressure, and diffuses through the rubber where it evaporates from the other side. The same process takes place in the opposite direction so that the net transference of gas is proportional to the difference in the partial pressures at the two faces of the rubber. Because of the lack of data it is not feasible to analyze the relations between solubility and rate of diffusion through the rubber. The permeability in every case investigated increases rapidly with increase of temperature. According to Kayser[21] the solubility of both carbon dioxide and hydrogen decreases with increase of temperature. If this be true there must be a rapid decrease in the internal resistance of the rubber to the passage of the gas, because the ordinary temperature coefficient of gaseous diffusion is unable alone to account for the facts.

A rough parallel, with notable exceptions, may be drawn between the permeability of rubber to different gases and to the boiling points of the gases. In general, the higher the boiling point of the gas the greater the rate at which it penetrates rubber. The specific chemical characteristics of the gas and of the rubber colloid determine, however, the solubility, rate of penetration, etc., and not enough is known of them at the present time to warrant further speculation. There are, however, many interesting fields of investigation opened by this work, and the results should be extremely useful in the many cases where the behavior of rubber in contact with gases is concerned.

SUMMARY

Certain of the factors which determine the permeability of rubber to gases have been investigated and the relative rates of penetration of a number of gases determined. The major findings are summarized as follows:

1. The permeability of rubber compounds varies with the composition as would be expected. The aging of rubber films is accompanied by a decrease in permeability; a similar decrease may be effected by overvulcanization. The rubber, which shows a very low permeability for these reasons, is usually very much deteriorated and frequently brittle, so that it is a disadvantage from the standpoint of gas-tightness.

2. The permeability to any gas is found to be directly proportional to its partial pressure provided the total pressure is constant. The variation of permeability with total pressure depends on the thickness of the rubber, the way in which it is supported, etc.

3. The permeability to hydrogen is inversely proportional to the thickness of the rubber. No other gas was tested in this respect.

4. The specific permeability to hydrogen at 25 deg. C. of vulcanized rubber similar to the grade known as dental dam is about 20×10^{-6} c.c. per minute. This value varies somewhat with the age and chemical characteristics of the rubber.

5. The temperature coefficient of permeability is quite high. For example, in the tests at 100 deg. C. the permeability to carbon dioxide or helium was about seventeen times the rate at 0 deg. C.; the permeability to hydrogen was about twenty-two times as great at 100 deg. as at 0 deg. C.

6. The relative permeability of rubber to some common gases is shown in the following summary:

Gas	Relative Permeability Hydrogen = 1
Nitrogen	0.16
Air	0.22
Argon	0.26
Oxygen	0.45
Helium	0.65
Hydrogen	1.00
Carbon dioxide	2.9
Ammonia	8.0
Methyl chloride	18.5
Ethyl chloride	200.0

7. The permeability of rubber to water vapor is high—approximately fifty times the permeability to hydrogen. This value, not having been determined with any precision, is not included in the table above.

ACKNOWLEDGMENT

Special acknowledgment is due the Goodyear Tire & Rubber Co. for the samples of rubber and fabric furnished to us in the course of this work. Many of these were especially constructed to meet our specifications. The company's enthusiastic co-operation has been of great assistance.

[21] *Wied. Ann.*, vol. 43, p. 544, 1891.

Increasing Demand for Paints, Oils and Varnishes in South Manchuria

The erection of new buildings in connection with the development of South Manchuria should increase the importation of paints, oils, and varnishes, which have amounted to about $1,000,000 annually, approximately 60 per cent of which was used by the South Manchurian Railway Co. Prior to the war, British and American paints dominated this market, but as it became more difficult to obtain the desired brands, because of the lack of shipping facilities, those of Japanese manufacture became better known. With the return of normal conditions the potentialities of this market have become greater, providing American makes can compete with the prevailing prices, as their superior quality is recognized. One of the brands now in demand is an ordinary lead paint, packed in drums of 28 and 112 lb., the former selling at $2.50 and the latter at $4.50. Mixed paints, put up in 1-lb. tins, sell wholesale at $1.50 per dozen tins. Enamels, which are now in great demand, wholesale at $3.50 per dozen tins of ½ lb. each. Varnish is selling at $4.20 per dozen tins of 2 lb. each. There are two kinds of paint oil on the market, one reported to be of pre-war stock is put up in 4-gal. drums, selling at $7 per drum wholesale; and the other, a Japanese product, put up in 36-lb. drums, selling at $4 per drum.

Synopsis of Recent Chemical & Metallurgical Literature

Slag Brick.—A. GUTTMANN, in an article in *Stahl und Eisen* for March 4, describes Schol's process of making slag brick of high heat resistivity in use at the Oberscheld iron works. Here an iron furnace slag containing about 35 per cent SiO_2 and not less than 44 per cent CaO is pushed horizontally into a shallow pool, so as to be transformed into an almost frothy material called "thermosit," with a density of 0.3 and thermal conductivity of 0.07. The thermosit is screened and the grains of half an inch size and less are mixed with a certain proportion of a binding agent, prepared from fine slag sand and unslaked lime; the lime is slaked and the dried mixture is ground. One part of this slag-cement and six parts of the thermosit, together with water, are then introduced into a drum, from which they enter the brick press, in which pressure is applied first from the top and then from below. This mode of compression is adopted in order to obtain high porosity and high permeability as well as low thermal conductivity. The bricks leaving the press are very soft and have to be kept for about six hours in exhaust steam before being dried in the open air. In strength the bricks answer very well in houses of two or three stories, and do not soften under water.

Basic Open-hearth Slags.—At the 1920 meeting of the Iron and Steel Institute (British) JOHN F. WILSON presented some notes derived from his furnace experience on "Slag Conditions in Open-Hearth Basic Steel-Making Practice." Recognizing the fact that when melted, slag constituents are in solid solution with each other, he still was of the opinion that much information could be had from studying the acid: base ratio. Basic slags appear to adjust themselves to the furnace conditions, with the end of maintaining a viscosity not too thick or too thin—something like the consistency of cream. This criterion required somewhat different compositions for different temperatures; if, for instance, the slag is too thin, there must be added to it by the furnaceman sufficient ingredients to rectify the matter, or there will be reduced from the slag such elements as give increased fusibility (Fe, Mn, P), or, thirdly, chemical action will abstract from the tanks or metallic bath such elements as to make the slag less fusible. Correspondingly for slags too stiff.

Starting with that slag which is inert yet contains the highest proportion of acids possible in normal basic furnace work, the author notes that this slag has the desirable or creamy viscosity at the lowest temperature. This is called a "silicate slag." If, after allowing for lime-phosphorus and lime-sulphur compounds, the equivalent FeO + MnO + MgO is more than 0.7 × CaO, the slag will be of the olivine type—purely monosilicates. If less than 0.7 × CaO it is of the mellilite type with perhaps one molecule of bisilicates to two of monosilicate. If excess base is added to olivine slag, that excess quickly combines with acids from the metal to form silicates or phosphates. Excess silica from the metal reduces phosphorus or corrodes the tanks.

High-phosphate slags carry silicates of the olivine type, but are less fusible than silicate slags. Very high-phosphorus slags are of economic importance, but in furnace work tend to carry excess base over the monosilicate requirement. This should be reduced to the minimum so as to keep the working temperature down and the soluble phosphorus up.

Tapping slags are best made up so that the steel is properly purified at a sufficiently high temperature, and by least expenditure of bases. Their constitution is quite complex, and must contain "active" bases in order to purify the metallic bath of S and P. Compounds between bases are probable.

Passing on to the effect of slag upon various furnace reactions, Mr. Wilson says that the principal methods of steel manufacture decrease in some way the depth of slag covering. Thick slag volume retards heat transmission into the metal bath, this requiring high flame temperatures and excessive wear on furnace. It blankets or smothers gas evolution from the steel, thereby slowing down the speed of decarbonization, and the intimate contact between metal and slag during the boil is hindered.

In the discussion, J. H. Whiteley said that one of the unexplained things about basic slags was the method by which iron oxide increased in analysis. It might be given off by the metal, but to only the slightest extent. Metallic globules in the slag might churn to the surface and become oxidized, but ordinarily shot iron in basic slags did not exceed 0.5 per cent, as compared to 5 per cent in the acid slag during the boil, in spite of which percentage iron oxide in the slag is then reduced. The only other possibility was the reaction $Fe_2O_3 + Fe = 3FeO$. While in the acid slag there might be 30 per cent of FeO in the slag as silicate and only 0.2 per cent of Fe_2O_3, in the basic process there might be 8 per cent FeO and 2 per cent Fe_2O_3. Possibly in basic slag the iron oxide was much less closely held in chemical combination and so was relatively free to become oxidized continually by furnace gases.

Silicon in Acid Steel.—A very clear discussion of the reaction occurring when silicon goes up just before tapping an acid heat was presented by B. YANESKE and G. A. WOOD, before the annual meeting of the British Iron and Steel Institute, in their paper entitled "Reduction of Silicon From the Slag in the Acid Open-Hearth Process." It is commonly known that sometimes a heat is tapped which eventually shows much more silicon than counted upon, although carbon and manganese are substantially correct. The authors have been able to study many such heats, following them back and constructing furnace logs, arriving at the conclusion that iron and not carbon is the reducing agent.

Close study shows the following occurrences for high-silicon heats: Silicon will increase continuously in metal if the bath is held quiet under a very siliceous slag; the action is accompanied by a loss in FeO analysis in the slag; yet silicon in the bath will be immediately reduced if either iron ore or lime be added, later to restart the cycle. Meanwhile carbon and manganese are substantially stationary, and may be anything from comparatively high to quite low. Dissolved oxygen in the metal is also very low, because actual losses of C, Mn and Cr during this period of the heat are less than would be expected. Temperature has no preponderating influence on the reduction of silicon and appears to act only indirectly by favoring a more acid slag.

The authors suggest a reaction (necessarily endothermic)



$$SiO_2 + Fe = FeSi + O_2 - ?Cal$$

to explain all these facts, as well as the following: If tests be taken when the silicon first starts to be reduced, they will be pitted on the *under* side (liberation of gas from the slag which surrounds the entire metal in the spoon, but this gas is only imprisoned at the bottom). As the reaction in the furnace becomes stronger, tests are pitted both top and bottom, the holes being connected by badly oxidized channels (passage of oxygenated gas). Tests are pitted in upper surface exclusively, only where there is an excess of oxide in metal, by the reaction



$$FeO + C = Fe + CO$$

Presence of oxide in metal during siliconization is impossible, as explained above, so tests pitted on the upper surface only are not found during the course of this phenomenon.

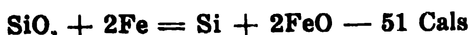
Campbell* advances the popularly held equation



$$SiO_2 + 2C = Si + 2CO$$

Stoichiometric calculations show that nowhere near enough C is lost from a bath to correspond with its gain in Si. Even if ferrosilicon is melted on the banks, it will largely enter the metal ostensibly by oxidation, through the slag, and reduction, to the metal. Yet silicon can thus be added without lowering carbon an amount demanded by Campbell's equation. It is attractive because silicon is more easily reduced in a high-carbon melt; yet the authors quote figures from low-carbon heats showing siliconization from the slag. A slag over mild steel usually tends to increase in FeO and decrease in SiO_2 near the finish, and more oxygen is liable to enter the melt because of insufficient carbon being present to deoxidize. Siliconization ordinarily cannot be expected from a neutral slag overlying oxidized metal. The authors further state that at furnace temperatures silicon has a greater affinity for carbon than oxygen, so that Campbell's reaction is improbable, basing their argument upon their observations that carbon does not lower in high-silicon metal, until the silicon first is eliminated again, it is commonly known that a newly-sanded hearth produces a quiet boil and requires much more ore to oxidize carbon; in other words, the unusually high silicon then in the metal requires FeO to reduce it first, that done the carbon starts. The apparent inversion of affinities observed when running an acid bessemer very hot is explained thus: high temperatures require highly siliceous slag, which resupply silicon to the metal as fast as it is oxidized. On burning out the carbon to red fumes of iron oxide, the silicon is reduced simply because then enough FeO is produced to lower the acidity of the slag.

McCance† advances the equation



$$SiO_2 + 2Fe = Si + 2FeO - 51 \text{ Cals}$$

noting that an increase in temperature would lead to a greater reduction and the formation of more silicon. True, but it would also form more FeO, yet experience shows that the slag actually loses FeO during siliconization, and the action is initiated when FeO in slag is already very low. In fact oreing causes a loss in silicon in the metal. Nor does this reaction explain the holes in test pieces.

*"The Manufacture and Properties of Structural Steel." 1896 Edition. p. 180.

†CHEM. & MET. ENG., vol. 22, No. 14 (April 7, 1920), p. 634.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Synthetic Resins.—Resinous condensation products are obtained by passing a vaporized mixture containing dienes such as isoprene, for example, the mixture of gases and vapors obtained by cracking mineral oil under high pressure, over a heated contact mass (bauxite, fuller's earth, clay, animal or vegetable charcoal, etc.) at a temperature above the melting point of the resin formed, say from 110 to 250 deg. C.; the molten resin is drawn off from the bottom of the contact vessel and solidified. The product is soluble in alcohol or ether, and may be used in the manufacture of varnishes, coating compositions, plastic compositions, insulating materials, etc., and may be vulcanized. (Br. Pat. 138,046—1919. HALL MOTOR FUEL, LTD., London, March 24, 1920.)

Catalysts for Ammonia.—Catalysts for use in the synthesis of ammonia at atmospheric pressure and moderate temperatures and containing as the active constituent a metal which when heated in nitrogen forms a nitride decomposable by hydrogen are prepared by causing an oxide of such metal to react with a reducing metal such as aluminum or magnesium; the reaction mass which constitutes the catalyst contains the catalytic metal in a finely divided state and distributed over the oxide of the reducing metal, and by the use of such a catalyst the synthesis of ammonia is effected at a temperature lower than that necessary with the catalytic metal alone. The following are suitable catalytic metals —lithium, uranium, cerium, lanthanum, thorium, titanium, calcium, barium, strontium, glucinum, zirconium, vanadium and molybdenum; according to an example, finely powdered quicklime is intimately mixed with very finely powdered aluminum or magnesium, and reduction is started by igniting a length of magnesium ribbon introduced into the mixture. To obtain a greater dilution of the active metal in the catalyst, a further quantity of the reducing metal is added, and the reduction process repeated; and to regenerate the catalyst, fresh quantities of catalytic metal oxide and reducing metal are added, and the mixture brought to reaction as before. If the reaction mass is allowed to cool in the air or in pure nitrogen, the catalytic metal is in part converted into nitride, and the resulting catalyst is of increased activity. (Br. Pat. 140,061—1919. L. DUPARC and C. URFER, Geneva, May 12, 1920.)

Vulcanizing India Rubber.—Natural or synthetic rubber is vulcanized by the addition of salts of mono- or di-substituted dithiocarbamic acids and di- or trivalent metals or inorganic radicles, and sulphur, the amount of sulphur being reduced to 2 to 0.2 per cent of the rubber. In an example, a mixing of 100 parts rubber, 0.5 part sulphur, and 1 part pentamethylene dithiocarbonate of zinc, with or without the addition of mineral oxides, reclaimed rubber or substitutes, is vulcanized in the usual manner. (Br. Pat. 140,387—1919. G. BRUNI, Milan. See also 140,388—1919. May 12, 1920.)

Current Events
in the Chemical and Metallurgical Industries

New Jersey Clay Workers Meet at Trenton

The annual summer meeting of the New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society was held at Trenton, N. J., June 25, with morning and afternoon sessions at the Trenton Country Club. This delightful spot proved an ideal location, and brought an inspiring environment to the gathering. About 65 members and guests were present from all parts of the state, as well as from New York and other neighboring sections.

Helping the New Ceramic School

The meeting was called to order shortly after 11 o'clock, opening with an interesting address by Chairman Abel Hansen, head of the Fords Porcelain Works, Perth Amboy, N. J. Mr. Hansen spoke of the new ceramic school at Rutgers' College, New Brunswick, made possible through the securing of an appropriation of $100,000 from the state, during the last session of the legislature, and urged those present to help the movement with suitable donations of burned clay building materials, as well as general ceramic products. In this way, he pointed out, the fund will go even further than anticipated, making the new building a real monument to the State of New Jersey. He also brought out the need for interesting young men in the advantages of the institution, so that a representative class of students would be evidenced at all times. He said that the demand for ceramic engineers was great, and far in excess of the supply.

Sagger Making

The technical session was inaugurated with a valuable paper by Charles F. Gieger of the Carborundum Co., on the subject of "Superior Saggers." This address traced the manufacture of saggers from the mixing of the clay to burning in the kiln, and pointed out some of the errors now prevalent in production, frequently making for saggers good for but one or two heats.

He said that choosing sagger mixtures on the basis of porosity, though a practice of long standing, was not to be recommended, because porosity is not the governing factor; the hot strength of the burned sagger mix and the rate of deterioration in strength on repeated heatings are items that should control the selection of a sagger mix. Most refractory materials, he set forth, have a much lower mechanical strength at temperatures above 1100 deg. C., than when cold, and in most instances, the primary cause is not due to the softening brought about through vitrification; it is simply that the physical properties are not the same at all temperatures.

The speaker explained preferred methods of preparing sagger mixes, covering the dry grinding of several clays together in a dry or wet pan, or in mills, followed by a thorough pugging in a wet pan, with mullers raised slightly. When the mix is thoroughly plastic, the grog is added, and the entire mass fully ground and mixed.

The concluding paper of the morning session was an interesting résumé on the subject of ceramic drying, covering some recent accomplishments in this line, presented by D. H. Applegate, Jr. of Proctor & Schwartz, Inc. The talk was illustrated with a number of lantern slides, showing various mechanical drying installations. Modern developments, it was pointed out, have made possible effective drying of ceramic wares in far less time than ever thought possible, and with a degree of accuracy and uniformity that leaves nothing to be desired.

Studies of Clay in the Raw State

Following a fine luncheon on the veranda of the club house, the afternoon meeting was opened with an illuminating address by A. V. Bleininger of the Bureau of Standards, on the subject of "Studies of Clay in the Raw State." The talk set forth data regarding investigations and experiments now being conducted by the Bureau, and which, it is expected, will terminate in a pronounced value to those in the ceramic industry.

These tests cover such matters as the influence of organic compounds on clay plasticity; the effect of salts in clay as utilized for paper manufacture; the rate of drying with regard to ultimate shrinkage; the introduction of chemicals to bring about desired colors in paper-making clay, and similar topics.

Selection of Refractories

Mr. Bleininger's address was followed by an equally interesting and pertinent talk by R. M. Howe, Refractories Manufacturers' Association, Mellon Institute, on the topic of "The Selection of Refractories." The address was illustrated with a number of charts showing the results of tests conducted at the institute.

Mr. Howe mentioned facts relative to the mining and mixing of raw clay for the manufacture of firebrick and other high grade refractories. He spoke of the influence of grind on the finished article, making a comparison between finely ground and coarser grade materials. He dwelt at some length on the matter of spalling, and tests conducted along such lines, showing the defined relationship between the amount of grog used and the resistance to spalling.

Firing Wares in Tunnel Kilns

The concluding paper of the meeting was one dealing with the subject of tunnel kilns by Conrad Dressler, American Dressler Tunnel Kilns, Inc., New York. The speaker traced the development of the modern tunnel kiln, and explained the degree of efficiency now obtained in burning spark plugs, electrical porcelain specialties and kindred products. Kilns of this character are being operated to cone 18 and 19, and giving highly satisfactory service.

A number of interesting pictures were thrown on the screen, setting forth various tunnel kiln installations in different parts of the country.

Hercules Powder Co. Sued by duPont Co. for Alleged Patent Infringement

A suit which is not only of interest as a legal battle between two great rival manufacturers of explosives and chemicals but also is of vital importance to practically every manufacturer of pyroxylin solutions, lacquers, artificial and split leathers, and celluloid articles, will soon be brought to trial in the federal district court for New Jersey.

The suit, based on alleged infringement of patents, has been instituted against the Hercules Powder Co. by the E. I. duPont de Nemours & Co. The patents upon which the action was brought, it is claimed by the duPont Co., protect the use of a mixture of ethyl acetate and benzol, with or without the addition of ethyl alcohol, as a solvent for nitro-cotton. As pyroxylin solutions, or dopes, used in the manufacture of split and artificial leathers, lacquers, cements, celluloid articles, and hundreds of other commodities, are frequently made by dissolving nitro-cotton in these solvents, and the two companies are among the leading competitors in the business, this suit assumes a high proportion of interest to many concerns throughout the country. Definitely stated, the patents which it is claimed have been infringed upon are numbers 1,118,498; 1,135,026; 1,321,633 and 1,321,634 granted to the duPont Co. as the assignee of Frederick Kniffen and M. V. Hitt. The two Kniffen patents specifically cover a solvent for pyroxylin consisting of ethyl acetate and benzol and the process of forming a body of pyroxylin made by dissolving pyroxylin in a mixture of ethyl acetate and benzol and then causing this mixture to evaporate. The two Hitt patents cover practically the same proposition, one claiming a solvent for pyroxylin and the other the use of this solvent to dissolve pyroxylin and consequently forming a body of it. The solvent covered is a mixture of ethyl acetate and benzol (or some higher member of the benzol series of hydrocarbons such as toluol), and ethyl alcohol, methyl alcohol, or some other volatile saturated aliphatic alcohol whose rate of evaporation is somewhat similar. This solvent is essentially the same as that involved in the Kniffen patent except that part of the etheyl acetate is displaced by alcohol. This is an alleged improvement on the Kniffen solvent.

It is understood that the Hercules Co. will try to show that the solvent, which is alleged to infringe on the duPont patents, was a matter of common knowledge years before the patents were taken out, and that the only reason ethyl acetate was not very generally employed was the availability and cheapness of other chemicals before it became a commercial commodity. With ethyl acetate on an available basis, it was, according to the belief of the Hercules Powder Co., put to an old and well recognized use in the solvent mixture about which the action has been brought.

Canadian Power Co. to Build Hydro-Electric Plant

The Bridge River Power Co., Ltd., of Vancouver, B. C., is to develop hydro-electric power at the Bridge River power site. A total of 400,000 continuous hp. will be available when the site is fully developed and power in blocks of from 5,000 kw. up will be available within two years' time. Power will be sold as low as $16 per hp. year, depending on whether the plant consuming the power is located at the power house or at a distance, also on the power and load factors.

The Gasoline Problem

In connection with the active and widespread efforts to find substitutes for gasoline Dr. Van H. Manning has expressed the opinion that the problem will be solved primarily by obtaining more gasoline from mineral matter. The following summing up of Dr. Manning's views was made in his capacity as Director of the Bureau of Mines, in fact just before he left the Government service to take charge of the research division of the American Petroleum Institute:

The present situation of high gasoline prices, and threatened shortage, has been caused by an increase in the uses of gasoline faster than the increase in production and importations of crude petroleum, from which it is derived. It is now found that sufficient gasoline cannot be obtained from the old processes of refining crude oils to meet the present and anticipated needs. Fortunately, however, processes have been developed in recent years for producing synthetic gasoline from the heavier and less volatile portions of the crude oils, from which processes some 15 per cent of the 4,000,000,000 gal. of gasoline produced in 1919 was derived. Synthetic gasoline can also be manufactured from oil shales and gasoline substitutes are being manufactured from byproduct coke ovens, and can be made by low-temperature destructive distillation of coals and lignites.

I am strongly of the opinion that the problem of obtaining greater supplies of gasoline will be solved primarily by obtaining supplies from mineral matter, and that alcohols and other substitutes derived from vegetable matter can be but a minor factor in the situation for an indeterminate period of time.

Increasing the Yield of Present Oil Fields

Obviously, the most satisfactory solution of the problem would be to obtain greater supplies of crude oil, and for this reason our Government should give serious consideration to the encouragement of our nationals in acquiring supplies abroad. This Government should also do its utmost to provide technical and scientific guidance for the industry at home for the obtaining of more supplies of oil from our own fields. It is a fact not commonly known even in the oil industry, that the wells obtain but a small proportion of the oil which exists in the sands and that probably not more than from 10 to 20 per cent is commonly extracted. Oil is found in sands and sandstones in pores which are almost microscopic in size. When the gas which forces this oil out of the pores of the sands is exhausted, the remaining oil is held like water in a sponge and the well ceases to yield oil in commercial quantities although a larger part of the 80 to 90 per cent of the oil remaining can be obtained by the proper methods.

Some exceedingly promising methods have been in use for a number of years, which have proved indisputably that a great deal more oil can be obtained from our oil sands. But there are numerous important problems which will call for the best scientific and technical research for their solution before a full measure of our oil supplies can be obtained. I am strongly of the opinion that one of the first considerations in insuring a future supply of gasoline should be of this 80 to 90 per cent of the oil which is now being left in our fields, and that this Government should properly conduct the necessary technical and scientific investigations and foster the use of improved processes in every way possible.

Another problem which should receive immediate

consideration is the manufacture of synthetic gasoline from heavy oils. At the present time there is only one process which is being largely used—the so-called Burton cracking process held under patent by the Standard Oil Co. of Indiana. This process can use only one quality of oil, which is but a minor proportion of the heavier oils produced in this country. Some 40 to 50 per cent of all petroleum which is now being used in a most inefficient manner for steam raising would be made available for manufacture into synthetic gasoline by the development of a commercially practical process for cracking these heavy oils into synthetic gasoline. The discovery of such a process available to all refiners might readily double the quantity of gasoline obtainable from our present production of crude oil and defer any apprehension of a gasoline shortage for many years to come.

Gasoline From Oil Shales

In recent years, vast quantities of shales have been found in the Rocky Mountain states, in California, Kentucky, and many other states, from which can be obtained from half a barrel to over a barrel of oil per ton of shale. The U. S. Geological Survey estimates that the quantity of oil locked up in the shales of Colorado, Utah and Wyoming, is many times more than will ever be produced from our oil fields. From these shales, gasoline and other petroleum products may be obtained by retorting and refining. This has been a commercial process for over fifty years in Scotland. In fact, petroleum products were obtained in the United States from oil shales before the discovery of oil. Although there is considerable interest and experimentation going on looking to the utilization of these enormous supplies of petroleum products in the West, there are many problems to be solved before oils can be obtained successfully from shales. And to those who are endeavoring to develop this latent resource, there is need for the Government to render every service and encouragement in the way of research and otherwise, in order to hasten the date when oil from shales may be made available.

Substitutes From Byproduct Coke Ovens

A considerable quantity of gasoline substitutes is now being obtained from byproduct coke ovens. It is expected that 95,000,000 gal. of benzol will be produced in 1920, which will be about 2 per cent of the total gasoline supplies for the year. Everything should be done to encourage and foster this industry. Still larger quantities of gasoline substitutes can be made by retorting the coal and lignites which now are being consumed as they come from the mines. If the available oil could be extracted from every ton of coal and lignite before they were consumed, it would add very greatly to the supplies of motor fuels. I wish to point out that the production of benzol from coals is likely to be inseparable from the utilization of alcohols from vegetable matter. It is a fact that the present gasoline-using engine cannot use straight alcohol satisfactorily; also, it is going to be practically necessary that any substitute for gasoline as an engine fuel must be practically interchangeable with gasoline. To accomplish this purpose it is necessary to blend alcohol with gasoline. But alcohol will not blend with gasoline unless there is a considerable quantity of benzol or a similar product in the mixture. Therefore, unless some other solution of this problem is found, it will be necessary to produce large quantities of benzol from coal in order to blend the alcohol with gasoline and make it an interchangeable fuel.

Alcohol From Vegetable Matter

At the present time but a comparatively small amount of alcohol produced from sugar refinery wastes is being placed on the market in competition with gasoline. This is being sold as alcohol, benzol, ether and gasoline blends. However, the quantity of alcohol obtainable from sugar refineries is negligible compared with our gasoline needs.

It is true that there are immense quantities of waste vegetable matter throughout the country, and were it possible to gather the refuse from the farms and from the lumber camps and other places, a tremendous quantity of alcohol could be obtained. But it is unfortunately true that this waste vegetable matter is widely scattered and in few places is it concentrated enough that it seems commercially feasible to make alcohol in competition with gasoline.

From a quantitative standpoint, petroleum, coal, and oil shale are likely to be the cheapest raw material for making gasoline substitutes. It must be borne in mind that the obtaining of gasoline substitutes alone will not solve the problems resulting from the failing petroleum supply. Gasoline is but one of the essential products from petroleum. An automobile, or farm tractor would be even more helpless without the lubricants obtained from petroleum than without the gasoline. There is not a moving part in any piece of machinery in the United States which does not take lubricants which are derived from petroleum.

Suggested Lines of Investigation

It would be a mistaken policy to limit the investigation of gasoline substitutes to vegetable matter. Emphasis should be placed on the investigation of the problems mentioned. Serious consideration should be given to encourage the development of gasoline and gasoline substitutes; (1) by increasing the recovery of oil from our oil fields, (2) by developing processes for making synthetic gasoline out of heavy oils, (3) by encouraging the development of processes for making gasoline and gasoline substitutes out of oil shales, coals, lignites, peats, and (4) by developing processes for making alcohols, ethers, etc., from waste vegetable matter.

Chemistry Co-operating in Plant Protection

Progress was achieved at the Rochester meeting on June 23 when a group of about thirty-five persons met under the auspices of the National Research Council and adopted tentatively articles of association for the proposed "Plant Protection Institute." This is one of the products of the vigorous effort by Dr. H. E. Howe, who is preaching the gospel of co-operative research and industrial development.

This movement includes entomologists, plant pathologists, and the makers of insecticides, fungicides, and the manufacturers of apparatus for the use of these materials. Agencies formally co-operating are the American Society of Economic Entomologists, the American Phytopathological Institute and manufacturers of equipment. It is hoped that standardized labels, standard directions for application of these materials and other similar co-operation can be achieved as well as the much needed research in the chemical and plant industry fields.

Swenson Evaporator Co. Wins Suit

The Swenson Evaporator Co. of Chicago, Ill., a company engaged in the manufacture of evaporators for various industries, sold to the Minneapolis & Ontario Paper Co. for its plant at International Falls, Minnesota, equipment amounting to $170,000 in 1916. This material was delivered to the paper company so that the mill could be put in operation within less than a year.

Early in 1919, the evaporator company filed suit in the United States District Court at Minneapolis for the remaining amount due in accordance with contract, which was long overdue, claiming about $40,000 and interest.

The paper company claimed that this money was not paid as the machinery was not built according to contract and filed a counter-claim for damages to the extent of $700,000, this amount being gradually reduced by rulings of the court to $92,000, as representing the maximum amount that could be due the defendant in case the jury decided they were entitled to any damages at all.

The trial opened on June 7, before Judge Booth of the United States District Court, in St. Paul, and lasted three weeks.

The paper company relied mainly upon the testimony of two former employees of the mill, Norman E. Brokaw and Prof. Adolph F. Myer.

The evaporator company's witnesses included Robert Woodhead, superintendent of the Canada Paper Co., C. F. Beyerl, who had charge of the construction of the mill in question and various employees and officers of the Swenson Evaporator Co.

The testimony proved, according to the verdict reached by the jury, that the troubles of the paper company were due to incompetent management and operation, and not to any faulty design or defects in material furnished. It was shown also that the machinery and plant were never given a fair trial, and that similar machinery made by the same company was giving satisfactory service at other pulp mills when operating on similar materials.

The case was submitted to the jury June 25, 1920, and a verdict for the Swenson Evaporator Co. for $43,862 returned the next morning.

Chemical Merger Expected

Negotiations looking to the merger of several of the large byproduct and chemical companies are said to be progressing satisfactorily. The plan involves the merger of the General Chemical Co., Barrett Co., Semet-Solvay Co. and National Aniline Co. It is possible that an announcement bearing upon the proposed merger may be made before the close of the month. Prices at which the shares of certain of the subsidiary companies will go into the merger have been agreed upon.

It is understood that the aggregate earnings of the companies to be embodied in the merger—Barrett, National Aniline, General Chemical and Semet-Solvay—are now running at rate of $30,000,000 annually of which National Aniline contributes about $12,000,000.

Germany's Potash Industry

It is reported that the net profit of the German potash industry for the year 1919 was 7,661,511 marks, as compared to 2,317,667 marks for 1918.

Personal

COMFORT A. ADAMS, dean of Harvard School of Engineering, has resigned to devote his entire time to the work of the National Research Council, in which he is chairman of the Engineering Division.

Dr. EDWARD BARTOW, of Illinois University, has accepted a position as head of the chemical department for Iowa State University, Iowa City, Iowa.

FRED A. BIGELOW has been elected president of the Carpenter Steel Co., Reading, Pa., succeeding W. B. Kunhardt, who becomes chairman of the board of directors.

W. D. COLLINS has been designated as chief of the Quality-of-Water division of the United States Geological Survey. Mr. Collins formerly was a member of the chemical staff in the Water Resources laboratory of the Survey. For several years, however, he has been serving as a chemist in the Bureau of Chemistry, Department of Agriculture.

C. B. HOCKER, of the engineering department of the Western Electric Co., New York, is making an extended visit to the Chicago plant.

Prof. HECTOR JAMES HUGHES has been made dean of the Harvard University Engineering School, Cambridge, Mass., to succeed Comfort A. Adams, resigned.

Colonel ARTHUR B. LAMB, who is now in charge of the research laboratory of the Nitrate Division, at American University, Washington, D. C., has decided to resume his duties at Harvard University, and will return there in September.

J. B. MCINTOSH, well known among copper and lead men in the West, has resigned as superintendent of construction, Murray Plant, American Smelting and Refining Company, to accept the position of chief mechanical and construction engineer for Compañia de Real del Monte Pachuca, and will leave for Mexico July 15. Mr. McIntosh acted as civil engineer for the Anaconda Copper Mining Company for many years, having a prominent part in the construction of the Washoe Smelter. In 1907 and 1908 he acted as engineer in charge of construction for the Tooele Smelter, built by the same interests, resigning to go to Bisbee, Arizona, where he directed the preliminary work on the Clarkedale Smelter. For the past 8 or 10 years he has been attached to the engineering division of the Utah department, American Smelting and Refining Co. and has executed several notable improvements in their plants during that time.

HARRISON E. PATTEN has resigned from his position as physical chemist in the Bureau of Chemistry, Washington. He left his work there on the first of the present month.

W. N. PRITCHARD, Jr., formerly superintendent of a pulp mill of the Procter & Gamble Co., Augusta, Ga., is now doing research work on dyes for the Calco Chemical Co., Bound Brook, N. J.

GEORGE W. SARGENT has severed his connection with the Crucible Steel Co. of America as vice-president and metallurgist, and is now devoting his attention to the Molybdenum Corp. of America, of which he is president.

EARL STAFFORD has recently become a member of the engineering staff of Arthur D. Little, Inc., chemists and engineers, Cambridge, Mass. Mr. Stafford is a graduate of the Engineering School of Tufts College, 1908, and for the past twelve years has devoted his attention largely to hydro-electric developments with particular reference to ore treating plants, pulp and paper mills and light and power companies.

R. H. TAWNEY, who was a representative of labor on the so-called Sankey Commission investigating the English coal situation, spoke before the Chicago City Club on July 1 on the subject: "The Movement for the Nationalization of Mines in England."

ROBERT V. TOWNSEND, formerly chemist in charge of the chlorinated toluene products, Semet-Solvay Co., Syracuse,

N. Y., has accepted a position with the Victor Talking Machine Co., Camden, N. J., where he will organize and direct its department of chemical research.

Prof. ALFRED H. WHITE, head of the department of chemical engineering, University of Michigan, has sailed for France to be gone about a month in the interest of the Air Nitrates Corporation of New York City.

C. W. WRIGHT, of Rome, Italy, and his brother, C. A. Wright, formerly of the U. S. Bureau of Mines, sailed July 8 for Italy, on the S. S. Canopic. Their address will be 28 Via Parlamento, Rome.

Obituary

L. H. HASKELL, vice-president of the Southern Cotton Oil Co., died at his home in Savannah, Ga., on June 4, 1920.

B. F. MECHLING, director of Mechling Brothers, manufacturers of heavy chemicals, Camden, N. J., died on July 2, at his home in Philadelphia. He had been ill for the past two years but his condition was not serious until recently. In addition to his conection with Mechling Brothers he was president of the Albro-Clem Elevator Co. and the Elevator Safety Appliance Co., both of Philadelphia. Mr. Mechling was 73 years of age and is survived by his widow and three children.

Current Market Reports

The Non-Ferrous Metal Market

New York, July 9, 1920.—The outside market has advanced to 18.50c., as copper stocks dwindle. Spot lead practically does not exist. Zinc stocks, also, are very low.

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots	7.62½@7.87½
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	7.75
Zinc, spot, New York	8.00
Zinc, spot, E. St. Louis	7.60

OTHER METALS

Silver (July 8)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@85
Iridium	oz.	300
Palladium	oz.	75@80
Mercury	75 lb.	90@92

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	14.25@14.75
Copper, light and bottoms	12.75@13.75
Copper, heavy cut and crucible	15.00@15.50
Brass, heavy	9.00@10.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.00
Lead, tea	4.50@ 5.00
Lead, heavy	6.50@ 7.00
Zinc, scrap	4.50@ 5.00

The Iron and Steel Market

Pittsburgh, July 9, 1920.

In the iron and steel industry production has increased and shipments have decreased, "Order No. 7" of the Interstate Commerce Commission being blamed for the latter and receiving no commendation for the former. It operates to decrease the supplies of open top cars for loading Connellsville coke and for shipping pig iron and steel products, while the increased supplies of cars to coal mines have brought about a better distribution of coal, the byproduct coke ovens and steel mills being beneficiaries among others. What the iron and steel industry wants is to ship its accumulation of product, not means to produce still more and pile at a still greater rate.

June Production of Pig Iron

Production of pig iron in June was at the rate of about 37,400,000 gross tons per annum. On the basis of estimating capacity under ordinarily favorable working conditions at 45,000,000 tons, rates of production have been approximately 90 per cent in March, 75 per cent in April, 79 per cent in May and 83 per cent in June. At the recent rate of increase October would see 100 per cent production. The March rate was the highest since October, 1918, the rail strikes coming in April, with a gradual recovery thereafter.

The report on steel ingot production in June is not yet available, but it seems fair to assume that ingot production has continued in relation to pig iron production, in which case the June rate of ingot production was about 43,200,000 gross tons per annum, capacity being somewhere between 50,000,000 and 55,000,000 tons, and probably nearer the higher figure. Normally the production of finished rolled steel is about 76 per cent of the ingot production, but at the present time the proportion is much less, as many mills are accumulating semi-finished steel, partly by reason of greater convenience in piling and partly because of uncertainty whether customers will want all steel that would now be rolled according to their specifications, at the late date at which some of the steel would be shipped, for even the point of shipping current production has not been reached, reduction of the accumulation being still farther in the future.

Quiet Markets

There is very little interest in the pig iron and steel markets, which are all very quiet, except for business between the Steel Corporation subsidiaries and their regular customers, which business has become of practically routine character, the customers having confidence in the Steel Corporation prices on account of their being lower than the prices named by any of the independents. Contracts and orders are placed even though the time of delivery is altogether uncertain. The matter of delivery is really a detail as the corporation is selling to customers who are now receiving steel, as far as shipping conditions permit, and it is merely a matter of extending the service, as time passes, for additional periods.

Little attempt is being made to prognosticate the future of the iron and steel markets, as everything is seen to hinge on transportation conditions, and the outlook in that respect is of course cloudy. Few observers doubt that transportation conditions really will improve very materially and long before winter, when indeed a fresh batch of troubles is likely to come. Three dates are to be mentioned as promising, directly or indirectly, some help in transportation by producing greater incentive to utilize to the best advantage the existing physical facilities: July 20, when the Railroad Labor Board is expected to make its awards; August 1, when the decision in the freight rate cases is expected; September 1, when the Government guarantee of railroad earnings expires and the railroads will have to earn whatever money they get.

Labor Outlook Clear

The Columbus convention reached an agreement in the matter of wage rates in sheet and tin mills hitherto controlled by the Amalgamated Association. The men receded

from their various strong demands, and some entirely minor concessions were made them. Several manufacturers who have hitherto been content to sign the Amalgamated Association scales year by year after the usual negotiations are now strongly disposed to discontinue this practice when a scale year terminates under conditions auspicious for such an undertaking. The workers' organization has controlled less than 40 per cent of the sheet and tin mills of the country, all the Steel Corporation mills, for instance, being open shop, and the organization has been largely in the nature of an employment agency, affording facilities for the manning of mills and their operation by dealing with a mill committee in the matter of petty grievances rather than with individuals. At some of the mills built in the past few years the scale has been signed from choice, on the belief that the plants could thus be gotten into operation more quickly. With the open shop such an important issue with the industry in general, such a disposition has disappeared.

Now that the American Federation of Labor has conceded to the Amalgamated Association jurisdiction in case of an effort to unionize the iron and steel industry as a whole, by promising the Amalgamated Association a 51 per cent vote on any organizing committee the federation may set up pursuant to the resolution at the recent Montreal convention, the common opinion in the iron and steel industry is that no general organizing effort will be made. In the circumstances there is not much incentive for the American Federation of Labor to undertake such an operation, while there is nothing in the recent history of the Amalgamated Association, in its narrow sphere, to attempt so large a proposition. The Amalgamated Association would not think of conducting such an organizing campaign as that of last year, with its very radical atmosphere, as the association is distinctly conservative, and yet as to producing results by way of a strike the methods pursued last year were easily the most likely to succeed, even if a strike based on agitation of such a character could not be expected to succeed.

The definite reason why the iron and steel industry has remained so readily on the open shop principle is that it has payment by results as to practically all its skilled labor, the remedy for labor unrest urged as the most effective in all recent councils on this subject, and the principle of payment by results is likely to be extended from time to time in the industry to reach men farther down than those now paid definitely on a tonnage basis.

The Chemical and Allied Industrial Markets

New York, July 9, 1920.

The chemical market is in the same erratic buying position that it has occupied recently. Offerings are few enough, at what buyers consider a fair price, and consequently there is little activity displayed. The transportation situation seems to be relieved somewhat and deliveries on contracts are being made more rapidly than they have for some time. The *potassium salts* have held firm throughout the period with some offerings of *caustic* being made at 30c. while other interests are holding out for 38@40c. per lb., but even at these figures there is very little material visible. *Bichromate of potash* is steady at 44c. on spot, with possible shading of few cents for future contract as producers are unable to take care of anything but contract business. Manufacturers have advanced the price of *potassium chlorate* to 16@17c. per lb., which represents a rise of 1c. per lb., caused by recent heavy demand. Current prices of *potassium bromide* are holding firm and 90c. is the average price with some interests going as high as 95c. per lb. *Copperas* has fallen off slightly to $2.75@$3 per cwt. against $2.90@$3 of the previous report caused by drop in the volume of business. It is impossible to locate *salt cake* for less than $40 and as high as $50 per ton is being quoted on material that has changed hands several times. A year ago $8-$10 per ton was a reasonable price. Offerings of *barium chloride* are being made at $158@$165 per ton and there is promise of the domestic market returning to normal in the face of importing competition. There has been little or no activity among the *acids* and previous quotations prevail.

Despite the predictions made earlier in the year that there would be a sharp decline about July 1, the coal-tar products market maintains that inactive appearance that is becoming habitual, and from indications will continue to do so. It is thought by many that, if for no other reason than the Japanese money situation, this drop is bound to occur and has been merely deferred until the late fall. On the other hand, the more optimistic members believe that Japan is safely over the crisis and will be back in the market soon, which will have the effect of not only keeping prices firm but will also strengthen them. *Phenol* remains in good supply and Government resale material can be obtained at 12c. per lb. It was estimated that the 27,000,000 lb. placed on the open market, with conditional clauses against exportations and selling to jobbers, would last four years, based on the approximate consumption of 6,000,000 lb. per year, but there is some speculation rife as to whether this supply will hold out. However, the firm that is handling this material is certain that it will be available for at least a year or year and a half. There is no *naphthalene* being offered except in small lots and 19@21c. per lb. is being demanded. *Metaphenylenediamine* came up during the week and is quoted at $1.23@$1.30 per lb. against a low price of $1.15 of the previous week. The supply of *aniline oil* and *salts* seems to be better and prices on these two items are easier at 32@38c. for the former and 40@45c. per lb. for the latter. *Beta-naphthol*, tech., is quoted at 88c. per lb. for spot material and 80@82c. on contract; the *sublimed* grade is nominally quoted at the same figures, but there is no material available. Producers of pure *benzol* have made an advance to 35@40½c. per gal., f.o.b. works, drums extra and returnable. *Toluol* and *solvent naphtha* were also advanced, the new quotations being 35@40c. per gal. for the former, and 30½@35½c. per gal. for the latter. These items forming the basis for most of the coal-tar products, there seems to be no indication of a weak and falling market.

Waxes

Paraffines hold the center of interest in this market. Scarcity combined with heavy demand is tending to hold prices at the present high levels. The different grades of this wax had range between 7@12½c. per lb., a year ago, against current range of 9@18½c., and it is thought that still higher levels will be reached. The flooding of the market with 2,000 tons of *carnauba*, No. 3, North country, has caused a drop in this item, which is now listed at 36@37c. per lb. against 43@44c. until the current quotation. *Japan* wax has been affected by the money conditions in the East and is considerably weaker at 19@19½c. per lb.

Naval Stores

This market is fast approaching last year's figures. In the case of the rosins it is already below that market which was quoted at $15@$16.95 for B-D grade, against $12@$15.95 current quotations. *Turpentine* a year ago was selling at $1.10, and if present conditions prevail it will not be long before this limit is reached. Buyers are very few even at the present $1.49 level, which is almost $1 below the price asked three months ago.

Miscellaneous

Molybdenum ore shows a marked increase in activity after a long interval of dullness. While the ore is now quoted at $1 per lb. of MoS_2, an advance from 85c. business has been transacted at considerably below the dollar mark. The ore in most of these instances, however, represents odd lots and war-time stock purchased from munition works. The greater use of molybdenum for the making of parts in the automobile industry has done much to open up business.

In the *feldspar* market there has been an upward movement, with orders at least three months in advance of available stock. Little has been done toward working the Connecticut resources for the last six months and the Canadian mines show a similar inactivity. The ground product, f.o.b. New York State and North Carolina, is quoted at $17 per net ton, a rise of $1 within the week.

Connellsville coke is nominal at $18@$19, foundry, and $17.50@$18.50 furnace, with very little obtainable.

The Chicago Market

Chicago, Ill., July 8, 1920.

Quiet is the ruling spirit in local markets. On many items the difference between spot and future quotations is as high as 50 per cent, indicating that lower spot prices will arrive some time. This tends to discourage spot buying beyond certain and definite needs. A great portion of the capacity of producers is tied up under contract, which fact has driven the immediate and early delivery business into the hands of brokers and speculators. These interests, being affected by the general financial tightness, seem unable to hold prices in the face of weak demand and the general trend of the market is therefore downward.

Transportation conditions are improving. Last week an embargo was placed on intercity shipments in the Chicago District, embracing Hammond, Gary and similar nearby points. This was with a view to permitting the carriers to clear out the accumulation of through shipments, some of which have been stalled for weeks. Consumers depending for supplies on consignments from far-away points are being benefited thereby. Considerable worry as to the coal situation has been expressed, fears of a shortage during the coming winter being prevalent. A careful survey of the situation, however, indicates that there is no cause for alarm and production is keeping pace with demand, which is all that is ever expected this time of year.

Heavy Chemicals

In general, spot market is weak, even in the face of very low supply and, as producers are well sold up for some time to come, but few transactions are recorded for future delivery. Shortage in *alkalis* is most pronounced, with prices changed but fractionally since last reported. ***Caustic soda*** has been all but unobtainable, the prices mentioned being 6½c. per pound on the solid and 6c. on the granulated. These quotations should be considered as nominal. *Sal soda* shows increasing strength with contract business going at $1.70@$1.75 per cwt., spots running up to $1.90, and goods hard to locate at any figure. *Bleach* and *soda ash* show no change.

Producers of *alcohol* remain wholly unable to keep up with demand, the scarcity of the *methyl* grade being most pronounced. Not only are manufacturers having difficulty in securing molasses but the supply they do get is weaker in sugar content than that formerly obtained, owing to a greater effort by the sugar refiner to extract all the sugar possible. This is caused by the present abnormal price on sugar, and the apparent impending break in this commodity may relieve the condition. Meanwhile, the conversion of molasses plants to corn continues. *Denatured* alcohol, normally around 50c. at this time of the year, is firm at $1.09 per gal., owing to its wide consumption by industries ordinarily using *methyl*. *Methyl*, when found, is going at $3.65 per gal. for 95 per cent and considerable contract business is being closed both at that figure and on an open price basis. Market on *ethyl* grade is unchanged. *Formaldehyde*, still hampered by alcohol shortage, remains scarce with price firm at 55c.

Mercury remains firm at a price of $90 per flask, which is notable in view of the fact that various mercurial products which are factors in the drug trade were reduced by the manufacturers. *Aqua ammonia*, on contracts, remains unchanged, but practically all spots are second hand, on which definite quotations are unavailable. Transactions in carboys ranged up as high as 15c. per pound for 26 deg. Demand for *sal ammoniac* is off and price has dropped on the lump variety to 23@24c. per lb. and on the refined gray to 16c. Domestic *barium chloride* is hard to get. The imported is quoted at $175 a ton, nominally, as local supply is about exhausted. *Carbon tetrachloride* is weak on spots, 11c. being the high figure on recent transactions. Contracts cannot be negotiated at much below 13c.

Nothing of interest has occurred in the acid trade in the past fortnight other than a reduction in producers' quotation on *pyrogallic*. Makers now offer the re-sublimed at $2.35@$2.40 per lb. and the crystals at 40c. less.

Coal-Tar Products

The great shortage in all classes of coal-tar products still maintains although reduced activities in the textile industry should cause a lessened call for colors. Inquiry remains light, in the face of which advances were registered July 1 on *naphtha*, *benzol* and *toluol*. Pure ***benzol*** is now quoted at 35c. per gal., *naphtha* at 30c. and ***toluol*** at 35c. As producers are far behind on contracts and but few transactions are recorded in spots, these prices are almost nominal. Ordinary routine transactions in the acids have left prices unchanged.

Formerly noted uncertainty in price on ***aniline salt*** has ended with the price firm at 38c. per lb. The same is true of *aniline oil*, 33½c. being current. The advance in ***benzol*** indicates no further depression on these items. Spot stocks of *naphthalene* are practically exhausted and quotations depend on the buyers' need for supplies. Fluctuation is so great as to render a report useless.

Vegetable Oils

Buyers' apathy continues. Favorable growing weather for cotton coupled with an optimistic government crop report served to discourage *cottonseed oil* buying and nothing has occurred to stimulate the demand on any other item in the line. *Linseed oil*, suffering from the public's refusal to buy on a declining market, is moving slowly, but the price is firm at from $1.54 per gal. in tank cars to $1.64 in barrels f.o.b. warehouse. All other oils in this market show but fractional changes.

Naval Stores

Turpentine on local sales has declined abruptly from a figure of $2.20 a gal. two weeks ago; it is now down to $1.75 to $1.85, with buyers showing no eagerness to load up. No great business is to be anticipated until prices demonstrate stability. Transportation conditions are considerably improved so that immediate requirements are being filled with little trouble.

Pine oil, both pure and destructively distilled, remains very hard to get, and is unchanged in price.

The St. Louis Market

St. Louis, Mo., July 6, 1920.

There has been little change in the chemical market during the past two weeks and prices for the most part have remained stationary. Local stocks are low, especially of chemicals which are not produced locally. The railroad situation has not improved materially and carload shipments are slow and deliveries erratic.

Heavy Chemicals

Local producers report little spot buying but many inquiries by contract buyers. The market for ***sulphuric acid*** is quiet and prices unchanged. The 60 deg. grade is quoted in carload lots at $15 to $16 per ton and 66 deg. grade at $22 per ton. The demand for ***oleum*** continues light and price is unchanged at $27.50 per ton. There has been little change in the demand for ***muriatic acid*** and the price remains at $25 per ton in carload lots and 2@2¼c. per pound in carboys for the 18 degree grade. The supply of ***sodium bisulphate*** is very short and the demand good. Quotation remains unchanged at $6 per ton in carload lots.

The market for ***nitric acid*** is quiet and prices unchanged. The 36 deg. grade is quoted at $7 per cwt., 38 deg. grade at $8, 40 deg. grade at $9 and the 42 deg. grade at $10, in carload lots. The recent action of the Chilean association of producers in advancing the prices of ***nitrate of soda*** will undoubtedly cause an increase of price of ***nitric acid***, as soon as the new supplies reach the market.

Quotations on ***phenol*** are unchanged at 12c. per lb. in quantities 15 tons and over. The supply is plentiful, due to a local firm disposing of surplus Government stock. The supply of ***zinc oxide*** is very limited and manufacturers are quoting on third quarter delivery. Prices are firm at 9@10½c. per lb., depending on the grade.

There is a fair demand for ***caustic soda*** and supplies are more plentiful. Prices are unchanged at $6.25 per lb. in carload lots. ***Soda ash*** is unchanged at $3.75 per lb.

The supplies of all grades of ***alcohol*** are very limited and the demand light. Denatured ***alcohol*** in Nos. 4 and 5 grades is quoted at $1.06 per gal.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	...-...	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.00 - 7.50	8.00 - 9.00
Acetic, glacial, 99½ per cent, carboys	cwt.	15.50 - 16.00	16.50 - 17.50
Boric, crystals	lb.	.15 - .15½	.15½ - .16½
Boric, powder	lb.	.15 - .15½	.15 - .16
Citric	lb.	1.05 - 1.12	1.17 - 1.18
Hydrochloric (nominal)	cwt.	2.00 - 3.00	3.10 - 3.25
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		...-...	...-...
Nitric, 40 deg	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.60 - .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.25 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 19.00	...-...
Sulphuric, 60 deg., drums	ton	...-...	...-...
Sulphuric, 66 deg., tank cars	ton	23.00 - 24.00	25.00 - 26.00
Sulphuric, 66 deg., drums	ton	35.00 - 40.00	45.00 - 50.00
Sulphuric, 66 deg., carboys	ton	36.00 - 40.00	50.00 - 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 -...
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.60
Tannic (tech.)	lb.	...-...	.60 - .90
Tartaric, crystals	lb.	...-...	.80 - .85
Tungstic, per lb. of WO	lb.	...-...	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.	...-...	3.25 - 3.30
Alcohol, Methyl, pure	gal.	...-...	3.50 - 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	...-...	1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	...-...	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05	.05½ - .06
Alum, potash lump	lb.	.07½ - .08½	.09 - .09½
Alum, chrome lump	lb.	.15½ - .18	.19 - .20
Aluminum sulphate, commercial (nominal)	lb.	.02 - .03	.03½ - .04½
Aluminum sulphate, iron free	lb.	.03½ - .04	.04½ - .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ - .13½	.13½ - .14½
Ammonium nitrate	lb.	.08½ - .09½	.10 - .11
Ammonium sulphate	lb.	.07 - .07½	.08½ -...
Amylacetate	gal.	...-...	5.00 -...
Amylacetate tech	gal.	...-...	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .23
Barium chloride	ton	150.00 - 160.00	...-...
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.09½ - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		...-...	...-...
Blue vitriol (see copper sulphate)		...-...	...-...
Borax (see sodium borate)		...-...	...-...
Brimstone (see sulphur, roll)		...-...	...-...
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3.55	...-...
Calcium carbide	lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump	ton	23.00 - 25.00	30.00 - 40.00
Calcium chloride, granulated	lb.	.01½ - .01½	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 - 4.25	4.50 - 6.50
Calcium peroxide	lb.	...-...	1.50 - 1.70
Calcium phosphate, monobasic	lb.	...-...	.75 - .80
Calcium sulphate, pure	lb.	...-...	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.12 - .13	.13½ - .15
Carbonyl chloride (phosgene)	lb.	...-...	.80 - 1.05
Caustic potash (see potassium hydroxide)		...-...	...-...
Caustic soda (see sodium hydroxide)		...-...	...-...
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.	...-...	2.00 - 2.05
Copperas (see iron sulphate)		...-...	...-...
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	...-...	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		...-...	...-...
Epsom salt (see magnesium sulphate)		...-...	...-...
Ethyl Acetate Com. 85%	gal.	1.35 -	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		...-...	1.75 -...
Formaldehyde, 40 per cent (nominal)	lb.	.36 - .40	.57 - .65
Fusel oil, ref	gal.	...-...	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	...-...	...-...
Glauber's salt (see sodium sulphate)		...-...	...-...
Glycerine	lb.	...-...	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	...-...	.03 - .20
Iron sulphate (copperas)	cwt.	...-...	2.75 - 3.00
Lead acetate, normal	lb.	...-...	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	...-...	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	...-...	1.50 -...
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	...-...	3.25 - 3.60
Nickel salt, double	lb.	...-...	.14 - .16
Nickel salt, single	lb.	...-...	.16 - .18
Phosgene (see carbonyl chloride)		...-...	...-...
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	...-...	.35 - .37
Potassium bichromate	lb.	.44 - .45	.46 - .47
Potassium bitartrate (cream of Tartar)	lb.	.52 - .56	.57 - .58
Potassium bromide, granular	lb.	.80 - .85	.90 - .95
Potassium carbonate, U. S. P.	lb.	...-...	.85 - .88
Potassium carbonate, crude	lb.	.21 - .25	.26 - .28
Potassium chlorate, crystals	lb.	$0.16 - $0.17	$0.18 - $0.20
Potassium hydroxide (caustic potash)	lb.	.30 - .33	.35 - .38
Potassium iodide	lb.	...-...	3.35 - 3.60
Potassium nitrate	lb.	.15 - .17	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 -...
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .36
Potassium sulphate (powdered)	ton	$225.00 - 240.00	...-...
Rochelle salts (see sodium potas. tartrate)		...-...	...-...
Salammoniac (see ammonium chloride)		...-...	...-...
Sal soda (see sodium carbonate)		...-...	...-...
Salt cake	ton	...-...	40.00 - 50.00
Silver cyanide (nominal)	oz.	...-...	1.25
Silver nitrate (nominal)	oz.	...-...	.74 - .76
Soda ash, light	100 lb.	...-...	3.50 - 3.60
Soda ash, dense	100 lb.	...-...	3.55 - 3.65
Sodium acetate	lb.	.08½ - .09	.09½ - .12
Sodium bicarbonate	100 lb.	2.45 - 2.60	2.75 - 3.50
Sodium bichromate	lb.	.26½ - .27½	.28 - .29
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 10.00
Sodium bisulphite Powered	lb.	.06 - .06½	.07 - .10½
Sodium borate (borax)	lb.	.09 - .10	.11 - .12
Sodium carbonate (sal soda)	100 lb.	1.60 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	.10 - .10½	.10½ - .11
Sodium cyanide, 96-98 per cent	lb.	.24 - .25	.26 - .27
Sodium fluoride	lb.	.18 -...	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	4.25 - 6.00	6.25 - 6.50
Sodium hyposulphite	lb.	...-...	.03 - .04
Sodium molybdate	lb.	2.50 -...	3.25½ -...
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	.16 - .18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	...-...	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 - 1.70	1.75 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.09½ - .10	.10½ - .11
Sodium sulphite, crystals	lb.	.03½ -...	.04 - .06
Strontium nitrate, powdered	lb.	.17½ - .18½	.19 - .20
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	25.00 - 30.00	...-...
Sulphur dioxide, liquid, cylinders	lb.	.09 -...	.10 - .12
Sulphur (sublimed), flour	100 lb.	...-...	3.80 - 4.35
Sulphur, roll (brimstone)	100 lb.	...-...	3.40 - 3.90
Tin bichloride (stannous)	lb.	.42½ -...	.46 - .50
Tin oxide	lb.	...-...	...-...
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.13 - .13½	.13½ - .17
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.11 - .12	.13 - .15
Zinc oxide, U. S. P.	lb.	.10½ - .13½	...-...
Zinc sulphate	lb.	.03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40 — $1.50
Alpha naphthol, refined	lb.	1.60 — 1.70
Alpha naphthylamine	lb.	.53 — .55
Aniline oil, drums extra	lb.	.34½ — .36
Aniline salts	lb.	.41 — .45
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.35 — 1.40
Benzidine, sulphate	lb.	1.15 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.00
Benzoate of soda, U.S.P.	lb.	.80 — .90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35 — .40½
Benzol, 90%, in drums (100 lb.)	gal.	.33 — .38½
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta naphthol, sublimed (nominal)	lb.	.. — ..
Beta naphthol, tech (nominal)	lb.	.80 — .88
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.05 — 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 — 1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.50 — 1.60
Dimethylaniline	lb.	1.35 — 1.45
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.32 — .35
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.40 — .45
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.80 — .85
H-acid (nominal)	lb.	2.25 — 2.50
Metaphenylenediamine	lb.	1.23 — 1.30
Monochlorbenzol	lb.	.18 — .20
Monoethylaniline	lb.	2.00 — 2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.... —
Naphthaline, flake	lb.	.... — .19
Naphthaline, balls	lb.	.... — .19
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.18 — .25
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.35 — .45
Para-amidophenol, base	lb.	2.50 — 3.00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.40 — 1.50
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.50 — 2.75
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .20
Pyridin	gal.	2.00 — 3.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0.50	— $0.52
Salicylic acid, U. S. P.	lb.	.50	— .60
Salol	lb.	.90	— 1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	— .35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.25	— .26
Sulphanilic acid, crude	lb.	.32	— .35
Toluidine	lb.	1.70	— 2.50
Toluidine, mixed	lb.	.45	— .55
Toluol, in tank cars	gal.	.35	— .....
Toluol, in drums	gal.	.38½	— .40½
Xylidine, drums, 100 gal.	lb.	.50	— .65
Xylol, pure, in drums	gal.	.37	— .45
Xylol, pure, in tank cars	gal.	.35	— .....
Xylol, commercial, in drums, 100 gal.	gal.	.37	— .45
Xylol, commercial, in tank cars	gal.	.23	— .27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	— $0.39
Beeswax, refined, light	lb.	.39	— .40
Beeswax, white pure	lb.	.63	— .68
Carnauba, No. 1 (nominal)	lb.	1.00	— 1.05
Carnauba, No. 2, regular (nominal)	lb.	.85	— .88
Carnauba, No. 3, North Country	lb.	.36	— .37
Japan	lb.	.19	— .19½
Montan, crude	lb.	.23	— .25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	— .09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	— .10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	— .12½
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½	— .15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½	— .17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	— .18½
Stearic acid, single pressed	lb.	.25	— .26
Stearic acid, double pressed	lb.	.26	— .27
Stearic acid, triple pressed	lb.	.27	— .28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$12.00	— $15.05
Rosin E-I	280 lb.	15.95	— 16.10
Rosin K-N	280 lb.	16.10	— 16.20
Rosin W. G.-W. W.	280 lb.	16.25	— 16.50
Wood rosin, bbl.	280 lb.	17.00	— 17.00
Spirits of turpentine	gal.	1.49	— .....
Wood turpentine, steam dist.	gal.	....	— ....
Wood turpentine, dest. dist.	gal.	....	— ....
Pine tar pitch, bbl.	200 lb.	.....	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	— 15.00
Retort tar, bbl.	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.70	— .....
Rosin oil, second run	gal.	.73	— .....
Rosin oil, third run	gal.	.90	— .....
Rosin oil, fourth run	gal.	.95	— 1.00

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	29

Crude Rubber

Para—Upriver fine	lb.	$0.36½	— $0.37½
Upriver coarse	lb.	.26½	— .27½
Upriver caucho ball	lb.	.27½	— .28½
Plantation—First latex crepe	lb.	.36	— .37
Ribbed smoked sheets	lb.	.35	— .36
Brown crepe, thin, clean	lb.	.36	— .37
Amber crepe No. 1	lb.	.....	— .40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½	— $0.20
Castor oil, AA, in bbls.	lb.	.20	— .22
China wood oil, in bbls.	lb.	.18½	— .19½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	— .18½
Cocoanut oil, Cochin grade, in bbls. (nominal)	lb.	.18½	— .19½
Corn oil, crude, in bbls.	lb.	.17½	— .18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15½	— .16
Cottonseed oil, summer yellow	lb.	.18½	— .19
Cottonseed oil, winter yellow	lb.	.21	— .22
Linseed oil, raw, car lots (domestic)	gal.	1.57	— 1.67
Linseed oil, raw, tank cars (domestic)	gal.	1.52	— 1.62
Linseed oil, boiled, car lots (domestic)	gal.	1.60	— 1.70
Olive oil, commercial	gal.	3.10	— 3.25
Palm, Lagos	lb.	.12½	— .13½
Palm, bright red	lb.	.13	— .13½
Palm, Niger	lb.	.11	— .12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.13	— .15
Peanut oil, refined, in bbls.	lb.	.22	— .24
Rapeseed oil, refined in bbls.	gal.	1.70	— 1.72
Rapeseed oil, blown, in bbls.	gal.	1.80	— 1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	— .18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12½	— .13½

FISH

Winter pressed Menhaden	gal.	$1.17	— $1.18
Yellow bleached Menhaden	gal.	1.20	— 1.22
White bleached Menhaden	gal.	1.23	— 1.24
Blown Menhaden	gal.	1.30	— 1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	— $25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	— 20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	— 10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	— 25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	— 19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	— .....
Barytes, floated, f.o.b. St. Louis	net ton	26.50	— 28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	— 11.25
Blanc fixe, dry	lb.	.05½	— .06
Blanc fixe, pulp	net ton	60.00	— 80.00
Casein	lb.	.15	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb.	.04½	— .05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	— 12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	— 15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	— 22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	— 40.00
China clay (Kaolin), imported, lump	net ton	25.00	— 35.00
China clay (Kaolin), imported, powdered	net ton	30.00	— 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	— 8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	— 10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	— 23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	— 20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	— 20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00	— .....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	— .....
Fuller's earth, imported, powdered	net ton	35.00	— 40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	......	— .01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	......	— .02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	......	— .05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	......	— .10
Graphite, crucible, 85% carbon	lb.	......	— .08
Graphite, crucible, 88% carbon	lb.	......	— .09½
Graphite, crucible, 90% carbon	lb.	......	— .10½
Pumice stone, imported, lump	lb.	.04	— .50
Pumice stone, domestic, lump	lb.	.06	— .....
Pumice stone, ground	lb.	.04	— .07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.....	— 10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.....	— 14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	— 17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7.50
Soapstone	ton	15.00	— 25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50	— 14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00	— 9.00
Talc, rubber grades, f.o.b. Vermont	ton	9.00	— 15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	— 15.00
Talc, imported	ton	60.00	— 70.00
Talc, California Talcum Powder grade	ton	20.00	— 35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90- 100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	80- 90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45- 53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45- ...
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75- ...
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40- ...
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90 ...
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90- 100
Silica brick, 9-in. and 9 in. sizes, Chicago district	1,000	55- ...
Silica brick, f.o.b. Birmingham	1,000	51- 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50- 55

Ferro-Alloys

All f.o.b. Works

Ferro carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	— $250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.19	— .20
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	— .21
Ferro-manganese, 76-80% Mn.	gross ton	200.00	— 250.00
Spiegeleisen, 18-22% Mn.	gross ton	75.00	— .....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.50	— 3.00
Ferro-silicon, 10-15%	gross ton	60.00	— 65.00
Ferro-silicon, 50%	gross ton	80.00	— 90.00
Ferro-silicon, 75%	gross ton	150.00	— 160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90	— 1.10
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	— .....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50	— 7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.70	— .85
*Coke, foundry, f.o.b. ovens	net ton	18.00	— 19.00
*Coke, furnace, f.o.b. ovens	net ton	17.50	— 18.50
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	— .....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	.....	— 25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02	— .....
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.85	— .90
Manganese ore, chemical (MnO_2)	gross ton	75.00	— 85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	1.00	— .....
Monazite, per unit of ThO_2	unit	42.00	— .....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	— .....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	— .....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12	— .14
Pyrites, domestic, fines	unit	.12	— .14
Rutile, 95% TiO_2 per lb. ore	lb.	.20	— .25
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	— .....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	— 7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	— 3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	— 3.00
Vanadium pentoxide, 99%	lb.	12.00	— 14.00
Vanadium Ore, per lb. of V contained	lb.	1.00	— 2.50
Zircon, washed, iron free	lb.	.10	— .....

*Nominal

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

DUNCAN—Joseph Hardy plans to build a 100-ton cyanide mill at its gold mine here.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., has awarded the contract for the construction of certain alterations and additions to the Aeronautical Engine Testing Laboratory Building at the Navy Yard here, to Hyde & Baxter, 711 13th St., N. W., at $14,990. Noted July 6.

Illinois

NEWTON—The city plans to extend the present waterworks system, including a filter plant. Estimated cost, $25,000. Fuller & Beard, Chemical Bldg., St. Louis, Mo., engrs.

Kansas

GREAT BEND—The Sisters of St. Dominic have awarded the general contract for the construction of a 3-story, 50x150-ft. hospital, to T. C. Cork. A chemical laboratory will be installed in same. Estimated cost, $150,000.

Kentucky

HENDERSON—The Lucking Distributing Co., Cincinnati, O., has purchased the plant of the Peerless Distilling Co., here, and plans to make improvements and install machinery in same, for the manufacture of grain alcohol. Estimated cost, $30,000.

LOUISVILLE—The Dixie Belle Refining Co., 701 Inter-Saw Bldg., plans to build a refinery on Western Parkway.

LOUISVILLE—The Stall Oil Refining Co., 733 River Rd., is in the market for lubricating machinery.

Maryland

ST. HELENA—The Glidden Co., Madison Ave., N. W., Cleveland, O., has purchased the lithopone plant of the Chemical Pigments Corp., here, and plans to increase the capacity of same.

Massachusetts

CAMBRIDGE—The Presto-Lite Co., Inc., 30 East 42nd St., New York City, will receive bids until August 5 for the construction of a 1-story, 25x100-ft., acetylene plant, here. Estimated cost, $80,000. Noted April 14.

SPRINGFIELD — The Westinghouse Electric & Mfg. Co., Page Blvd., has awarded the contract for the construction of a 1-story, 125x160-ft. foundry, to Bernard H. Prack, Keystone Bldg., Pittsburgh, Pa. Estimated cost, $35,000.

Michigan

DETROIT—The Michigan Grey Iron Castings Co., Harbaugle Ave. and Wabash Ry., is in the market for miscellaneous foundry equipment for plant addition.

GRAND RAPIDS—The Amer. Can Co., 120 B'way, New York City, will soon award the contract for the construction of a factory on 6th St. Estimated cost, $1,000,000. M. M. Loony, 120 B'way, New York City, archt. and engr.

Minnesota

FREEPORT—The city engaged the Bradley Eng. Co., engr., St. Cloud, to prepare plans for a sewage system, including Imhoff tanks and sludge beds. Estimated cost, $30,000.

Missouri

MOBERLY—The city plans an election to vote on $250,000 bonds to construct a pumping and filtration plant, etc.

New Jersey

IRVINGTON—The Atlas Foundry Co. plans to construct a 60x60-ft. grey iron foundry addition, and is in the market for machinery for same. Estimated cost, $8,000. W. E. Lehmall, Newark, engr. W. H. Mantz, genl. mgr.

New York

ALBANY—H. M. Biggs, State Comr. of the Health Dept. Laboratory, will soon receive bids for the construction of a 1-story, 31x85-ft. laboratory building. Estimated cost, $15,000.

BROOKLYN—The Natl. Lead Co., 111 B'way, New York City, has awarded the contract for the construction of a 4-story, 50x100-ft. factory on Marshall St., to the White Constr. Co., 95 Madison Ave., New York City, at $110,000.

BUFFALO—The F. F. Dally Co. of New York, 227 Military Rd., plans to construct a 1-story, 28x127-ft., addition to plant for the manufacture of blacking. Estimated cost, $6,000.

BUFFALO—The Linde Air Products Co., 1681 Fillmore Ave., plans to repair laboratory building recently destroyed by fire. Estimated cost, $4,000.

BUFFALO—The North Buffalo Hardware Fdry. Co., 743 Hertel Ave., plans to alter a 1-story, 67x350-ft., foundry. Estimated cost, $6,000.

BUFFALO—The University of Buffalo, 24 High St., is having plans prepared for a 3-story chemical laboratory. Estimated cost, about $300,000. McKim, Mead & White, 101 Park Ave., New York City, archts. and engrs.

NEW YORK—Sommerfeld & Steckler, archts. and engrs., 31 Union Sq., will receive bids about August 2 for the construction of a 7-story, 50x50-ft. factory for the Rigaud Perfume Co., 75 Barron St.

Ohio

AKRON—The Goodrich Co., South Main St., plans to build several buildings, including a water-softening plant, etc., on Rubber and Falor Sts. Estimated cost, $10,000,000.

CANTON—The city plans to construct a sewage disposal plant 10 miles south of here. Imhoff tanks will be installed in same. W. E. Sarver, city engr.

CANTON—The Timken Roller Bearing Co., Dueber Ave., will build a 1-story, 120x200-ft. factory addition to its tube mill for the manufacture of steel on Harrison Ave., S. W. Estimated cost, $40,000. Work will be done by day labor.

CINCINNATI—The Amer. Can Co., 120 B'way, New York City, has awarded the contract for the construction of a can factory, including a 6-story, 72x260-ft; 1-story, 60x1400 ft.; 1-story, 90x97-ft., and a 1-story, 80x160-ft., buildings, to the Ferro Concrete Constr. Co., Richmond and Harriet Sts. Estimated cost, $1,000,000. Noted April 14.

CLEVELAND—The city has awarded the contract for the construction of a filtration plant at the Baldwin Reservoir to R. E. Carey Co., West 112th St. Estimated cost, $312,360. Noted May 12.

CLEVELAND—The General Chemical Co., Warner Rd., S. E., has awarded the contract for the construction of a large addition to the national works of the company, including a sulphate of alumina plant, to the J. G. White Eng. Corp., 43 Exchange Pl., New York City.

CLEVELAND—The Hydraulic Pressed Steel Co., Hydraulic Ave., has awarded the contract for the construction of a 1-story, 75x200-ft., factory addition at 5704 Hydraulic Ave., to Craig Curtis Co., 1031 Guardian Bldg. Estimated cost, $75,000.

CLEVELAND—The Lake Erie Steel Co., Stop 13 A.B.C. line, has awarded the contract for the construction of a 1-story, 50x180-ft., steel mill addition, to the Republic Structural Iron Wks. Co., East 53rd St. Estimated cost, $75,000.

CLEVELAND—The Mechanical Rubber Co., Lisbon Rd., has awarded the contract for the construction of a 1-story, 34x102-ft., substation, to the Stone & Webster Co., Leader-News Bldg. Estimated cost, $100,000.

CLEVELAND—The Union Rolling Mills Co., 8200 Aetna Rd., had plans prepared for the construction of a 1-story, 22x182-ft. rolling mill addition. Estimated cost, $30,000. William Davis, 892 The Arcade, archt. and engr.

CLEVELAND—D. D. Wessels, 1385 East 173rd St., is having plans prepared for the construction of a 2-story, 100x110-ft., factory for the manufacture of concrete tubs, on East 21st St. and Oregon Ave. Estimated cost, $100,000. W. G. Caldwell, Park Bldg., archt.

COLUMBUS—The Atlas Brass Fdry. Co., 980 South Park St., has awarded the contract for the construction of a 1-story, 80x100-ft., brass foundry on Stewart Ave., to Nonnemachee & Frank, 427 Citizen Bank Bldg. Estimated cost, $20,000.

LORAIN—The West Shore Realty Co., care Holland Eng. Co., B. of L. E. Bldg., Cleveland, will soon award the contract for the construction of a sewer, water main and sewage disposal plant with two septic tanks. Estimated cost, $35,000.

OXFORD—The Miami University plans to build 3 buildings, including an addition to the Chemistry Building. Chemical equipment will be installed in same. Estimated cost, $125,000.

TROY—The Gummed Products Co. plans to construct a 2-story, 100x140-ft. factory on Market St. Estimated cost, $200,000.

Oklahoma

KELLYVILLE—J. W. St. Sing, clerk of the Bd. Educ., plans to build a 2-story high school here. A chemical laboratory will be installed in same. Estimated cost, $50,000.

OKLAHOMA CITY—The city is having preliminary plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, $1,000,000. Fuller & McClintock, 170 B'way, New York City, engrs.

PERRY—The city is having preliminary plans prepared for the construction of a sewage disposal plant here. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., consult. engr.

Pennsylvania

JEANNETTE—The Amer. Window Glass Co., Farmers' Bank Bldg., Pittsburgh, has awarded the contract for the construction of a 1-story, 42x180-ft., cutting-room building, to the Bollinger-Andrews Co., Empire Bldg., Pittsburgh. Noted May 12.

PHILADELPHIA—John N. Gill Co., Otis Bldg., is constructing a factory to be used as a machine shop and erection shop for vacuum dryers and chemical machinery, on a 5-acre site near Cedar Grove Station on the Frankford Branch of the Philadelphia and Reading R.R.

PHILADELPHIA—The Prest-O-Lite Co., Inc., 30 East 42nd St., New York City, will receive bids until August 5 for the construction of a 1-story, 25x100-ft. acetylene plant, here. Estimated cost, $80,000. Noted April 7.

South Dakota

DE SMET—The Bd. Educ. is having plans prepared for the construction of a 2-story, 60x133-ft., high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. W. L. Alban, Endicott Bldg., St. Paul, Minn., archt.

Vermont

PROCTOR—The Vermont Marble Co. is building a marble sawing mill.

Virginia

RICHMOND—The Amer. Lace Leather Co., Virginia St., between 13th and 14th Sts., is having plans prepared for the construction of a building. Carneal & Johnson, Chamber of Commerce Bldg., archts.

RICHMOND — The Virginia-Carolina Chemical Co., 12th St., had plans prepared for the construction of a 5-story steel factory. Estimated cost, $250,000.

West Virginia

CHATTAROY—The Bd. Educ. plans to build a high school here. A chemical laboratory will be installed in same. Estimated cost, $100,000.

MARTINSBURG—The Natl. Shale Brick Co. plans to construct a brick plant. Estimated cost, $250,000.

WARWOOD — The Wheeling Cement Products & Building Co., 622 Wheeling

Bank & Trust Co. Bldg., Wheeling, will build a plant for the manufacture of building tile here. Estimated cost, $35,000. Work will be done by day labor.

Wisconsin

CUMBERLAND—The city is having plans prepared for the construction of a sanitary sewer system and treatment plant. Estimated cost, $80,000. L. P. Wolff, Guardian Life Bldg., St. Paul, Minn., engr.

RACINE—The Hamilton Beach Mfg. Co., Rapids Drive, is having plans prepared for the construction of a 1-story, 80x200-ft. foundry. Foundry equipment will be installed in same. Estimated cost, $60,000. A. L. Tiegel, Baker Block, archt.

WAUKESHA—The Waukesha Casting Co., 340 B'way, is having plans prepared for the construction of a 1-story, 120x130-ft. foundry. Estimated cost, $50,000. C. Kawin Co., 431 South Dearborn St., Chicago, engr.

Quebec

CHELSEA—The Royal Securities Co., 164th and St. James Sts., will receive bids in August for the construction of a pulp and paper plant here. Noted April 21.

MONTREAL—The Pottery Co., Ltd., has purchased a large site in the eastern section of the city and plans to construct a plant on same. The company is in the market for additional kilns.

Ontario

LONDON—The Bd. Educ., 848 Dufferin Ave., will receive bids until August 1 for the construction of a collegiate building on Waterloo St. Physics and chemistry laboratory equipment will be installed in same. Estimated cost, $500,000. L. V. Carrothers, Hydro Bldg., archt.

WINDSOR—C. W. Ripley, 519 Sandwich St., plans to build a foundry on Sandwich St. Estimated cost, $25,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 30 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

FOREST PRODUCTS LABORATORY will hold its decennial celebration at Madison, Wis., July 22 and 23, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its midsummer meeting at Boston, July 15 and 16.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its Fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

Industrial Notes

PARSONS, KLAPP, BRINCKERHOFF and DOUGLAS announce the removal of their general and engineering offices from 60 Wall St. to their own building at 84 Pine St., New York.

THE GENERAL FIRE PROOF CO., Youngstown, Ohio, devotes its May issue of "General Fire Proofing" to the problem of industrial housing and contains examples of recent projects.

THE STOKER MANUFACTURERS ASSOCIATION recently held a meeting at Lakewood, N. J., at which the following officers and executive committee were elected: Sanford Riley, president; M. Alpern, vice-president; A. G. Pratt, treasurer, S. A. Armstrong and H. A. Hatton, on the committee, and J. G. Worker, secretary.

HARRY LEVEY, INC., has been organized as the first motion picture producing company which will devote itself exclusively to the making of industrial and educational motion pictures. Arrangements have already been made for the production of a series of pictures showing the making of dyes, explosives, automobiles, airplanes, paints, leather and electrical apparatus. Temporary offices are at the Hotel Astor, New York. Production studios are at 109 East 124th St., New York.

THE INTER-RACIAL COUNCIL, Woolworth Building, New York City, has established an information service for the benefit of employers of foreign born labor and for the workers themselves. The object of the service is to stabilize immigrant labor and to promote better relations between the various races in America and native born. The service will also check the tendency of the foreign born to return to their native land under the mistaken impression that prices are lower and living conditions better than in America.

THE GENERAL BRIQUETTING CO., New York, announces the appointment of Thomas F. Kelly, formerly with the Lackawanna Steel Co., as sales engineer of the flue dust, ore and by-products department.

THE CRESCENT BELT FASTENER CO., New York, has recently published a booklet on "Modern Scientific Methods of Belt Joining" which contains many practical data to those interested in the maintenance of production schedules and continuous performance of machines where belting is used. Instructions are given which will enable anyone to make belt joints, retaining the belt's full strength and assuring long life. Essential data are presented on a single sheet which can be suitably displayed on the wall. Copies of this illustrated circular will be sent upon request.

W. J. RAINEY, INC. is the name of the new incorporation of the business heretofore carried on under the name of W. J. Rainey, as announced by the Trustees of the Estate of W. J. Rainey. The officers of the new corporation are: Roy A. Rainey, chairman of the board, Scott Stewart, president and treasurer; L. L. Willard, vice-president in charge of operations; John McElwain, vice-president in charge of sales and purchases of raw materials; H. R. Ahrens, secretary. The executive offices of the company will remain at 52 Vanderbilt Ave., New York."

THE CHICAGO PNEUMATIC TOOL CO., New York, announces the election of Allan E. Goodhue as vice-president in charge of sales. Mr. Goodhue since May 1, 1919, has been managing director of the company's English subsidiary, The Consolidated Pneumatic Tool Co., London, England; also director of European sales for the Chicago Pneumatic Tool Co. He sails for New York on the "Olympic" and is scheduled to arrive about July 3.

SKF INDUSTRIES, INC., at a special meeting held May 13, 1920, accepted the resignation of B. G. Prytz, as president. Mr. Prytz has been elected managing director of the parent company, with headquarters at Gothenburg, Sweden. At the same meeting F. B. Kirkbride, vice-president since the organization of the company, was elected president.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., reports an order for a 1-ton "Greaves-Etchells" furnace for the Buenos Ayres Western Ry. Ltd.

THE WICKWIRE SPENCER STEEL CORP., Buffalo, N. Y., which publishes "Wick-Tack" has issued a very interesting number for June, 1920, which contains items on the personnel of the company, association activities, articles and editorials.

J. G. WHITE ENGINEERING CORP. announce that they have received a commission to build a very large addition to the National Works of the General Chemical Co. at Cleveland, Ohio. One of the most important features of the addition will be a sulphate of aluminum plant of large capacity. The engineers have been working on the engineering plans for some months and it is expected that the construction work will be started at an early date.

FRANK L. MCCARTNEY, formerly New York branch manager for the Monsanto Chemical Co., has been appointed general sales manager, with complete charge of all sales for all plants, including branch houses.

JOS. RISEMAN & CO., 152 Broadway, N. Y., announce that their business will be carried on from the new address given herewith.

BLAW-KNOX CO. announce that "Blawnox" is the new name conferred by the United States Senate upon the town of Hoboken, Pa., the home of the company. The company first established in Hoboken about five years ago, occupying a comparatively small shop, at the same time operating another plant at Wheatland, Pa. About two years ago the latter plant was removed and added to the Hoboken works. The magnitude of the works has since increased by the erection of a large hammer-welding plant, augmenting the already extensive oxy-acetylene and electric welding facilities of Blaw-Knox Company. About 1,000 persons are employed in the shops, most of whom live in Old Hoboken. A petition signed by the people of the town, asking the Senate to change the postoffice name to Blawnox, has just been granted. This company also announces that Dewitt Clinton Grove, past vice-president of the Technical Publicity Association, has become advertising manager of the company. He succeeds George Land, who resigned July 1, to enter the agency field as head of the Technical Publicity Co. of Pittsburgh.

THE SWENSON EVAPORATOR CO. of Chicago is selling a large evaporator for export to Chile to be used in research for the production of Chilean nitrate.

THE DETROIT ENGINEERING SOCIETY entertained a Swiss delegation of sixty-five members in Detroit recently. The party made a thorough inspection of industrial plants in and about Detroit.

ARTHUR R. MAAS LABORATORIES, Los Angeles, Cal., has issued a twenty-two page pamphlet entitled "Chemistry and You," which has been issued for the purpose of acquainting those interested with their business, Chemical Service. The laboratories are equipped to handle problems related to industrial developments on the Pacific Coast, "from test tube to factory," having a well equipped laboratory and the necessary apparatus to test out processes on a semi-commercial scale. Arthur R. Maas is in charge of the organization; E. L. Campbell is chief chemist, R. B. Stringfield is in charge of chemical and H. L. Glaze of the mechanical engineering problems.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

Volume 23 New York, July 21, 1920 *Number* 3

Would Platinum Registration Be a Safeguard Against Theft?

NUMEROUS large platinum thefts in recent months again emphasize the importance of some drastic measures to forestall further activity of the clever operators who have been so successful recently. One of the most effective proposals to this end which we have heard has been advanced by Dr. W. F. HILLEBRAND, Chief Chemist of the Bureau of Standards, to the effect that some form of platinum registration should be required.

It is recognized by Dr. HILLEBRAND that there are many complications and possible difficulties, and no one has yet suggested exactly how such a plan can be carried through most effectively and safely. It is an important proposal, however, and one which is worthy of very careful attention by everyone interested in the platinum industry whether he is a manufacturer or a user.

An ideal regulation would have national scope and effect, but of course anything affecting commerce in platinum could not legally be adopted by Congress except on the basis of affecting interstate commerce, and much traffic in platinum, of course, is intrastate. It is believed, however, that a registration could be required under internal revenue regulations if a nominal tax upon platinum sales were imposed. Such taxes could be made very nominal, perhaps one-tenth of 1 per cent, and thus amount only to enough to pay the costs of operating the registration agencies. It would thereby put no financial burden upon either manufacturer or user of the metal and the principal objection would be the possible complications and delay in the commercial handling of the material.

However, it is probable that everyone—producer, manufacturer and user—would be benefited despite these restraints, for the recent losses of platinum have been appalling. The Bureau of Standards lost more than $10,000 worth of metal on one occasion. The University of Missouri and the University of Michigan also suffered losses. The largest loss of all recently reported is a $40,000 theft from one of the manufacturers in the neighborhood of New York City. Certainly with these hazards accompanying the storage and use of platinum metals, we are justified in encouraging some inconvenience in the traffic. Under the circumstances, it appears that the proposal that all platinum sales should be registered with some appropriate agency is the best solution yet made. In any event, we urge careful consideration of this possibility in the hope that a really effective basis for protection of platinum metals can be developed.

Discussion of the subject by our readers is cordially invited.

A Plan to Co-ordinate University Scientific Research

CONFLICTING testimony on the subject of scientific research in our universities is offered in the annual reports of the president of the Carnegie Foundation for the Advancement of Teaching and the Committee on Chemistry of the Society for the Promotion of Engineering Education. The former is of the opinion that "in the sharp competition for the reputation supposed to come to a university from carrying on research the obligation to teach has become less and less realized, and the teaching of undergraduates, in some of our great institutions, is poor." The Committee, on the other hand, while recognizing frankly the poor quality of much of our instruction, attributes it more to the unceasing grind of class and laboratory work to which instructors are held, and the consequent lack of time for vitalizing research. Perhaps the two views are not strictly comparable, as President PRITCHETT undoubtedly has reference to the larger institutions in which contact between professor and student may be very limited, while the Committee certainly speaks for the smaller institution and the overworked instructor. Both are in agreement on two things: the prevalence of poor instruction and the necessity for research. With the former we will not concern ourselves for the moment, vital though it is; but the latter suggests some constructive comment.

President PRITCHETT says that "the development of a true spirit of research is a necessary part of every true university." And the Committee reports that "more research work must be done at many of the smaller institutions if their teaching staffs are to continue fit to train even undergraduates for the industrial world." With this indorsement, from which few will dissent, we may proceed to examine how best to vitalize research in the educational institutions of the country. The first thing that impresses even the casual observer is that there is no apparent co-ordination of the efforts at research in the different schools; that the subjects for investigation depend on the predilection of the professor, and are likely to be of little or no value; that unimportant subjects for research are often selected in ignorance of gaps in our knowledge that might better be filled; that from a national point of view, at least, there is no definite correlated program, and that much energy and ability are expended aimlessly. This is not framed as a harsh indictment, but merely stated as a condition.

The idea of co-ordinating university scientific research throughout the country is not new, having been the subject of much informal conversation and correspondence. But the time and conditions seem appropriate for the formulation of a definite program toward

that end. The first requisite is a central medium or clearing house, and that is at hand in the National Research Council. This body is cognizant of numerous problems of exact scientific nature or industrial utility that could be apportioned among institutions according to their equipment, physical and mental. The predilection of the investigator might still be catered to, but there would be correlation of his work with that of others and a systematic effort to obtain useful information. The demands of the war showed lack of knowledge along many lines, and the experience of those days can be turned to good account in this way.

The service of such a program to science and industry is but one of the benefits that will result, if we may take the opinion of the Committee on Chemistry previously referred to. It believes in the plan on account of the new vigor it will instil into college and university teachers; for the good example it will set for senior and post-graduate students; and for the influence it will have in retaining good men in the teaching profession. It has already recommended the plan to the National Research Council, and it has received favorable consideration. To us it seems like an excellent opportunity to mobilize a vast amount of energy and ability and train it for great usefulness, and for that reason we are glad to lend our support and encouragement.

Miami Copper Co. Not in Contempt of Court

THE District Court of the United States for the District of Delaware, HUGH M. MORRIS, Judge, has dismissed the petition of Minerals Separation which sought to have the Miami Copper Co. punished for contempt of court and restrained from further use of its present processes. The order of court is reviewed elsewhere in this issue. It will be observed that, in effect, this order is the same as that of the United States District Court of Montana, dismissing Minerals Separation's petition to find the Butte & Superior Co. in contempt. In that case, it will be recalled, the plaintiff was "remitted to some one of the familiar methods to secure determination upon the merits of these alleged infringements," and was not "permitted to transfer the controversy from merits to contempt." In other words, if Minerals Separation believes that both Butte & Superior and Miami companies are infringing with their present processes, the way is open for new litigation to prove its contentions.

A further order by the District Court at Wilmington making Minerals Separation North American Corporation an additional party plaintiff has an important legal technical bearing in connection with the disclaimer regarding claims 9, 10 and 11 of U. S. Patent 835,120, which are the "small quantity of oil" claims not sustained by the Supreme Court. The question at issue is whether the failure of Minerals Separation North American Corporation to join in the disclaimer might not possibly have the effect of completely destroying the disclaimer and consequently throw out of court all infringement suits so far brought under this patent. Judge MORRIS gives leave to file a supplemental bill making Minerals Separation North American Corporation an additional party plaintiff, but without prejudice to the Miami company to renew its objection to the bill when filed.

Relations Between Institute of Metals, The Foundrymen and Mining Engineers

THOSE men actively interested in the Institute of Metals received something of a shock when they heard that the American Foundrymen's Association had decided to solicit papers on non-ferrous foundry practice, and had appointed a strong committee to attend to this work. They recollected that thirteen or fourteen years ago the American Brass Foundrymen's Association was organized, somewhat as an offshoot from the American Foundrymen's Association, the originators being men who felt that the older body was neglecting the non-ferrous field, especially from the point of view of physical metallurgy. The name was later changed to the American Institute of Metals, and the society bade fair to duplicate the wonderful success of the Institute of Metals, its British junior, certainly with no overwhelming advantage in size of industry or number of personnel to aid it.

In all the years of its existence the American Institute of Metals had made efforts, not without considerable success, to bring out papers and discussion on the so-called "practical" aspects of founding. However, only one who has tried it can realize the difficulty of securing such contributions from men who are qualified by experience in their subject, but not in literary accomplishment. Naturally, then, the *Proceedings* contained more and more pages written by men who were investigating the properties of alloys with microscope, pyrometer and all manner of physical instruments, and who were constantly finding new facts well worth recording, rather than by men who were attempting to establish the best balance between pouring temperature, furnace losses and scrap production, and attaining an approximate solution largely by intangible and indescribable refinements in skillful manipulation. "Scientific" men thus have a double advantage over "practical" men. In the first place, they write more, and practice makes it easier. In the second place, it is far easier to describe a thermal experiment precisely with the help of a cooling curve than it is to describe the proper way to gate a particular casting, even with a dozen sketches.

Meantime the 300 to 400 non-ferrous establishments represented in the American Foundrymen's Association became insistent for papers more nearly applicable to routine problems in the brass, bronze or white-metal foundries, and it was therefore resolved to attempt at least one such session at the annual meeting. Since the fall meeting of the Institute of Metals had been held simultaneously with the Foundrymen, to get the advantage among others of their annual exposition of mechanical appliances, the resolve was communicated to them. Feeling the great difficulty of securing such desirable papers, yet the distinct gain which such discussions should have, no matter from what source, the Institute of Metals decided to work hand in hand with the senior association and to pool their resources so that a real event could result. In this case duplication of effort is apparently needed before even reasonable returns can be expected.

For "American Institute of Metals" the reader should think "American Institute of Mining and Metallurgical Engineers, Institute of Metals Division," in what precedes, since we all know that the two institutions joined forces over a year ago. Whether the fusion was an altogether happy move is a matter on which two opin-

ions may be had; but since it is an accomplished fact all well-wishers of the Institute of Metals and all members of the Mining Engineers who are interested even mildly in the physical metallurgy of alloys should make it a point to see that they are enrolled in the Institute of Metals Division. At present there are many opportunities open whereby such enrollment may be escaped, yet to be specifically a member of the Institute of Metals Division involves no additional financial obligation. It does not exclude the member from participation in any other section or activity whatever of the parent society, but on the other hand it does admit the holder to valuable joint meetings, exhibits and other activities with the Foundrymen's Association as already outlined, will group the member with the leading Americans working with the metallurgy of alloys, and will help perpetuate the identity and influence of a quite honorable and very useful organization.

Steel Industry Functions Well During the First Half of 1920

IN a very trying half year the steel industry of the United States has made an excellent showing. The production was considerably less than the capacity, but the proportion of output to capacity was much higher than in many other industries. It has been made clear that when there are such difficulties as shortage of labor and inefficiency of labor the production of steel is less affected than the consumption of steel, taking the various lines of consumption as a whole.

When it comes to transportation, furthermore, it is seen that a breakdown there does not affect the operation of blast furnaces and steel mills as much as it does business in general. It is true that the steel mills reached the middle of the year with a large quantity of steel unshipped, but the reference here is to the production of iron and steel rather than the delivery. The accumulation of unshipped steel, indeed, reflects credit upon the industry, for the influence of the accumulation would be to restrict production. The manufacturers have shown ingenuity and courage in piling up the steel that they could not ship.

As to actual tonnage, it seems fair to take the steel-ingot producing capacity of the country at 50,000,000 gross tons a year. The half year's production of steel ingots was approximately 21,000,000 tons, or about 84 per cent of previously estimated capacity. And the 50,000,000-ton estimate cannot be considered a low one, seeing that in both 1912 and 1913 the actual production was only a shade over 30,000,000 tons, while the capacity existing at the close of 1913 could not possibly be estimated at over about 35,000,000 tons, so that 50,000,000 tons capacity at the beginning of this year would represent an increase during the war of 43 per cent.

The production of finished rolled steel, in the forms for which the statistics are gathered, normally runs about 76 per cent of the ingot tonnage, on account of scrap and scale losses, the material being eventually recovered very largely, but in the past half year the production probably fell a few hundred thousand tons short of the 16,000,000 tons that this proportion would give. Rather than curtail production of ingots and pig iron further, the mills accumulated ingots and semi-finished steel, thus showing courage and a willingness to perform.

The accumulation of semi-finished and finished steel at mills may be guessed at about 2,500,000 tons, the bulk of this being in finished product, rolled to customers' specifications, this representing between 12 and 15 per cent of the production, the accumulation occurring chiefly during the second quarter of the year.

Even the automobile industry, which has paid fancy wage rates and offered competition with other manufacturers that has been much complained of, can hardly show anything like a ratio of production to capacity of 84 per cent. Some manufacturing industries have been almost completely stalled in the past two or three months. As to the railroads, the output in transportation in proportion to physical facilities has been very low, yet it is now admitted by such men as DANIEL WILLARD that the railroads must do much better, in point of efficiency, than their best records of the past. This reference is only to quantity of transportation, in ton-miles. The quality has been particularly low, in point of there being such serious delays and such an ill-assorted movement. The steel industry probably made as good a record in quality as it did in quantity.

Chemical Engineering and The Motion Picture Industry

IN THE development of artistic motion pictures, improvements in projection apparatus and in the art of photography have played an important part, but without the highly developed film which is now available, and lacking photographic chemicals and dyes of excellent quality, it is doubtful whether the "movie" would have become as popular as a form of entertainment. The first requirement, of course, is a film of uniform and excellent quality. The research chemist and the chemical engineer have contributed largely to the results which are now obtainable. There remains, however, an opportunity for the development of materials and apparatus which will make possible the production of better pictures and considerably extend their field of usefulness. The production of non-flammable film is a problem that remains unsolved and the projection of pictures in colors would enhance both their educational and their artistic value.

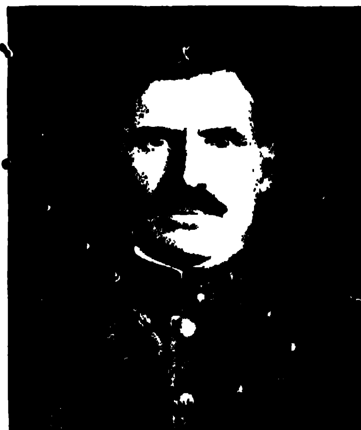
There is no doubt that should an inexpensive non-flammable film be forthcoming, there would be an increased use of motion pictures, because of their educational value, by schools and by industrial establishments; this would create a demand for an inexpensive, light-weight projection apparatus that could be carried about easily and be operated by electric current obtained from a lamp socket. Even with the film and projection apparatus now available motion pictures have demonstrated their value as aids to the selling of heavy machinery and non-portable mechanical equipment and have been used as an aid to research in metallurgical and other investigations. These are but more obvious possibilities.

For such uses the cost of producing the finished film becomes an item of importance. A description of the production of motion-picture film is given on another page of this issue. It will serve to call attention to a field in which the chemical engineer can render a valuable service to a growing industry.

Fries Made a Brigadier General

IN DESIGNATING Amos Alfred Fries as the head of the Chemical Warfare Service under its new status, provided in the Army Reorganization Act, it is a generally held opinion that the Chief of Staff conferred this distinction upon one who is highly deserving of the honor and entirely capable of discharging the responsibilities of the position. According to the terms of the act, the rank of Brigadier General is bestowed upon the director of the Chemical Warfare Service. Thus, for a second time, Colonel Fries has attained the rank of General. His first commission as Brigadier General was awarded in France Aug. 16, 1918, when he was placed in charge of the chemical warfare section of the American Expeditionary Forces. With the demobilization of the Army, he was returned to his permanent rank of Lieutenant Colonel of Engineers. Since the resignation of General William L. Sibert, he has directed the work of the Chemical Warfare Service with that rank.

When, in August, 1918, he was made chief of the Chemical Warfare Service in France, General Fries was faced by tremendous odds. There was much indifference toward gas, both at home and among the officers of the Expeditionary Force in France. The American Army had little knowledge of gas warfare and gas was regarded as an unimportant factor in the situation. There was not a gas mask in the possession of an American soldier. The searching out and training of officers with a knowledge of chemistry was a most difficult task in itself. Under the stress of those exciting days, the building up of a personnel of the gas service was accompanied by perplexing delays.



BRIGADIER GENERAL A. A. FRIES
Head of the Chemical Warfare Service

Once the nucleus of his staff was formed, General Fries attacked the problems of obtaining supplies, building repair factories and providing for the manufacture of gas shells. Miracles were worked in the old French caserne at Chaumont. It took the most determined efforts to secure anything like the necessary volume of supplies and every increase in personnel was opposed. The accomplishments of those early days, however, attracted wide attention in the Army. The Germans were resorting more and more to the use of gas. The spirit of indifference to General Fries's service disappeared. The Army turned to him, not only for protection from the ravages of the German gas troops but for plans for fighting gas with gas. On the day the armistice was signed, General Fries's command consisted of more than 600 officers and 3,000 men. An expansion was about to be undertaken which would have given the Chemical Warfare Service 1,600 officers and 18,000 men.

Despite the trials and viscissitudes which accompanied the building up of the Chemical Warfare Service, General Fries remarked the other day that nothing in his experience with the American Expeditionary Forces so put him on his mettle as did the carrying out of the command given him personally by General Pershing during the Moro campaign in the Phillippines. General Pershing at that time was a Captain of Cavalry, and during the Philippine campaign he set out on a small expedition against the Moros. His engineer officer was First Lieutenant Amos A. Fries. Contact with the Moros was established in due course, but the wily savages had taken a stand beyond the narrow arm of the lake. General Pershing directed that bamboo rafts be made so that the intervening waterway could be crossed. The building of the rafts came under the jurisdiction of the engineer officer, as did the opening of the passage through a dense cover of water lilies. While cutting this passage, Lieutenant Fries and a raftload of enlisted men became so befouled by the lily growth that they could neither go ahead nor return. The Moros were quick to take advantage of the situation and for more than two hours Lieutenant Fries and his men were under the fire of the tribesmen. Finally they cleared the channel behind them and were able to return to their own forces without casualties. The difficulties of that situation have continued through the years to overshadow any other tight place in which General Fries has found himself. General Fries can boast of an honor which all Presidential aspirants covet. He was born in a log cabin. It was situated in Vernon County, Wisconsin. His early education was obtained in that neighborhood. His parents later moved to Missouri and finally to Oregon. In 1893 he was graduated from the Medford, Ore., high school. He taught school for a year, trying to devise some plan of entering the Army—an ambition he had cherished since boyhood. The opportunity came in the form of a competitive examination arranged by the Congressman from his district. As the successful candidate, he received an appointment to the United States Military Academy, from which he was graduated April 26, 1898. He was just in time to enter the war with Spain. He served throughout the war as Second Lieutenant of Engineers. He became a First Lieutenant Feb. 2, 1901; a Captain, June 11, 1904; a Major, Feb. 27, 1912, and Lieutenant Colonel, May 15, 1917.

From Jan. 22, 1911, to June 10, 1914, General Fries was the director of military engineering at the Engineer School at Washington Barracks. He also served for a time as business manager of *Professional Memoirs*, the official publication of the Corps of Engineers, and was, for two years, the editor of that magazine. General Fries was forty-seven years old on March 17.

No more fitting tribute could be paid to him at this stage of his career than to place him at the head of the Chemical Warfare Service, for it was largely due to his energy and zeal that the Army was brought to a realization of the importance of this branch of the service. That he will have the cordial and loyal support of the entire personnel in the service is quite as certain as that he will inspire his subordinates with his own enthusiasm. Both the Army and the chemical industry are to be congratulated on the fact that chemical warfare is in the hands of an officer who is both competent and sympathetic.

Uncovering the Platinum Theft at the Old Hickory Powder Plant, Jacksonville, Tenn.

A Chemical Detective Story in Which Scientific Facts Furnished Clues Enabling the Authorities to Apprehend the Source of the Platinum—Chemical Composition of the Stolen Material a Determining Factor

BETWEEN 4:30 p.m., March 17, and 9 a.m., March 18, 1920, almost 2,200 grams (73 troy ounces) of platinum laboratory ware, mainly crucibles, crucible covers, and dishes, was stolen from the Chemistry Building of the Bureau of Standards. The value of this ware at the time of the theft was nearly $11,000. The matter was reported to the local police authorities, who immediately commenced an investigation.

During the first week in April information was received through the newspapers and also from the Washington police of the arrest in New York of two men, giving their names as Robert E. Carter and Joseph Fredericks, who were attempting to dispose of about 280 troy ounces of platinum sponge. Lots of 50 oz. and 10 oz. had been left at the offices of two concerns in New York which deal in platinum and the other noble metals. The remainder of the sponge was later found in two rubber hot water bottles in a small grip checked at the hotel where the two men were registered.

Charged With Theft From Chemical Company

It developed that a certain detective agency had distributed a circular advertising the theft of platinum from the Roessler & Hasslacher Chemical Co., of Perth Amboy, N. J. The metal lost by this company included pure iridium sponge, platinum sponge, platinum sheet, and alloys of platinum and iridium containing 10 and 15 per cent iridium, as well as a considerable amount of gold and silver. This theft occurred between Dec. 26 and Dec. 29, 1919, and a reward of $5,000 was offered for the return of the metal. The circular mentioned was in the possession of the two concerns to which the platinum sponge had been offered by Carter and Fredericks. The New York Police Department was notified and the men were arrested and subsequently detained, under $5,000 bail, the charge being that the platinum in their possession was stolen from the Roessler & Hasslacher Co.

Acting on the idea that the platinum in question might include that taken from the Bureau of Standards, the Department of Justice was asked to investigate the matter. At the suggestion of this Department, Dr. E. Wichers, of the platinum laboratory of the Bureau of Standards, was directed to assist in this investigation in New York, working with the office of the United States Attorney and the Bureau of Investigation, U. S. Department of Justice.

Said Platinum Was Mined in Ontario

In the preliminary hearings, Carter stated that his connection with Fredericks was merely casual and that he had obtained the platinum by placer mining on an unregistered claim in a region about 100 miles north of Parry Sound, Ont. The mining was done by Carter and an associate named H. H. Brooks. The platinum was brought into the country without declaration to the customs officials. Carter claimed to be a native Canadian and stated that he had been in the United States only on one or two occasions for a very few days. It was noted, however, that he spoke with a marked Southern accent. It was also observed that he wore a silver belt buckle bearing initials "H. H. B." It seemed probable, therefore, that Carter's real name might be Brooks, especially as Carter failed to account for the belt buckle in a satisfactory manner.

Carter gave certain references in Ontario which were investigated by an agent of the Roessler & Hasslacher Co. and found to be false. One of these references gave the name of the Maxwell House as a hotel in Parry Sound. It was also known from statistics of the U. S. Geological Survey that the total annual production of placer platinum in Canada did not exceed 25 oz., and furthermore, that no placer mining of platinum was carried out in Ontario at all. This was subsequently confirmed by the Canadian Department of Mines.

Mining Venture Story Flimsy

In an interview with the representatives of the Bureau of Investigation and the Bureau of Standards, Carter gave some of the particulars of his mining venture in Ontario and described how "Brooks" had removed the gold from the crude platinum and had then converted the remainder to sponge by dissolving it in aqua regia followed simply by drying and direct ignition of the chloride solution. This was done on the scene of the mining operations with reagents and equipment brought from Trenton and Montreal for this purpose. The story was flimsy enough at best but it was obvious that a chemical analysis of the sponge would clearly distinguish between platinum that had undergone even the simplest refining and the crude mixture of platinum, iron (10-15 per cent), osmiridium and sandy matter which would result from platinum ore treated in the manner described.

It seemed probable, further, that an exact analysis of the seized platinum might help to decide the real origin of the metal in the event that Carter's story should be completely overthrown. Most of the platinum stolen in Perth Amboy was alloyed with 10-15 per cent of iridium. It was estimated that the laboratory ware lost by the Bureau of Standards would contain an average of about 1 per cent iridium, with less amounts of rhodium and probably some palladium and iron. Assuming that very little, if any, refining had been done on the platinum after it was stolen, a simple determination of iridium would have been sufficient to distinguish between these two lots of metal. Accordingly a sample for analysis was obtained from the Police Department.

It was obvious that either the laboratory ware stolen from the Bureau of Standards or the sheet metal taken

from the Roessler & Hasslacher Co. would have to have undergone solution and reprecipitation to arrive at the sponge form of the metal found on Carter. This might involve some change in composition. It was also possible that the seized sponge represented several lots of stolen platinum. It was to be expected, therefore, that the results of the analysis would be of greater value in pointing the way in which the investigation of the theft was to be directed than as testimony in the argument of any particular case.

As already stated, the Roessler & Hasslacher Co. had proved false the Canadian references given by Carter. In fact, the whole of Carter's story was discredited without much difficulty. Since it was impossible, however, to establish any direct connection between Carter or Fredericks and the theft of their platinum, the next step in the argument was that the weight of platinum in Carter's possession was very nearly the weight of the platinum itself which had been stolen from the Roessler & Hasslacher Co., considering that all of the platinum had been carefully refined out of the platinum-iridium alloys. Since no thefts of equal magnitude had been reported, these arguments were presumably sufficient in the minds of the Grand Jury to bring an indictment. Carter and Fredericks were held in the Tombs awaiting trial on this indictment at the time of the developments to be described later.

Platinum Thefts Reported in the United States

Incidentally it may be stated that the weight of platinum taken in nine separate thefts, all from the laboratories of educational and state and Federal scientific institutions, that have been reported to the Bureau of Standards, is about 240 troy ounces. These thefts were all committed since April, 1919, and range from 75 g. to over 2,400 g. in separate cases. Three of the cases represent a total of 205 oz. Adding 342 oz. of platinum and iridium stolen from the Roessler & Hasslacher Co. and about 3 oz. from another industrial concern within the same period, there is a total of about 585 oz., to which the nominal value of $100 an ounce may be assigned, which had been stolen in about fifteen months and is as yet unrecovered. A few other thefts have since been reported. This is entirely apart from the case to be described in subsequent paragraphs.

To aid in the solution of the general problem of platinum theft, the Department of Justice is anxious to receive information concerning the attempted disposal of large quantities of platinum in any part of the country.

As was pointed out above, no single theft that had been reported was of sufficient magnitude to account for the weight of platinum in Carter's possession. It was, of course, possible that the rightful owners of Carter's platinum had not reported or possibly had not even detected their loss. At any rate, it seemed clear enough that Carter had not come into possession of the platinum in a legitimate manner. For this reason the U. S. Customs Service was preparing to bring action against Carter, in the event of his acquittal, on the ground of his own statement that the platinum had been brought into the country without declaration.

In discussing the entire case, Mr. Schauwecker, of the U. S. Assay Office, who has a very intimate knowledge of the distribution of platinum for war-time uses, made the suggestion that the platinum in question might have been taken from one of the Government munitions plants. Certain of these plants manufactured sulphuric acid by the contact process and used thousands of ounces of platinum for this purpose. The platinum used in the plants built during the war was refined by the U. S. Assay Office and was converted to chloride solution either by the Assay Office or by the company which operated the plant. The diluted chloride solution was used to impregnate granular magnesium sulphate, giving the needed catalyst for the manufacture of sulphuric acid. Owing to the fact that some of these plants were no longer in operation and were in the process of being salvaged, it seemed not impossible that an undetected theft had been perpetrated.

War and Navy Departments Take Inventory

Acting upon this idea, the Bureau of Standards stated the case to the Chiefs of Ordnance in the War and Navy Departments and suggested that an inventory be taken of all the platinum in their possession. The Intelligence Bureaus of both Departments were asked to determine whether anyone known by any of the three names so far applied to the prisoners had ever been employed in any Government munitions plant. Through the efforts of the Washington police, Fredericks had been identified in the National Bureau of Identification as having a police record in Detroit for a minor offense. Carter had no previous criminal record, as far as could be learned.

The investigation by the Intelligence Bureaus yielded no information pertinent to the subject. In the course of a few weeks word was received from the respective Bureaus of Ordnance that the survey of platinum had been completed and revealed no shortage. Owing to the fact that most of the platinum held by the War Department plants was still in the contact mass, it was apparent that the actual amount of platinum on hand could not have been determined and that as a matter of fact this could not be done without a very extensive series of assays or a complete recovery of the platinum in the mass. This was acknowledged to be true by officials of the Ordnance Bureau.

Analysis of Carter's Platinum

In the meantime, the analysis of the sample of Carter's platinum had been completed by the platinum laboratory of the Bureau of Standards. The results were as follows:

	Per Cent
Total platinum metals	99.20
Loss on ignition in porcelain crucible over blast lamp (volatile matter)	0.67
	99.87

Analysis calculated on "non-volatile" basis, i.e., 100 per cent metals:

	Per Cent
Iridium	0.33
Rhodium	0.10
Iron	0.01
Platinum	99.56
	100.00

Gold, copper and nickel were not detected. Spectroscopic examination revealed the presence of a trace of palladium, as well as small amounts of aluminum, titanium and magnesium. Traces of calcium and strontium, and possibly of silicon, were found. The platinum sponge in Carter's possession was apparently homogeneous except for the presence of small lumps of

a yellowish brown substance which on ignition yielded platinum sponge and gave off chlorine fumes. A microscopic examination of the product of the ignition of these lumps and of the main mass of sponge was made by Dr. E. T. Wherry, of the Bureau of Chemistry. This examination showed the sponge to be of an indefinite structure except for the presence of groups of well-defined octohedra which were judged to be pseudomorphs after crystals of ammonium or potassium chloroplatinate. The potassium line had not appeared in the spectrum of the sample and the conclusion seemed warranted that the platinum had been precipitated as ammonium chloroplatinate from a solution of the chloride, and the precipitate ignited to sponge. It is to be noted, however, that the octohedral crystals made up only a portion of the mass of the sample. The brown lumps seemed to be incompletely ignited ammonium chloroplatinate and revealed the fact that the conversion of the yellow salt to platinum sponge had been carried out with inadequate facilities or in haste.

Metal of Unusual Purity

The main thing to be learned from the chemical analysis as given above was that the platinum was of unusual purity. The very low percentage of iron was especially indicative of this. The low iridium content of the sample was very strong evidence that the platinum did not originate from the platinum-iridium alloys taken from the Roessler & Hasslacher Co. It was entirely improbable that the stolen alloys would have been subjected to sufficient refining to attain the purity indicated by the analysis. The same reasoning tended to eliminate the platinum ware lost by the Bureau of Standards or any other chemical laboratory, inasmuch as this ware contained a probable average of 1 per cent of iridium. It became doubtful, therefore, that further work on the case in hand would yield any results bearing directly on the Bureau's loss. Nevertheless, to aid in the proper administration of justice and to protect the legitimate users of platinum throughout the country, it was decided to continue the investigation.

In addition to the facts already stated concerning platinum-iridium alloys and platinum laboratory ware, it was known that nearly all other platinum of commerce usually contained from 0.5 to 1.0 per cent iridium, if not more. It is true that in the last two or three years the rising price of iridium has caused renewed efforts on the part of refiners to remove nearly all the iridium before allowing platinum to go on the market. However, nearly all the crude platinum which came into the country during the war was handled and refined by the U. S. Assay Office. From the analysis of samples of platinum prepared by the Assay Office and from communication with its officials it was known to the Bureau of Standards that a very high standard had been reached in this refining. Platinum 99.9 per cent pure and better was turned out in large quantities for the Nitrate Division of the Ordnance Department. (Most of this was subsequently alloyed with 1 per cent of iridium.) It was learned that the 5,800-odd oz. of platinum sponge prepared for use in sulphuric acid manufacture at the War Department powder plant at Nitro, W. Va., and the nearly 13,800 oz. for the plant at Jacksonville, Tenn., were also of high purity except that some of the platinum for use at Nitro contained about 0.5 per cent palladium. In view of these facts it was difficult to banish the idea that Carter's platinum came from one or the other of these plants, especially in view of two "clues" which might otherwise have seemed irrelevant.

It will be remembered that Carter had referred to a "Maxwell House" as a hotel in Parry Sound, Ont. Though this reference was false, it was thought probable that he mentioned the name of a hotel which did exist in some other locality, rather than that he invented a purely fictitious name. It was found that a "Maxwell House" was a well-known hotel in Nashville, which is about fifteen miles from the powder plant at Jacksonville. On the occasion of a second visit to New York on May 6 and discussion of the case with the police, it was learned that at the time of Carter's arrest he had in his possession a cake of soap bearing the stamp of the Ruffner Hotel of Charleston, W. Va., a city in the immediate vicinity of the plant at Nitro. The soap also bore the initials "H. H. B." cut into it with a pocket knife. Failing to obtain any information from the police at Charleston, the New York detectives had apparently abandoned this clue.

It seemed, however, that these two things established positive connection of Carter with Charleston and possible connection with Nashville. This information was used by the Department of Justice agents at Charleston and Nashville in a new attempt to connect either or both of the New York prisoners with these plants. Since the three names ascribed to the subjects did not appear on the employment rolls, and since there was no apparent shortage of platinum, no ground was gained in this way.

Companies Had Employees' Photographs

It was reported by the Ordnance Department that the Hercules company and the du Pont company, which had operated the plants at Nitro and Jacksonville respectively, had on file at their headquarters offices at Wilmington complete employment records, together with photographs of all employees. Since the agents of the Bureau of Investigation and the Bureau of Standards had seen both Carter and Fredericks, it was thought that an examination of the photographs of the employees would determine whether these men had been employed at either plant under different names than those they now gave. In this connection it should be stated that under the New York law it is impossible to take photographs of persons in custody until after their conviction. Fredericks' photograph had been obtained from his former police record and had been sent to Nitro and Jacksonville without being identified. No photograph of Carter was available to send to the plants and it thus became necessary to make this personal visit in the expectation of identifying him in the employment records of the two companies.

On visiting Wilmington, it was learned that most of the employment records and all of the photographs of employees had been returned to the local offices at the plants after the War Department had assumed active control. Believing that the evidence warranted the assumption that Carter had actually been in Charleston shortly before his arrest, it was decided to proceed to Nitro and examine the records there. Carter could not be identified and unfortunately the photographic files were not complete. Still confident of the logic of the deductions made from the chemical analysis of the platinum in question, the representative of the Bureau of Standards undertook to follow out what seemed to be the last possible lead and proceeded to Jacksonville.

The visit to the Jacksonville plant met with sudden success. Aided by what was really a fortunate accident, Carter was identified as H. H. Brown, who had been employed as a salvage foreman until his departure from the plant on March 27, on ten days leave. On April 20 he had been discharged for unexplained absence. While it seemed that Brown had had no possible means of access to the platinum stocks of the plant, the manner in which he had obtained the 280 oz. found in his possession was to be explained by the next important development, which followed within an hour after Brown's identification. This was the receipt by the Nashville office of the Bureau of Investigation of the following letters, which were written by a man in the Tombs prison in New York and addressed to his wife. The letters were intercepted and sent to Nashville from the office of the District Attorney of New York City, where it was believed that the letters had to do with the traffic in narcotics. The letters were published in the Nashville papers on May 30:

Letters From Suspect to His Wife Implicate Crone

May 14, 1920—Dear Wife: Just a few lines, hoping it finds you in the best of health as it leaves me, and I hope you have sent me that letter, and I have sent a letter to the lawyer to come down and see me, and I want you to call him up so to make sure that he will come down, and you should not worry about what I have said to Uddie. I did not mean to say that you are keeping the money for yourself. I know any time you have a dollar I could get it, so please don't take it up the way you mean. I will send Jack Noyer a letter and explain to him that you are sticking to me and that they could trust you with any amount of money, and I am going to try to lay my bit off for two weeks and then I will see what I should do, and Monday I want you to get ready to go out of town and when you are there you should tell this party that Robert Carter is under $5,000 bail, and they will raise the bail to about $15,000, and he should give you at least $20,000 worth of stuff, and he should put them in 25 ounces in each package, and you could get about $85 or $90 an ounce. The reason why you are asking for that amount is because Carter will not be able to leave town as soon as he gets out on bail so he will hafter stay in New York a few days so that no one is folling him around. and he need some expense money, and he will jump bail and never come back to New York, and as soon as you get this stuff from the fellow you should get a vault and put the stuff in there. You could get a vault at the Bowery and Grand Street, and you could get for the stuff $100 a ounce, and each package should bring you $2,500, and the address is where the fellow is working at the Old Hickory Powder Plant, his name is H. R. Crone. Telephone of the place is Hadley 4601, when you get that number tell them to connect you extention 93 and if that ain't the wright number look up the telefone book for Old Hickory Powder Plant and this powder plant is about 20 miles away from the ceity and you should get yourself a round trip ticket to Nashville, Tennessee, and when you get there you should ask for a good hotel and you should ring him up on the phone and tell him you are the partey from new York and you have a letter from Carter for him and he will come around to you in an auto and call for you. You are to ask him where he could meet you and tell him that everything is O.K., and that Carter is not saying a word and he trusted your husband as being that I can not get out so you made the trip for me, and tell him as soon as Carter gets out Carter will explain him what kind of a fellow I am to him and as I have no more to say I will close and send you my best regards and also with love. I remain yours husband, Joe. P.S. you do as I tell you you will be worth a big piece of money in a short time.

Old Hickory Powder Plant, H. B. Crone, Tel. Hadley 4601, Ex. 93; office hours from 8 to 4.

May 15, 1920—Dear Wife: Just a few lines hoping it finds you in the best of health as it leaves me and I have sent a letter out to Meyer for one of the boys I put in just as you have stated to me and I have sent a letter to my mother stating she would give you one hundred dollars, but she will not get that letter until Monday and the fellow from the lawyer's office was down to see me and he could not get in so I send him the answer down what I wanted and before you get out of the house always look for mail and I hope you have received the two letters Saturday, one for yourself and the other one for the party out of town. And everything will be arranged for you when you get that party and may be you will hafter stay at the hotel a day or two. And you should make yourslf that you are very wise and tell him that you have a buyer that will take all the stuff that he has at the price from 85 to 90 dollars a ounce. JOE.

Crone Is Arrested

Crone was kept under surveillance for several days until the agent of the New York office of the Bureau of Investigation obtained from Brown the confession that the platinum in his possession was obtained from Crone, who had stolen it from the reserve stock of platinum at the plant. Crone's arrest followed immediately upon Brown's confession. Up to the time of the present writing, Crone has denied any guilt in his handling of the platinum at the plant.

How the Theft Was Consummated

About the first of March, Crone, as chief chemist of the plant, was directed to convert the reserve stock of platinum chloride solution, representing almost 2,300 oz. of platinum, to platinum sponge, place it in sealed aluminum cans, and transfer it to the custody of the accounting office, where it was placed in a safe inside of the vault in this office. About 75 oz. of platinum was handled at a time and the work was completed between the middle and the last of April. The safe contained eighty-eight of these sealed containers, each bearing a label indicating the weight of platinum (about 25 oz.) it contained. After Crone's arrest, the contents of these cans were examined. Of the eighty-eight cans, two contained platinum. One of these was the first one placed in the vault. The other represented a quantity of chloride solution which would only half fill one of the cans. The remaining eighty-six cans contained what appeared to be a mixture of mercury with ordinary moist dirt, the ratio between the two being carefully adjusted so as to fill the can completely and also give the correct gross weight to the sealed can.

Remainder of Platinum Taken Not Yet Found

It is presumed that Crone's defense will be along the line that Brown is shielding the real thief, who gained access to the vault and made the substitution there. One of the most interesting details of Brown's confession was that Crone had directed him to sell some of the platinum in order to provide funds for Crone's defense "when the crash came." Brown disclaims any knowledge of the whereabouts of the platinum except that which was in his possession, which is the total amount that has been recovered to date. Crone and Brown had both worked in the Parry Sound, Ont., region. There was no evidence to indicate that Fredericks was implicated in the theft of the platinum or in the attempted disposal of it except that he acted as a guide for Brown in New York.

Examination of the register of the Ruffner Hotel at Charleston disclosed the fact that Brown registered there on March 28, the day after he left Nashville. It was learned that his stop at Charleston, while on the way to New York, was in the nature of a visit and apparently had no connection with the stolen platinum or the Government plant at Nitro.

Developing, Printing and Assembling of Motion-Picture Film

BY L. W. CHAPMAN

AN IDEA of the size of the motion-picture film industry may be gathered from the statement that more than 270,000,000 lin.ft. of film valued at more than $10,000,000 was exported from this country during 1919 and that an estimate of the total amount manufactured in the United States is given as in excess of two billion feet, valued at approximately $75,000,000. As the process is carried out in the motion-picture laboratories, the cost of developing, printing and assembling approximately equals that of the cost of the film.

The description which follows is of the process as conducted in the two laboratories of the Famous Players-Lasky Corporation at Los Angeles, Cal., at which nearly a million feet of film is used per week.

Film as received from the manufacturer is without perforation and this, then, is the first operation performed in the laboratory. These perforations are made by automatic machines and the film, if to be used for negative, is wound in 400-ft. (122-m.) lengths on camera reels; if used for positive the film is wound in 400-ft. rolls and when printed is cut into 200-ft. lengths. Negative film has a silver bromide base, and that from which the prints, or positives, are made has a silver chloride base.



FIG. 1. DARK ROOM

In the laboratory dark room the exposed negative is looped on cedar frames holding 200 ft. (61 m.) of film and on which the film remains throughout the operations of developing, fixing, and washing. Wooden developing tanks are used which hold 180 gal. (680 l.) of developer and accommodate five frames at one time. These slide in vertical grooves at the ends of the tank. The developing of the negative requires from twelve to fifteen minutes in a solution made up according to the following formula: Metol 1½ oz., potassium bromide 2½ oz., hydroquinone 5¼ oz., pyro 2 oz., sodium sulphite 9 lb., sodium carbonate 4½ lb., water 80 gal. (42.4, 70.8, 148.8, 56.7, 4,082, 2,041 g. respectively to 303 l.). The bath is maintained at a temperature of from 18.3 to 18.8 deg. C., copper coils being provided through which warm or cold water can be circulated as required. In Fig. 1 is shown the operation of looping the film on frames, the inspection of a partly developed film and the washing of the developed film before fixing. The development is conducted so as to produce what is termed a "soft negative," the printing of the positive being relied upon to bring out contrasts. Development of the negative is in the hands of experienced operators and their judgment is relied upon to determine the degree to which it is carried.



FIG. 2. WASH ROOM

After development is complete the film is removed from the tank, washed by immersing in a tank containing running water and transferred to a tank similar to the developing tank, containing the fixing solution which is made up as follows: hypo 800 lb., chrome alum 30 lb., sodium sulphite 32 lb., sulphuric acid 85 oz., water 300 gal. (363, 13.6, 14.5 and 2.4 kg. to 1,135 l.). Film remains in the fixing bath for fifteen minutes. From the fixing bath the frame is transferred from the dark room through a light-proof vestibule to the lighted washroom. The washing is conducted in two stages by immersing the frame in tanks containing running water, the flow of water being such that a complete change is made in five minutes, the operation requiring one-half hour. The washroom is shown in Fig. 2.

In drying the film much care is needed. The operation is carried out by revolving the film on reels. (Fig. 3.)



FIG. 3. DRY ROOM

These reels are made by spacing cedar slats about 8 in. (20 cm.) apart on wheels 4 ft. (1.22 m.) in diameter. The reels are 10 ft. (3 m.) in length and will carry about 1,200 ft. (36.6 m.) of film. The reels are revolved by means of an electric motor at 50 r.p.m. and the drying operation requires about three-quarters of an hour. In order to prevent the film from curling the rate of drying must not be too rapid and the moisture in the atmosphere of the dark room, the wash-room and the drying room is therefore maintained at about 60 per cent relative humidity by an automatic air-conditioning apparatus which washes, humidifies and circulates air through these rooms, and also maintains the room at a uniform temperature. Dust particles are a source of trouble, being a cause of "light specks," and in order to produce a film free from this defect it is essential that the air in the rooms be washed.

For the production of a five-reel story requiring 4,500 to 4,800 ft. (1,370 to 1,460 m.) of film, from 20,000 to 30,000 ft. (7,000 to 9,000 m.) of negative may be taken. After the negative is developed and dried a sample or "rush" print is made which the director, or "film editor," "cuts to the action." Titles and any directions for the dyeing, printing or toning of the positive are returned with the edited print to the laboratory. The titles are photographed from wash drawings and in the laboratory are treated the same as other negatives. The negative is cut to correspond with the "edited" positive and assembled together with the titles by scenes. (Fig. 4.) These are then cemented together in proper sequence in lengths of about 200 ft. and after inspecting, cleaning and dusting are ready for printing.



FIG. 4. NEGATIVE CUTTING AND ASSEMBLING ROOM

As a five-reel story may contain three hundred or more scenes many of which have been taken under varying light conditions there results variation in the density of the negative. It is important that uniform intensity of illumination be obtained when the film is projected on the screen. This result is accomplished by controlling the printing operation.

Since each scene is photographed under uniform conditions as affecting the lighting of the subject, the length of film representing one scene will produce when developed a negative of uniform density. Each scene is "light tested" to determine the amount of exposure to be given in the printing operation to produce a print of a standard density. The light test is carried out by printing a length of the negative from the first portion of a scene corresponding to that of twenty-two pictures or about 16½-in. film. This print is exposed by means of the "light test" box. This box is light-tight except for a ground glass top which is the width of the film and 16½ in. (26.7 cm.) in length. There is painted near the edge of the ground glass in small figures the numbers from 1 to 22; these are spaced ¾ in. (1.9 cm.) centers so that a number will be printed in each individual picture. A standard 40-watt frosted-globe tungsten lamp is placed at one end of the test box and about 4 in. below the ground glass. The illumination of the ground glass and therefore the amount of exposure of a positive made through the ground glass is then more intense at the end near the source of light, and a print will be obtained showing gradual increase in density from the picture numbered 22, which is nearest the lamp, to that numbered 1, which is furthest away. The time of exposure is automatically and absolutely controlled and is therefore the same for all tests. The test prints are developed for exactly three minutes in the standard developing bath, which is maintained at the standard temperature. These prints are fixed, washed and dried in the usual manner. A portion of a "light test" print is shown in Fig. 5. A "light test" card is made out for each reel of 200 ft. of negative and on this card are noted the scene number, a brief title of the scene and any directions for toning or dyeing of the print. The light test prints are inspected over a ground glass which is uniformly illuminated and the inspector selects the picture which has the desired density. The number which is printed in this picture is recorded on the light test card. (Fig. 6.) In making the light test a notch is cut in the edge of the film to locate the beginning of each scene and title.

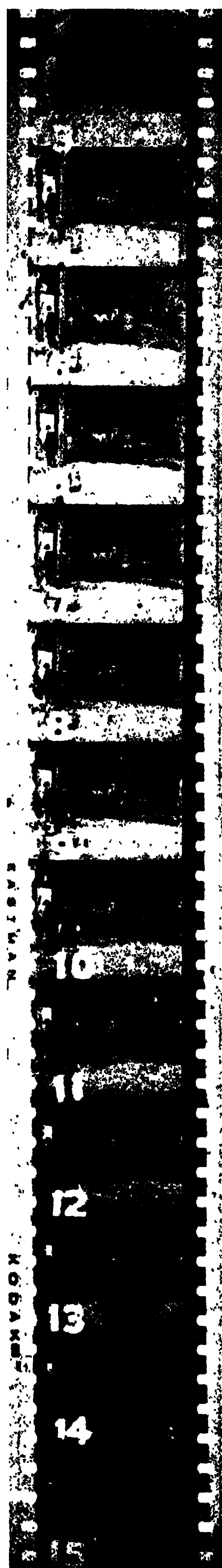


FIG. 5. PORTION OF A "LIGHT TEST" PRINT

The printing is performed in a Bell & Howell electrically operated printing machine. (Fig. 7.) The negative and the film to be printed are passed



FIG. 6. LIGHT TESTING

at a uniform speed by an aperture, the area of which may be varied and through which the film is exposed to the light from a standard 40-watt frosted globe tungsten lamp, the negative being pressed firmly against the positive by air pressure. The exposure aperture is of the same width as the film, but the opening in the other direction is controlled by the machine operator, the amount of opening being controlled by a lever, a pointer on the end of which swings over an arc on which are printed the numbers from 1 to 22. The printing operation is begun by setting the pointer to correspond with the number which was recorded on the light test card for the first scene. The light is turned on and the motor which winds the film through the printing machine is started. The negative before reaching the aperture passes through a device by which the notches which have been cut in the edge of the film at the beginning of each scene are made to sound an audible click. This click indicates that another scene is about to pass



FIG. 7. PRINTING ROOM

the aperture and the operator moves the pointer to the number on the arc which corresponds to the number given on the light test card for the succeeding scene. The printing is in this manner controlled so that a positive of uniform density is obtained. The machines print at a rate of 62 ft, (18.8 m.) of film per minute.

Direct current at constant voltage is used in the light test and printing.

The exposed print or positive is wound on frames and goes through the same treatment as the negative, using, however, a developer having the following composition: Metol 6½ oz., hydroquinone 64 oz., sulphite 14 lb., carbonate 20 lb., bromide 4 oz., made up to 80 gal. with water (184, 1,813, 6,350, 9,070, 113 g. respectively to 303 l.). After fixing and washing the film may be dyed or toned and these portions are printed and developed separately. The films are dyed by immersing in tanks similar to the developing tanks containing a water solution of the dyes. Several dyes may be used in sequence on the same film and it is possible to obtain from forty-five to fifty different tints from nine dyes in this manner. In addition to uniform coloring of the print, different tints for the high lights, half-tones and full tones may be obtained, depending on the relative adsorption of the dyes which result from variations in the thickness of the deposit.

After washing, the print is dried in the same man-



FIG. 8. INSPECTING ROOM

ner as the negative. The prints are assembled into lengths or "reels" of about 1,000 ft. (305 m.), dusted in vacuum dusters, projected to inspect for defects (Fig. 8), measured and packed in galvanized iron tins which are packed in wooden boxes for shipment.

It will be noted that a considerable amount of waste film results from the various operations. This is purchased by a company which collects the waste film from several of the studios. The silver deposit is dissolved from the film by means of "lye" or caustic soda, and the silver recovered. The same company also collects the solutions containing silver from the motion-picture laboratories and the silver from these is also recovered. Considerable quantities of the waste film are used by manufacturers of celluloid products.

We are indebted to Frank V. Biggy of the Morosco Studio of the Famous Players-Lasky Corporation, Los Angeles, Cal., for the illustrations, and for courtesies extended in the collection of these notes.

Engineers and Scientists in Westminster Abbey

MR. E. J. MEHREN, editor of the *Engineering News-Record*, who is traveling in Europe, has contributed to his journal the following interesting observations on a visit to Westminster Abbey:

Until yesterday I did not know that there was in Westminster Abbey a well-defined location for the tombs and monuments of scientists and engineers. We all know of Poets' Corner and of the Royal Chapels which contain the bones of many of England's kings and queens, but the engineers' and scientists' corner (an inadequate description for one spot in the quiet nave and in the north aisle) has not been celebrated in the descriptions of the Abbey that have come to my hand. Consequently I was the happier at the discovery.

Against the screen of the choir stalls, looking into the nave, is the monument of Sir Isaac Newton, while directly in front, well out in the center of the nave, are the tombs, under the pavement, of Telford and George Stephenson, Telford's marked by one of the small square pavement stones cut with his name and Stephenson's by a full length floor panel—a work of art in bronze. A statue of Telford stands elsewhere in the Abbey. What a fitting home for the long sleep of these master engineers! Above them springs the wonderful Gothic nave, airy in its lightness, yet built of stone—a sight such as I have never seen. The master builders of a later age lie asleep beneath the work of the master builders of all time, masters who outrivalled those of ancient Egypt or Greece or Rome—the Gothic cathedral builders of the thirteenth century. Egypt built great temples and mighty pyramids; so did Greece and Rome. But structurally the forms were simple. With the high-flung naves and crossings and choirs of the Middle Ages came engineering problems of no mean order. Yet so well were the principles understood that wonderful grace and appearance of lightness were secured. Today, with all our advances, we do nothing to equal their master works.

But to return to the engineers in Westminster: By the side of Newton, directly in front of the Newton monument, lies the body of the late Lord Kelvin, while 20 ft. to the north, in the aisle, lie, side by side, the bodies of Herschel, the astronomer, and of Charles Darwin. Above these vaults, casting on them a light mellowed by the art of the stained-glass worker, are a memorial window to Sir Benjamin Baker, the inscription recording two of his great works—the Forth Bridge and the Assuan Dam—and another to Lord Kelvin, "Engineer and Natural Philosopher," as the inscription has it. In this same north aisle are memorial windows, also, to Stephenson, Joseph Locke, designer of the Crewe engine; Brunel, Trevithick, and Charles William Siemens.

The Siemens window looks down on a group of tablets to scientists—to Lister, the physician; Darwin; Hooker, the botanist; Adams, the astronomer, and Joule, the physicist. The Joule tablet bears this inscription: "This tablet is here placed near the graves of Newton, Herschel and Darwin by those who in many lands have united to perpetuate the memory of James Prescott Joule, F.R.S., of Manchester, in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat."

In the central part of the nave and the north aisle are buried other great men with kinship to engineers. We find the tomb of Sir Charles Lyall, the geologist. It is covered by a brass-lettered slab bearing this tribute: "Throughout a long life he sought the means of deciphering the fragmentary records of the earth's history, in the patient investigation of the present order of nature, enlarging the present boundaries of knowledge and leaving on scientific thought an enduring influence." Out in the center of the nave, near the graves of Telford and Stephenson, are four graves placed with singular appropriateness under this great nave—mortal remains of four architects who played an important part in the revival of Gothic architecture. They are Sir Charles Barry, architect of the Houses of Parliament; Sir George Gilbert Scott, George Edmund Street and John Loughborough Pearson.

As I turned to leave this part of the Abbey, after musing there an hour, I chanced to walk over the Telford inscription and my eye caught on the slab at Telford's feet the name of Livingstone—David Livingstone, the African explorer—and the thought struck me that he was in kindred company. He explored an unknown country; he extended the bounds of knowledge regarding a section of the earth's surface. So did Telford and Stephenson and Lyall explore the unknown; so did they, and their great fellow engineers and scientists about them, extend the bounds of knowledge. They, no less than he, were explorers of a dark continent and have placed humanity under tribute for all time.

London, May 9, 1920.

Expansion of French Chemical and Oil Industries

The chemical industry of France continues to attract large amounts of capital and it is evident that it will become one of the leading industries of the country. Among recent company incorporations is found that of the Société Alsacienne de Produits Chimiques, with 16,000,000 francs (1 franc = $0.193 normal exchange), capital to take over the former German-owned Kesther establishments at Thann-Mulhouse (Alsace) in addition to a large modern plant at La Rochelle, formerly making war chemicals, which will now be used for the manufacture of synthetic camphor, sulphates of copper and potash, and a trade-marked brand of butterine.

The distribution of petroleum, fuel, and lubricating oils is also receiving the attention of capitalists. Two companies recently floated by local bankers of La Rochelle for operation in this consular district are the Société pour l'Importation des Huiles Combustibles, capital 5,000,000 francs, and the Société de Fabrication de la Vaseline, capital 1,400,000 francs. Other late incorporation of companies to deal in chemicals and oils and their capitalization are: Société Française Ratocczyn (gasoline, heavy oils, carburents, etc.), 23,000,000 francs; Société Pax (essential oils and other chemical products), 1,000,000 francs; Société pour l'Approvisionnement des Consommateurs d'Huiles Combustibles, 2,500,000 francs; Société la Pétroléenne, 22,000,000 francs; Société Chimique et Industrielle des Monazites (chemicals and the manufacture of thorium, cerium, mesothorium, and other rare metals), 2,500,000 francs; Société des Hydrocarbures et Produits Industriels, 10,000,000 francs; Société de la Silice (pulverized silicates and an artificial product) 600,000 francs.

The soap and similar industries are expanding and many new companies are being formed.

Some Investigations in Briquetting Oklahoma Coal*

BY J. C. DAVIS

TESTS were recently conducted at Oklahoma University to determine whether the briquetting of certain Oklahoma coals, using a crude oil residue as a binder, could be profitably carried on commercially. While the process in itself is not new, some interesting data were obtained.

BUREAU OF MINES RESEARCH

The Bureau of Mines has made extensive researches on the subject of briquetting and briquetting materials in its plants at Norfolk, Va., Pittsburgh, Pa., and St. Louis, Mo. Binders of various kinds were tried, including both inorganic and organic materials. Among the inorganic materials tried were clay, lime, magnesia, magnesia cement, plaster of paris, portland cement, natural cement, slag cement and water glass. Some of the organic materials experimented with were wood products, such as rosin, pitch and pine tar; sugar-factory residues such as beet pulp, beet sugar molasses, and cane sugar molasses; starches, tars and pitches from coal, such as blast-furnace tar, producer-gas tar, coal-tar creosote and various grades of pitches from various tars; natural asphaltum and petroleum products such as crude oil and crude oil residue. Anyone interested in these results may find a complete summary of the experiments in Bulletin No. 58 of the Bureau of Mines.

TESTS AT OKLAHOMA UNIVERSITY

The experiments made in the Materials Testing Laboratory, at the University of Oklahoma, were conducted by C. T. Griswold, mining engineer for the Atchison, Topeka & Santa Fe R.R., assisted by the writer, and it is with his permission that the data given herein are made public. After consulting the bulletin above referred to, it was assumed that a standard mixture should be made of 90 per cent moisture and a 7 per cent binder. The coal was then ground and thoroughly washed to rid it of slate and other impurities so far as practicable.

In order to carry out the tests a hollow cast-iron mold was made approximately 4¾ x 4¼ x 2¼ in., with a central hole of about 1¾ x 2¼ in., with rounded corners. A base plate was made so as to have a projecting rim extending into this opening from the under side. A plunger, sufficiently long to compress the coal, passed down through the opening from the upper side. The mold was then filled with the coal and binder; the plunger was placed in position and the mold put under the compression head of the 100,000-lb. Riehle testing machine resting on the self-adjusting lower head. Trouble was experienced in getting the briquets to come free from the mold, due to the roughness of the casting, and it was decided to have the entire inside of the mold finished, together with the projecting portion of the base plate and the plunger. The briquets then came out freely, perfect in shape, and of a size to give a weight of approximately 2¼ oz.

A number of experiments were then made to determine the best pressure to use. Pressures were tried out varying from 1,000 to 5,000 lb. per sq.in. The former pressure seemed too low to compress the binder properly into the coal. At a pressure of about 2,000 lb. per sq.in. the materials seemed to unite very satisfactorily. An increase to 3,000 lb. per sq.in. did not seem to improve the binding qualities materially and with pressures above this amount the particles of coal were crushed. It was therefore assumed that 2,000 lb. per sq.in. would be the proper pressure to use in the briquetting work.

TYPE OF OIL EMPLOYED

The binder used was a Wheeler crude oil. Tests were first made to see what reduction from the original volume would be necessary in order to give a satisfactory binder. Oil was reduced to 50 per cent of its original volume and continued by 10 per cent reductive steps down through 40, 30, 20 and 10 per cent. A 15 per cent grade was then made and found highly satisfactory. Briquets were formed using 5, 6, 7 and 8 per cent of each binder. In all cases the briquets were soft and could easily be crushed in the hand after having had time to cool completely and to harden until the 20 per cent reduction was reached. The 10 per cent seemed too hard and rather brittle, while briquets made from the 15 per cent were excellent.

The distillation test furnished by the oil company showed this crude oil to contain an asphalt base of 36 per cent—10 deg. penetration. The laboratory check made at the university showed the following:

STEAM DISTILLATION FIGURED ON BASIS OF DEHYDRATED CRUDE

	Per Cent
Kerosene distillate (40 5 deg. Bé)	2
Gas oil (34.3 deg. Bé.)	14
100 viscosity (at 100 deg. F.) lubricating oil	21
Fuel oil (calculated)	43
Residue	15

A binder was then made at the Cameron Refining Co., at Ardmore, Okla., to meet these specifications and was found to check with the above distillation test. Further tests on this binder registered penetration 26 at 25 deg. C. by New York penetrometer, 50-g. weights being used for five seconds. The melting point as shown by the ball and ring method is 126 deg. F. These tests lead to the following final specifications:

An asphalt binder with a penetration of 20 and a melting point of 160 deg. F. to withstand the excessive summer heat of this section. It is safe to assume that any other asphalt answering these specifications would be equally satisfactory for use. It may be necessary in any case to require a slightly higher melting point.

THE COAL USED

The coal used in all these tests was ground to pass a 10-mesh after studying the action of ¼-in. to 60-mesh. The 10-mesh did not seem to crush under the pressures needed for the purposes of satisfactory briquetting. The samples used were made from all coals passing a 1¼-in. round hole screen and contained both the slack and the finest dust mixed in the proper proportions of 31 to 9. Analyses of these coals showed the following percentages:

	Lehigh Unwashed	Lehigh Washed	Average Slack of McAlester-Wilburton
Moisture	2 30	2.79	2.04
Ash	19 54	12.10	10 93
Volatile matter	31.20	31 23	35 83
Fixed carbon	48 04	53 32	53 23
B.t.u.	10,710	12,200	

B.t.u. tests on the finished briquets showed the unwashed samples to contain 10,543 B.t.u. and the washed ones 12,570 B.t.u. Washing appears to increase the B.t.u. about 20 per cent.

Temperature and moisture variations were tried throughout the tests, temperatures being tried between

*Abstract from paper presented before the chemists and engineers meeting at Tulsa, Okla.

60 and 450 deg. F.; and moisture variations of from 3 to 10 per cent. It was found that the best results were obtained when the temperature was kept between 180 and 200 deg. F. When moisture contents between 3 and 5 per cent were used, there did not seem to be much difference in the quality of the briquets, but when 5 per cent was exceeded they showed voids and crushed much more readily.

Some of the briquets were subjected to rolling and drop tests. Twenty lb. of the briquets made from unwashed coal was placed in an oil barrel and the barrel rolled over the rough ground for two minutes at 32 r.p.m. These briquets showed a loss in weight of 3½ per cent. Some of them were then dropped from a height of 6 ft. three times onto a concrete floor and showed a loss of 1 per cent from this test. The washed briquets, then subjected to the same treatment, showed losses of 1½ per cent from rolling and ½ per cent from dropping. None of the briquets of either kind were broken into parts, the losses being due to breaking of the edges and corners. The height of the drop was then increased to 12 ft. and they were then broken into parts only on the third drop, showing in all cases clean cut cleavage planes. Any of the briquets tested were sufficiently strong to withstand the pressure of a man's weight as shown by placing them on the floor and stepping on them.

Burning Test

As the "test of the pudding is in the eating," so the test of the fuel is in the burning. A fire was made in an ordinary round heating stove having ¾-in. grate openings. The fire bed was 8 in. deep. Both kinds of briquets kindled readily, burned freely, made no more smoke than an ordinary coal, and did not soften, disintegrate or fall through the grate bars during the process of combustion. The washed coal briquets, however, made a much hotter fire. The unwashed left a refuse of 28.7 per cent and clinkered badly, leaving a hard consolidated clinker. The washed coal briquets left a refuse of 11.6 per cent and showed only a small amount of soft clinker.

Conclusions

These tests show beyond doubt that the Oklahoma soft coal of the above grades can be successfully briquetted, will make a cleaner domestic fuel than the ordinary bituminous coals, and will stand handling and rough usage to a remarkable degree. As a locomotive fuel they would no doubt prove very satisfactory. The initial cost for a plant to make briquets of a desirable kind is high, but it is believed that these briquets can be made to sell at a price no higher than the better grades of bituminous coal and will give greater satisfaction to the consumer.

Losses of Crude Oil by Evaporation

A recent report of the Bureau of Mines makes the statement that "The evaporation of crude oil without doubt causes one of the largest single losses to which the oil is subjected after it is taken from the ground. The few days during which crude oil is stored on the lease before being taken by the pipe line causes an aggregate loss per year from evaporation estimated at 122,100,000 gal. of gasoline in the Mid-Continent field alone. This has a value, at 22c. per gal., of $26,880,000 and represents about 3 per cent of the total gasoline produced in the United States from all fields and all sources."

Position of Nitrate-Producing Companies in Chile

The large Chilean companies are adding to their present holdings by buying out the smaller concerns and acquiring further nitrate deposits not yet worked. It is reported that some of the British companies desire to sell out because of burdensome taxation on their capital in England, but this cannot be verified. It is quite probable that if these companies would sell out it would be to some Chilean company and the property would be worked as before. The feeling in the nitrate industry in Chile at the present time is most optimistic, based on the probable demands from central Europe, principally Germany, which has always been a large user of nitrate as fertilizer, and the fact that the production of the artificial, or, rather, electrically manufactured nitrate, has not been so successful as anticipated and cannot compete with the natural product of the deposits in Chile either in price or quality.

Prices of Nitrate Increase

There have been several reasons why the nitrate-producing companies did not show large profits last year, the principal one being the small demand after the armistice was signed, amounting to an almost complete suspension during the early part of the year 1919, and only about 55 per cent of the "oficinas" (works) were in operation during the second half of the year. The second cause of the small profits for the year 1919 was the fact that contracts had been made at a low price, 9s. per quintal, for their output for deliveries up to the end of March, 1920. (The Spanish quintal, which is in use in the nitrate industry of Chile, is equivalent to 101.4 lb.)

When the price began to go up toward the end of the year the producers did not share in the increase nor in the higher prices prevailing during the past three months of this year, the prices going as high as 16s. 1d. per quintal in April, and at the present time 16s. 3d. is asked by the brokers. The cost of production in the meantime had risen considerably, owing to strikes of the workmen and the stevedores in the ports of shipment, making the cost delivered alongside much higher than in September, 1919. This, of course, made a reduction in the profits of the companies producing the nitrate of soda.

Companies in Good Condition

However, at the present time the old contracts at the low price have practically all been completed and the new contracts will be made at prices over 15s. per quintal, possibly over 16s. per quintal, and the companies will therefore be in a better position than at any time since the armistice was signed to do a profitable business, and it is therefore not likely that they would care to sell out their plants at a time when the future for a prosperous business seems almost assured. Some of the smaller plants might sell out or merge with one of the larger companies.

The German nitrate companies are uncertain and it is reported that some are in financial difficulties and might have to be sold out.

Press telegrams dated from London report that the German nitrate company called "Augusta Victoria" has made some inquiries as to the possibility of the sale of its Chilean properties to an American syndicate. This is one of the largest German companies and has its office in Bremen.

The Acid Bessemer Process*

BY RICHARD S. MCCAFFERY†

THIS paper considers certain aspects of the acid bessemer process, particularly in its relations to the duplex process—that combination in which the pig iron is first desiliconized and decarburized in acid bessemer converters and then dephosphorized in basic open-hearth furnaces. The acid bessemer process employs an acid-lined converter and produces an acid slag. The blow is usually thought to eliminate the silicon and manganese as oxides and then to burn off the carbon as carbon monoxide. On account, however, of the relatively large amount of metallic iron present in the converter, compared with the relatively small amount of the impurities it is desired to oxidize, the first reaction in the converter probably is the formation of iron oxide, which dissolves in the bath and acts as an oxygen carrier for the silicon and carbon. As soon as iron oxide is dissolved throughout the bath, the oxidation of silicon commences; but in the early stages of the blow the mass law would indicate that iron oxide must form first, and this oxide probably increases up to some saturation point. The molten metal in the converter from the early stages of the blow right through to its completion remains basic, while the slag produced is siliceous. This fact is shown by the corrosion of the acid bottom and the tuyères, which is greatest at the tuyère orifice where oxidation is most active and where there is the most iron oxide.

ADVANTAGE OF BASIC TUYÈRE BLOCKS

Why does this acid bottom corrode? Because it is attacked by a base. The thought, therefore, suggests itself, why not make the bottoms of basic or neutral material?[1] As the converter slag is acid, those parts of the converter coming in contact with the slag should be acid; but those parts of the converter that are in contact with the molten metal saturated with metallic oxides should be basic or neutral. Bessemer operators have for some time tacitly admitted this condition, for the blast pressures have steadily increased with the object of keeping the metal in suspension, and so preventing bottom corrosion; if the molten metal were not basic, it would not attack an acid bottom. In addition, the tuyères are bunched together at the middle of the bottom and a clear space is left around the outside of the bottom; if tuyères are placed too near the side walls, the wall corrosion increases. If the increase of blast pressure in bessemer converters was for the sole purpose of hastening the blow by getting more oxygen into the converter in the same time, the number of tuyères might have been increased, thus increasing the volume of air and decreasing the blast pressure. It is not desirable, though, to follow this procedure, because the additional tuyères can be provided only by placing them near the side walls, which results in increased lining costs.

In a normal blow, the carbon stage begins after the oxidation of the silicon, the carbon burning largely to carbon monoxide; it thus does not generate sufficient heat to raise the temperature of the bath during the latter part of the blow; the great rise in bath temperature takes place in the early stage when the silicon is burning. Many converters, though, particularly those of larger capacity, do not blow a charge in this way; they show a temperature rise during the latter part of the blow, the carbon being burned to dioxide instead of to monoxide, with the resulting liberation of 97,000 calories instead of 29,000 calories. As a matter of fact, many blows that are not initially of too high silicon content are finished at excessively high temperatures, in some cases running up to 1,800 deg. C. Although the bad effect of this practice is known and attempts are made to lower the final temperature by the addition of scrap to the converter or by the introduction of steam in the air blast, the best method of lowering this temperature, by burning the carbon to monoxide, which also decreases by one-half the power consumption during the carbon stage of the blow, is not used because it is necessary to keep the metal charge away from the converter bottom.

ECONOMY IN LOWER BLAST PRESSURES

By following the present practice the direct bottom expense may be reduced seemingly, by employing a high blast pressure, but the power cost is greatly increased and the temperature of the finished blown metal is very high; or if the finishing temperature is kept down to the proper point, there is the extra expense of scrapping or of steaming. It does not seem right to charge scrap in a process that has as one of its principal objects the production of scrap, or to expend energy for excess air in order to turn carbon to dioxide when the extra amount of air will be furnished by the atmosphere at the converter mouth. By this plan a vicious cycle is in operation: more energy is employed for blowing in more air, which produces more heat, which requires more energy, in the form of steam, to lower the temperature. With the use of basic or neutral bottoms, blast pressure may be reduced and the tuyère area increased because the basic charge will not corrode bottoms of this character. The actual blowing time then can be materially shortened, no scrapping or steaming is necessary, and a colder blown metal is produced.

The author has already pointed out[2] the possibilities of decreasing the time of blow and decreasing the power consumption with the use of a greater number of tuyères and lower blast pressure; and Table I summarizes the data obtained in a test of a 23-tuyère bottom compared with a bottom designed by the writer containing 35 tuyères.

TABLE I. RESULTS OBTAINED BY INCREASING NUMBER OF TUYERES AND DECREASING BLAST PRESSURE

	Old-style Bottom	New-style Bottom
Number of tuyère blocks, each containing twelve [illegible]-in. tuyères	23	35
Weight mixer metal, lb.	17,000	50,000
Blast pressure at engine, lb. per sq.in.	28	22
Total engine revolutions per blow	589	443
Time of blow, minutes	14	10[illegible]
Comparison of time, per cent	100	69
Comparison of power, per cent	100	60

IMPORTANCE OF TEMPERATURE IN DUPLEXING

In the open-hearth stage of the duplex process, the temperature of the open-hearth bath is an important factor if the dephosphorizing operation is to be successfully carried out, also the temperature of the blow metal passing from the converters to the open hearth

*Paper to be presented at the Lake Superior meeting of the A.I.M.E., August, 1920.

†Professor of Metallurgy, University of Wisconsin.

[1]The use of basic and neutral material for making the bottoms in acid-process steel converters is protected by U. S. Patent No. 1,338,655, issued April 27, 1920.

[2]*Iron Age*, (1919), vol. 103, p. 626.

is of great importance. To obtain maximum capacity in the open hearth, just as soon as it is ready for the blow metal, the blow metal from the converter should be ready to be poured in; and when the kicker charge is introduced, the bath should be at the proper temperature for the reactions to take place in the proper order. It should not be necessary to raise or lower the temperature of the heat very much. If the temperature of the molten bath in the open hearth is too high, the carbon is burned off first and after nearly all of it has been eliminated the phosphorus is oxidized and slagged. If the bath temperature is correct, the phosphorus reaction takes place first and the heat is finally worked down to the desired carbon content. Carbon is much more active in taking oxygen out of the molten metal than is phosphorus, with the result that when the process is carried out at the proper temperature and the heat is finished on carbon, the steel produced is much less likely to contain oxygen than when the heat is finished on phosphorus. The importance of this point, with respect to the bessemer stage, is that under certain conditions, already pointed out, the converters may furnish blow metal at an excessively high temperature which may be poured into an open hearth that, for various reasons, may be at a higher temperature than normal, with the result that the order of reactions in the open hearth is reversed and the open-hearth product may contain oxygen.

When running down at the end on phosphorus in this way, there is a twofold danger. If oxygen additions are made for the purpose of getting out the phosphorus, there is a chance that the steel will carry oxygen, although it may be thoroughly dephosphorized; whereas if there is not sufficient oxygen-carrying material charged to eliminate the phosphorus, the metal may not contain oxygen, but it will not be dephosphorized. The alternatives then, when an open-hearth bath is finished on phosphorus, are that the metal either will be oxidized or the phosphorus will not be eliminated, whereas, if the order of reaction were changed and the phosphorus were removed first and the carbon taken out at the end, the carbon would protect the metal from oxidation after dephosphorization and good steel would be produced.

It is not claimed that this happens in every open-hearth heat, but it does happen in some. This sequence of happenings can be avoided and the possibility of oxygen-carrying steel being made will be cut down to a minimum if excessive blast pressures are avoided. This can only be done economically, in the opinion of the writer, if basic or neutral converter bottoms are employed. The use of these bottoms will avoid the high blast pressures and cut down the power cost by burning the carbon to monoxide. In accomplishing both of these, the production of overheated blown metal will be minimized and the possibility of producing oxidized steel will be very slight.

Asbestos Can Be Fine Spun

The earliest use of asbestos was for spinning and weaving, to make incombustible thread and yarn rope and cloth, and this has continued to be the most important use of asbestos ever since the days of the Greeks and Romans. Only the best grades can be used for this purpose, according to J. S. Diller, of the United States Geological Survey, Department of the Interior. Thread can now be spun so fine that it will run about 32,000 feet to the pound.

Use of Domestic Graphite in Crucibles

The Bureau of Mines reports in Bulletin 112, "Mining and Preparing Domestic Graphite for Crucible Use," that prior to 1915 practically all of the graphite and clay used in the manufacture of crucibles in the United States was imported. The graphite came chiefly from Ceylon, Madagascar, and Korea, while the clay was obtained principally from Klingenburg, Bavaria. Domestic graphite was for the most part used in the manufacture of paint, lubricants, foundry facings, etc.

As a result of cessation of imports of clay, due to the war, manufacturers in this country sought a native product to replace it, and a substitute was soon found which compared very favorably with the foreign article.

The use of domestic flake graphite, however, in proportion to more than 25 per cent mixed with imported graphite was not very successful.

However, the domestic graphite mining and milling industry expanded rapidly under pressure of war conditions, being aided by a request of the War Trade Board on August 10, 1918, that crucibles manufactured during the balance of 1918 should contain 20 per cent domestic flake and 25 per cent thereafter. At the end of the war there were 39 graphite plants in Alabama, 3 in New York, 5 in Pennsylvania and 3 in Texas.

The graphite investigation of the Bureau of Mines covered three phases: (1) Field examination of the graphite deposits in the states mentioned, and a study of the methods used in mining and preparing graphite for market. (2) Experimental work on the concentrating and refining of crucible graphite to improve the quality of the product and lessen waste. (3) Experimental work in crucible manufacture to determine the property of domestic flake and the maximum proportion that might be used without impairing the quality of the crucible.

The present importance of these investigations lies in the fact that the domestic industry, if it is to survive the competition of imported graphite, which can be mined and prepared more cheaply than domestic graphite, must rely on improved and more efficient methods of producing and preparing graphite. Also for full extension of the market to domestic producers, crucibles made entirely of domestic or nearly all domestic flake in combination with domestic clays should be developed.

Peat Production in Norway

Smolen Island, near Kristianssund, N., is a flat spot of land possessed of immense areas of peat bog. It is doubtful whether there is anywhere a better location for the production of peat in large quantities.

Some time ago a company was organized under the name of "Smolen Co." It owns large areas on the island, and has a modern plant with six large machines for preparing the peat for market, after which it is transported on tracks down to the company's wharves.

It is expected that 30,000 tons will be produced this year, increasing till production reaches 50,000 tons a year.

Even a coasting steamship company serving the local trade in that vicinity has used peat for its steamers, enabling them to keep up their routes to full extent, while other local lines had to reduce their sailings because of the coal situation.

The "Smolen Co." intends also in the near future to extend its business to the manufacture of coal briquets for use by steamers and factories.

Properties and Constitution of Glues and Gelatines—III

Relations Between Physical Properties and Chemical Constitution and Influence of Size of Molecule Upon Physical Constants—Proximate Constitution and Jell Strength—Study of Magnesium Sulphate Precipitation of Larger Protein Particles*

By ROBERT H. BOGUE, Ph. D.

ATTEMPTS are constantly being made to correlate the physical characteristics of substances with their composition, their constitution and their molecular structure, and, by developing specific relations between these, to thereby account for and explain the particular behavior of the substances in question.

Since but little effort has been made by other investigators[45] toward the establishment of a relationship between the viscosity and jell strength of glues and gelatines and their constitution, it seemed desirable that a study be made with this end in view. This investigation was accordingly initiated, and a clear-cut relationship has been established.

Proximate Analysis

Several sets of experiments have been performed to show whether or not any relation exists between the proximate constitution of glues, and their jell strength and viscosities. These experiments covered glues of every grade and variety. They were analyzed for water, ash, organic matter and nitrogen.

A study of the results obtained from these determinations, shows that:

The water content of the air dry glues varies directly as the jell strength.

The total organic matter varies inversely as the jell strength.

There seems to be no consistent variation with jell strength in the case of ash or nitrogen.

The consistent variation with respect to water signifies only that the water-retaining capacity of glues runs parallel to the jell strength, and that whatever factor controls the one controls likewise the other.

Examples of the data obtained are given in Tables XXVI and XXVII.

TABLE XXVI. RELATION BETWEEN PROXIMATE CONSTITUTION AND JELL STRENGTH

Grade	Jell Strength	Per Cent Nitrogen	Per Cent Water	Per Cent Ash	Per Cent Organic Matter
H 1	79	14.70	.....	....	.....
H 2	78	14.74	.....	....	.....
H 3	75	14.18	13.66	3.89	83.45
H 4	74	14.49	.....	....	.....
H 5	73	14.56	.....	....	.....
H 6	71	14.43	.....	....	.....
H 9	60	13.88	12.15	3.70	84.15
B 1	75	14.61	.....	....	.....
B 2	69	14.18	13.33	2.95	83.72
B 3	65	14.35	.....	....	.....
B 4	58	14.54	.....	....	.....
B 5	55	14.56	.....	....	.....
B 6	52	14.16	.....	....	.....
B 7	50	14.59	13.06	3.15	83.78
B 8	48	14.61	11.85	3.41	84.70
B 9	liquid	14.40	10.68	3.35	87.48
Pressure B 9	liquid	14.24	.....	....	.....

*For Parts I and II, see Chem. & Met. Eng., vol. 23, Nos. 1 and 2, July 7 and 14, 1920, pp. 5 and 61.

[45]Trotman and Hackford [*J. Soc. Chem. Ind.*, vol. 23 (1904), p. 1072] developed a relationship between the "gelatinose" precipitated in a saturated zinc sulphate solution and the "consistency" of the jelly, which is in agreement with one of the relations hereinafter described.

TABLE XXVII. RELATION BETWEEN PROXIMATE CONSTITUTIO AND VISCOSITY

Viscosity	Jell	Water	Ash	Organic Matter	Nitrogen
47	H_4	14.30	2.80	82.90	14.75
48	H_4	13.30	3.90	82.80	14.36
49	H_4	13.10	4.14	82.76	14.44
50	H_4	13.85	4.03	82.12	14.51
51	H_4	12.00	3.04	84.96	14.69
52	H_4	12.30	2.20	85.50	15.00
54	H_4	13.30	3.56	83.14	14.66
46	H_2	14.46	3.74	81.80	14.65
47	B_2	13.80	2.91	83.29	14.49
48	B_2	13.36	2.97	83.67	14.61
49	B_2	12.90	3.03	84.07	14.66
50	B_2	12.14	2.10	85.76	14.83

Nitrogenous Analysis—Preliminary Tests

Study of Magnesium Sulphate Precipitation. In the study of proteins which have been to a greater or a lesser extent hydrolyzed, it has been customary to distinguish in these products of hydrolysis four distinct groups of substances. These are known as proteins, proteoses, peptones and amino acids. There are many sub-groups which have been designated positions in the series but they are not separated in this study.

The proteins[46] are designated as those groups which are precipitated by half saturated solutions of ammonium, zinc or magnesium sulphate. The proteoses are those groups which are precipitated between half and complete saturation. Peptones and amino acids are not precipitated at saturation of the above salts. The amino acids may be determined in this filtrate by the nitrous acid method of Van Slyke,[47] or by the formol-titration method of Sörensen,[48] and the peptones calculated.

Ammonium sulphate was not used in the precipitations, as it would involve a troublesome correction in the nitrogen determinations. Magnesium sulphate was used as being the less expensive of the remaining salts. The formol-titration method of Sörensen was used for the amino acid determinations.

To determine the most favorable conditions for precipitation and to study the errors in the process, two glues were treated by various methods as follows:

TABLE XXVIII. STUDY OF NITROGENOUS SEPARATIONS

	No. 8	No. 9
(a) Total nitrogen (by Kjeldahl, 1 g.)	0.1427	0.1420
(b) Protein + proteose nitrogen (saturation by $MgSO_4$)	0 1316	0.1274
(c) Peptone + amino acids (filtrate from b)	0.0100	0.0150
(d) Protein nitrogen (half separation by $MgSO_4$)	0.1013	0.0906
(e) Proteose nitrogen (by complete saturation by $MgSO_4$ after removal of protein)	0.0222	0.0299
(f) Proteose nitrogen (b — d)	0.0303	0.0368
(g) Peptone nitrogen [a — (b + i)]	0.0091	0.0113
(h) Peptone nitrogen (c — i)	0.0080	0 0117
(i) Amino nitrogen (Sorensen method)	0 0020	0.0033
Accounted for	0.1416	0.1424
Loss	+ 0.0011	—0.0004

[46]Schryver, "Allen's Commercial Organic Analysis," vol. 8, pp. 467-495.

[47]Van Slyke, *J. Biol. Chem.*, vol. 12 (1912), p. 275; and vol. 16 (1913-14), p. 121.

[48]Sörensen, *Biochem. Z.*, vol. 7 (1907), p. 45, *et seq.*. See also Schryver, *loc. cit.*, p. 488.

A study of the relations expressed above led to the adoption of the following scheme in analysis.

Each sample weighed out and made up to such volume that 50 c.c. contains one gram.

A 50 c.c. aliquot used for total nitrogen.

A 50 c.c. aliquot saturated with magnesium sulphate for the estimation of protein plus proteose nitrogen.

A 50 c.c. aliquot treated with 50 c.c. saturated magnesium sulphate solution for estimation of protein nitrogen.

Proteose nitrogen estimated by difference between protein plus proteose nitrogen and protein nitrogen.

Amino nitrogen determined by Sörensen's method[49] in filtrate from precipitation by saturated magnesium sulphate.

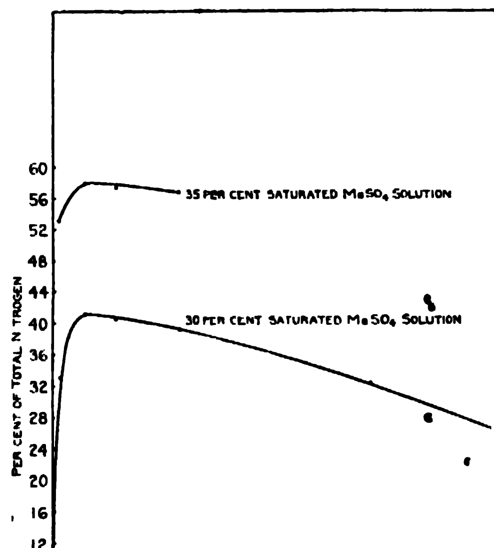


FIG. 14. EFFECT OF SULPHURIC ACID ON PROTEIN PRECIPITATION

Peptone estimated by difference between total nitrogen and the other three groups.

Effect of Temperature. That considerable variation in the uniformity of the magnesium sulphate precipitation might be due to variations in temperature was evident. This point was tested out carefully by precipitating a series of glues and allowing them to stand at different temperatures.

The data show that the solubility of the proteins varies directly as the temperatures, there being from 3 to 8 per cent more protein nitrogen thrown down at 17 deg. than at 25 deg. C.

TABLE XXIX. EFFECT OF TEMPERATURE ON PROTEIN PRECIPITATION

Grade H4, 30 per cent saturated $MgSO_4$ precipitations

No.	Precipitated at 25 Deg. Filtered at 25 Deg.	Precipitated at 17 Deg. Filtered at 17 Deg.	Precipitated at 17 Deg. Filtered at 30 Deg.
1	41.9	50.1	41.3
2	44.8	52.0	46.0
3	50.9	57.7	49.7
4	...	58.3	50.3
5	55.5	58.7	51.7
6	56.2	59.4	52.2
7	53.7	56.2	50.9

From the above, it is evident that wherever comparisons are desired between the nitrogenous substances precipitated from different glues, it becomes necessary to work under carefully controlled temperature conditions, or else run a complete set simultaneously. Otherwise wide variations may be expected. A temperature of 25 deg. C. was used in the following determinations as being the most convenient.

Effect of Varying Amounts of Sulphuric Acid. It was found that some acid must be added to the nitrogenous solution or to the magnesium sulphate in order that precipitation should result on the mixing of the two solutions. S. B. Schryver[50] has recommended the addition of 2 c.c. of dilute (1-4) sulphuric acid to each 100 c.c. of above mixed solutions. This point was tested by the addition to a glue of varying amounts of dilute sulphuric acid, from $\frac{1}{10}$ to 10 c.c. of a 1-4 solution, precipitation being brought about by a 30 and 35 per cent saturated magnesium sulphate solution.

It will be seen that in both instances the maximum precipitation was produced by the addition of ½ c.c. of 1-4 solution to 100 c.c. of the precipitating mixture. Both above and below this amount the nitrogen thrown down decreases. This amount was therefore used in all determinations.

The data are given in Table XXX, and are expressed graphically in Fig. 14.

TABLE XXX. EFFECT OF SULPHURIC ACID ON PROTEIN PRECIPITATION

Glue H4, 1 g glue. Total volume solution, 100 c.c.

C.c. 1-4 H_2SO_4 Added	30 per Cent $MgSO_4$ per Cent of Total N	35 per Cent $MgSO_4$ per Cent of Total N
0 0	2.95	....
0 1	33 2	53 3
0 5	41.3	57.9
1 0	40 3	57.3
2 0	39 3	57.0
5 0	32 4	....
10 0	17 5	.

Study of the Formaldehyde Titration. The usual directions for the formaldehyde titration[51] specify that the formaldehyde and the solution containing the amino acids should both be made faintly pink to phenolphthalein before mixing. It was found, however, that if these instructions were followed in our case, the solution resulting from the mixing would become intensely red, making a determination impossible. The control of saturated magnesium sulphate responded similarly. The process was therefore modified as follows: the amino acid solutions in saturated magnesium sulphate, and the control, were made faintly pink to phenolphthalein. The formaldehyde was treated with sodium hydroxide until, on adding 25 c.c. of it to 100 c.c. of the control, the intensity of the original pink remained unchanged. A drop more of the base would cause an intensifying of the color; a drop less a decrease or removal of color. The amino acid solutions were then treated similarly and titrated back to a uniform, rather deep, red with barium hydroxide in N/5 concentration.

The relative accuracy of the formaldehyde titration method with different concentrations of amino acids was studied as follows:. Two g. each of two glues were hydrolyzed with hydrochloric acid for 24 hr. These were filtered, clarified with a silver chloride precipitation, refiltered, made up to 200 c.c. and aliquots of 50, 25, 10, 5 and 1 c.c. removed in duplicate and titrated for amino acid content.

At the higher concentrations the color of the solution

[49] *Loc. cit.*

[50] *Loc. cit.*, p. 484.

[51] *Loc. cit.*, p. 488.

interfered with the accuracy of the end point, and at very low concentrations the errors of manipulation became large in comparison with the weight of sample. The intermediate concentrations check very well. It was therefore decided best that the entire filtrate from the

TABLE XXXI. EFFECT OF CONCENTRATION ON FORMALDEHYDE TITRATION

Volume, c.c.	Weight, g.	No. 8 $Ba(OH)_2$ c.c.	No. 8 Per Cent N	No. 9 $Ba(OH)_2$ c.c.	No. 9 Per Cent, N
50	0.50	14.0	8.12	15.0	8.70
50	0.50	13.7	7.94	13.1	7.60
25	0.25	7.7	8.92	7.5	8.68
25	0.25	7.9	9.16	7.3	8.48
10	0.10	3.1	9.0	3.0	8.7
10	0.10	2.8	8.1	2.9	8.4
5	0.05	1.4	8.2	1.5	8.8
5	0.05	1.4	8.2	1.4	8.2
1	0.01	0.30	8.7	0.25	7.3
1	0.01	0.25	7.3	0.27	7.8

precipitation by saturated magnesium sulphate be used in all amino acid determinations. The data are given in Table XXXI.

Relations of Nitrogenous Constitution to Jell Strength

Having found no fundamental relation to exist between the proximate constituents of glues and their jell strength, it was decided to separate their nitrogenous constituents by the previously described magnesium sulphate precipitation method. Accordingly, a large number of glues and gelatines were analyzed for their protein, proteose, peptone and amino acid content. Those analyzed included all of the standard grade

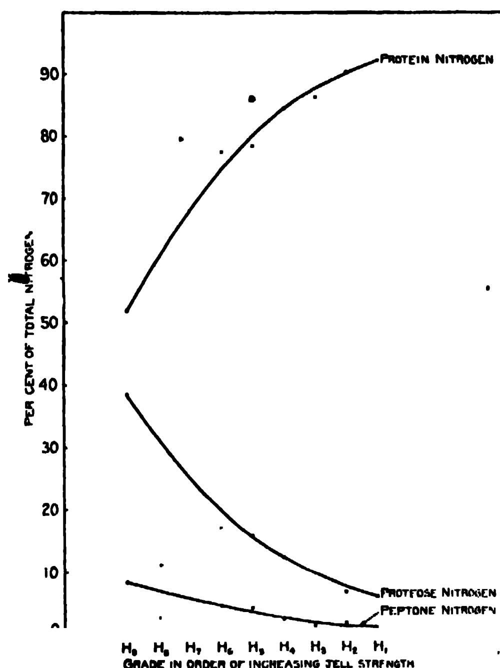


FIG. 15. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH, HIDE GLUES

glues, Russian isinglass from sturgeon sounds, an edible gelatine, fish glue, peptone and several other series of glues.

The results of all of these analyses show a most clear-cut relation to exist between these nitrogenous constituents and the jell strength, which may be summarized as follows:

The protein nitrogen varies directly as the jell strength.

The proteose and peptone nitrogen vary inversely as the jell strength.

The amino acid nitrogen shows a slight tendency to vary inversely as the jell strength.

The amino acid nitrogen is higher in bone glues than in hide glues and fleshings.

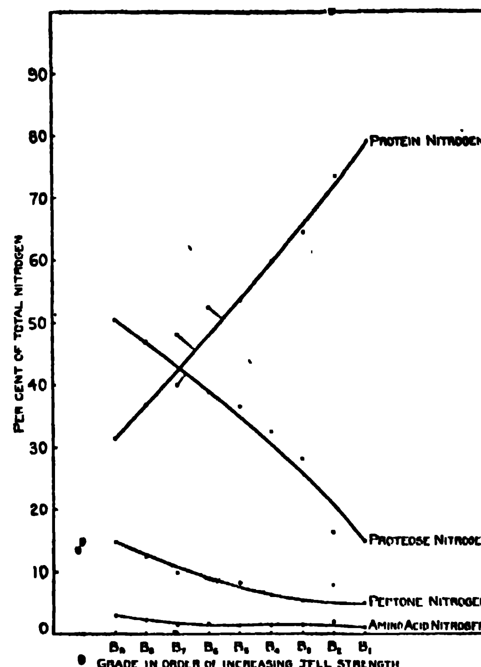


FIG. 16. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH, BONE GLUES

The jell strength of a glue is therefore determined by and is probably absolutely dependent upon the ratio of its protein nitrogen to its products of hydrolysis, chief among which is the proteose nitrogen.

The data of this set of determinations are given in Table XXXII. The figures represent the percentage of the total nitrogen which is precipitated. The graphical representations of the results are shown in Figs. 15 and 16.

TABLE XXXII. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH

	Grade	Protein N	Proteose N	Peptone N	Amino Acid N
Hide glues and fleshings	H_1	92.2	6.3	1.1	0.4
	H_2	90.4	7.0	2.0	0.6
	H_3	86.2	12 0	1.4	0.4
	H_4	84 6	12.4	2.6	0.4
	H_5	78 7	16 0	4.5	0.8
	H_6	77.6	17 0	4.7	0.7
	H_9	52.0	38 6	8.4	0.9
Bone glues	B_1	79.1	14 9	4 8	1 2
	B_2	73 5	16.4	8.1	2.0
	B_3	64.6	28 3	5.6	1.5
	B_4	59.8	32.4	6.4	1.4
	B_5	53.6	36.6	8.4	1.4
	B_6	52.5	37.9	7.8	1.8
	B_7	48.2	40.1	10 1	1.6
	B_8	36.8	47.1	12.5	2.3
	B_9	31.5	50.6	14.8	3.0
Special glues					
Russian isinglass	H_2+	91.0	4.4	4.5	0.1
Edible gelatin	H_3+	87.8	11.3	0.7	0.2
Fish glue	B_9	33.4	42.3	21.9	2.4
Pressure tankage	B_9	34.3	46.4	16.3	3.0
Peptone	B_9	0.0	33.2	48.5	18.3

In order to note if the variation in protein content as determined by precipitation in a half-saturated solution of magnesium sulphate would persist if the effect of viscosity were cancelled, a series of five glues of equal viscosity but varying jell strength were analyzed for protein nitrogen.

It was found that the protein nitrogen varied directly as the jell strength, regardless of the uniformity in viscosity, as is shown in Table XXXIII.

TABLE XXXIII. RELATION BETWEEN PROTEIN NITROGEN AND JELL STRENGTH

Jell Strength	Viscosity	Protein
63	46.2	83.5
64	45 8	84.2
66	46.0	84.9
68	45 8	85.3
70	46 2	85.5

Relation of Nitrogenous Constitution to Viscosity

Several series of glues were studied to ascertain if any relation existed between the nitrogenous constitution of glue and viscosity. Each series consisted of several glues of uniform jell strength and varying viscosities.

Although the greatest care was used in the elimination of sources of error, the results obtained do not show any consistent relation to exist between these nitrogenous constituents and viscosity.

TABLE XXXIV. RELATION BETWEEN NITROGENOUS CONSTITUTION AND VISCOSITY

	No.	Grade	Viscosity	Jell	Protein N	Proteose N	Peptone N	Amino Acid N
Series 1	1	H_4	47.0	..	73.8	19.2	6.58	0.42
	2	H_4	48.0	.	78.6	15.1	6.30	0.00
	3	H_4	49.0	..	75.3	22.0	2.70	0.00
	4	H_4	50.0	..	75.4	19 8	4.66	0.14
	5	H_4	51.0	..	72.9	22.3	3.54	1.26
	6	H_4	52.0	..	72.9	21.1	5.12	0.88
	7	H_4	54.0	..	72 2	21.8	4.60	1.40
Series 1	8	B_2	46.0	..	71.1	21.1	6.40	1.40
	9	B_2	47.0	..	63.8	26 0	7.88	2.32
	10	B_2	48.0	..			6.18	3 92
	11	B_2	49.0	..	60.6	30 9	6.29	2.21
	12	B_2	50.0	..	....	...	5.91	3.49
Series 3	1	H_4	45.6	65	84.4	10 8	3.7	1.1
	2	H_4	47.2	65	87.3	8 9	2 6	1.2
	3	H_4	48.0	66	87.0	8.8	2.6	1.6
	4	H_4	49.0	66	85 2	10.4	3.8	0.6
	5	H_4	50 2	66	85 2	10.7	3.5	0.6
	6	H_4	51 0	64	84.9	11.1	3.2	0.8
	7	H_4	55.0	64	81 8	12.6	4.6	1.0
Series 3	8	B_2	43.2	68	75.6	16.1	7.0	1.3
	9	B_2	45.8	70	77 0	14 4	6.3	2.3
	10	B_2	47.0	70	77.5	14 1	6.5	1.9
	11	B_2	48 0	70	76 2	15.3	6 3	2.2

Summary Upon Chemical Constitution

There appears to be no relation between the proximate constitution of glues and their jell strength and viscosities, except that the water content of the air dry glue is proportional to the jell strength. This means that the water-retaining capacity of glues and gelatines is controlled by the same factors as determine the jell strength, which, as has been shown, is the ratio of protein to its products of hydrolysis.

The jell strength varies directly as the protein nitrogen, and indirectly as the proteose and peptone nitrogen in all glues and gelatines.

The amino acid nitrogen is greater in bone than in hide glues, and tends slightly to increase with decrease in jell strength.

If the jell strength remain constant, the variations in viscosity are not traceable to variations in the ratio of the protein to its products of hydrolysis; proteose, peptone, and amino acids.

Influence of Size of Molecule Upon Physical Constants

It has been noted in a previous paper[52] that viscosity and jell strength are functions of the melting point. Assuming that the several grades of glues are essentially of the same original composition, differing only in the extent of the hydrolysis which they have undergone, it seems reasonable to expect that the melting point will be determined primarily by:

The resultant of the melting points of the several nitrogenous constituents, protein, proteose, peptone, and amino acids.

The resultant of the melting points of the variously sized molecules which constitute the several products of hydrolysis.

As to the first of these, we know that the protein gelatin possesses a higher melting point than its products of hydrolysis. We should therefore expect that in glues the melting point would vary directly as the grade (since we have found that "grade" or jell strength is a function of the protein content)[53].

This we know to be the case, since, in general, the viscosities vary as the jell strength[54] and viscosity is a function of the melting point[55].

With regard to the second of the possible causes for variation in melting point, it seemed probable that within any one group as protein, or proteose, the molecules constituting that group might vary considerably in size. (The ultimate molecule is referred to here, and not the aggregate of molecules going to make up a colloidal complex, which is even more subject to change. The writer differentiates these conditions by maintaining the molecule to be a group which may not be subdivided except by chemical processes, as of hydrolysis, whereas the colloidal complex is established probably be electrical phenomena and the processes of chemical condensation or hydrolysis are not involved.) This seems especially plausible since the line of division between the several groups is a very arbitrary one, depending solely upon their relative solubilities in salt solutions. So, for example, the "protein" consists of all those molecules which are sufficiently large to be insoluble in and precipitated by a half saturated solution of magnesium sulphate[56]. But it may be presumed that these large molecules may vary greatly in size. The protein fraction of one glue may have a large proportion of its molecules of great size, and another glue of size just sufficiently large to be precipitated. In such a case, especially when the protein fraction includes three-quarters or more of the total organic material of the glue[57], such variation in the size of its constituent molecules would certainly be expected to reveal itself by like variations in melting point and hence in viscosity.

This hypothesis was tested by subjecting a number of glues of uniform jell strength and varying viscosities to precipitation by less than half-saturated solutions of magnesium sulphate. It was assumed that as the strength of the salt solution was decreased, the minimum size of those protein molecules which were thrown down would be progressively raised, so with the lowest concentration of salt only the largest molecules would come down. Magnesium sulphate concentrations of from 50.0 per cent down to 24.0 per cent of saturation were used. Below 24.0 per cent, the precipitate was so finely divided and slimy as to render filtration practically impossible. The data of these determinations are given in Table XXXV.

[52]See Part II.

[53]See p. 107.

[54]See p. 64.

[55]See p. 64.

[56]Schryver, "Allen's Commercial Organic Analysis," vol. 8, p. 467, et seq.

[57]See p. 107.

TABLE XXXV. RELATION OF SIZE OF MOLECULE TO VISCOSITY

Showing per cent of nitrogen thrown down by varying percentage saturations of magnesium sulphate

	No.	Grade	Jell	Visc.	50 per Cent	35 per Cent	30 per Cent	28 per Cent	25 per Cent	24 per Cent
Series 3	1	H_4	65	45.6	84.4	69.2	41.3			
	2	H_4	65	47.2	87.3	68.8	46.0			
	3	H_4	66	48.0	87.0	71.8	49.7			
	4	H_4	66	49.0	85.2	71.6	50.3			
	5	H_4	66	50.2	85.2	68.0	51.7		34.6	28.6
	6	H_4	64	51.0	84.9	68.0	52.2		35.3	29.0
	7	H_4	64	54.0	81.8	64.8	50.9		34.8	30.0
	8	B_2	68	43.2	75.6	....	22.3	....	....	....
	9	B_2	70	43.8	77.0	....	36.3	....	....	....
	10	B_2	70	47.0	77.5	....	38.9	....	....	....
	11	B_2	70	48.0	76.2	....	39.8	....	....	....
Series 4	1	H_5+	64	45.4	81.8	58.2	44.2	39.2	....	....
	2	H_5+	64	47.4	87.3	68.8	46.0	42.1	....	....
	3	H_5+	64	50.6	74.0	60.6	49.2	45.8	....	....
	4	H_4—	65	46.2	85.4	62.9	47.3	39.5	....	....
	5	H_4—	65	47.8	87.2	65.1	46.6	40.9	....	....
	6	H_4—	65	48.0	75.6	57.6	44.7	44.7	....	....
	7	H_4—	65	49.4	76.5	59.0	47.2	45.3	....	....
	8	H_4	65½	49.0	72.2	59.0	44.5	42.0	....	....
	9	H_4	65½	50.0	86.0	66.9	52.8	44.0	....	....
	10	H_4	65½	50.2	85.2	66.4	52.1	48.7	....	....
	11	H_4+	66	47.4	83.0	63.1	47.7	42.5	....	....
	12	H_4+	66	48.6	87.0	71.8	49.7	46.1	....	....
	13	H_4+	66	48.8	85.2	71.6	50.3	46.1	....	....
	14	H_4+	66	49.2	86.2	64.3	52.2	46.8	....	....
	15	H_4+	66	49.6	85.2	68.0	51.7	49.0	....	....
	16	H_4+	66	49.8	83.2	65.5	52.7	49.4	....	....

An examination of the data will show that at the low concentration of 28.0 per cent to 30.0 per cent of saturated magnesium sulphate, except in one instance where it was necessary to go as low as 24.0 per cent, the nitrogen thrown down in the several precipitates varies directly as the viscosity, the jell strength being

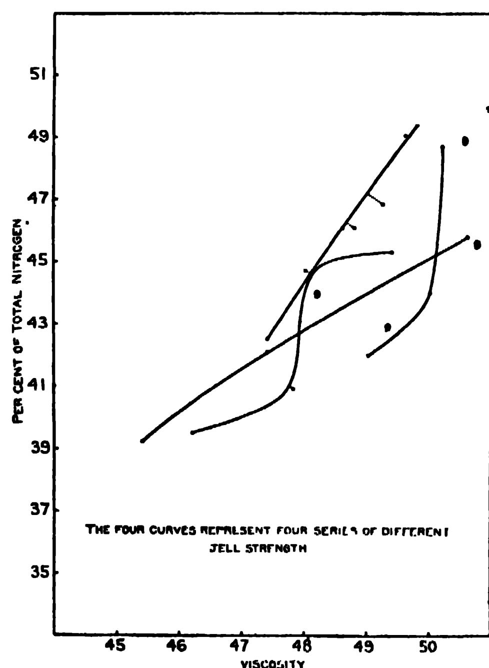


FIG. 17. THE RELATION OF NITROGEN PRECIPITATED BY 28 PER CENT SATURATED $MgSO_4$ TO VISCOSITY

uniform. This means that if the jell strength be constant the viscosity will vary as the size of the protein molecules.

The results from the precipitation by 28.0 per cent saturated magnesium sulphate solution are expressed graphically in Fig. 17.

It had been observed that if the viscosity were constant the jell strength would also vary as the melting point.[38] To further study the reason for this, a number of glues of uniform viscosity and varying jell strength were treated with 50.0 per cent and 30.0 per cent saturated magnesium sulphate and the precipitates Kjeldahled as before for nitrogen. The results are given in Table XXXVI.

TABLE XXXVI. RELATION OF SIZE OF MOLECULE TO JELL STRENGTH

No.	Jell	Viscosity	50 per Cent	30 per Cent
1	63	46.2	83.5	45.0
2	64	45.8	84.2	46.2
3	66	46.0	84.9	46.7
4	68	45.8	85.3	55.1
5	70	46.2	85.5	57.4

It will be seen that at both 50.0 per cent and 30.0 per cent magnesium sulphate saturations, the nitrogen thrown down in the several precipitates varies directly as the jell strength, the viscosities being practically constant. This means then that at constant viscosity the jell strength will vary as the size of the protein molecule, as well as with the total amount of protein.

It seems, therefore, in the light of this set of experiments that:

The melting point, and therefore the viscosity, of a glue is determined *normally* by the balance between its protein content and that of its hydrolyzed products, but

At any given uniform jell strength, the melting point and viscosity will depend upon the ratio of large to small sized molecules within the protein group.

The positiveness of the above results makes it appear improbable that variations in size of molecule within the other groups would be of sufficient influence to seriously modify the effects noted above. This is to be expected; for

The amounts of the other groups present in normal glues is nearly always small in comparison with the protein group,[38] and

As the size of the molecules decreases, their effect on melting point and viscosity likewise diminishes, so that a much larger amount would be necessary to produce an equivalent effect.

(Part IV will be published in a subsequent issue.)

Vegetable-Oil Industry in Japan

According to the latest available statistics, the exports of various vegetable oils from Japan for the first nine months of 1919, compared with those of the whole of 1918, are as follows:

Kind of Oil	January-September, 1919		Total, 1918		Exports to America, 1918	
	Lb.	Value	Lb.	Value	Lb.	Value
Coconut...	21,134,967	$2,757,046	53,950,258	$6,846,732	49,244,641	$6,216,924
Soya bean.	3,170,323	348,115	6,570,957	754,800	5,225,784	601,126
Cottonseed.	947,443	141,307	2,446,397	301,175	1,189,211	138,614
Camphor...	666,967	59,198	1,827,825	133,633	1,057,307	70,577
Peppermint.	438,179	485,140	286,180	274,033	8,368	6,450

The center of the oil-crushing industry is Kobe. The majority of the mills employ the pressure method of oil extraction, using one of three types of hydraulic-pressure machinery: (1) The round-bed type, with a bed about 18 in. in diameter, used for beans and rape-seed; (2) the oblong, flat-bed type, about 30 x 14 in., used for pressing coprá; and (3) the bowl type, in which a stone bowl is pressed into a mass of seed pulp held by iron hoops, used in second and third pressings of peanuts and beans. One mill is reported as using an American rotary-type screw expressor, and a few have adopted the benzine-extractor process. Nearly all the mills can crush any kind of vegetable-oil seeds by a slight adjusting of the machinery.

[38]See p. 107.

The Application of Copper-Refining Practice to Other Fields

BY LAWRENCE ADDICKS

ELECTROLYTIC refining has attained its chief application and highest development in the metallurgy of copper. The very dynamo, the invention of which created the large-scale demand for high-conductivity copper, gave the means of producing it by electrodeposition, and electrolytic refining on a commercial scale was one of the first electrical industries to be developed, while it remains today by far the largest application of the electrolysis of an aqueous electrolyte.

The experience gained in this field has found wide application in the refining of other metals, such as silver, gold, lead, bismuth, tin, nickel, iron and zinc, and in the recovery direct from the ore by leaching of copper, silver, gold and zinc. The successful application of electrolysis to these different fields requires a rebalancing of the various factors discussed in previous articles by the author, the relative values of which are often greatly altered by a change of metal. In any given case we must take into account (1) competition from other processes, (2) acid radical to be employed, (3) temperature of electrolyte, (4) character of deposit, (5) resolution at the cathode, and (6) depolarization at the anode.

COMPETITION

Electrolytic copper refining has no effective competitor in its own field. Fire refining makes a low conductivity product unless furnished with very pure raw material such as selected Lake "mineral," and the various selective methods of reverberatory treatment yield but a partial recovery of gold and silver.

In the leaching field electrolysis has to meet several competitive methods of reduction, notably precipitation upon iron. While a free acid equivalent by electrolyzing is returned to the cycle, there are usually serious handicaps imposed by large quantities of impurities which cause various troubles in the cells and which progressively accumulate unless some outlet is provided. Even where electrolysis is indicated, therefore, an iron precipitation plant is usually required as an adjunct, from 10 to 30 per cent of the copper being recovered as cement.

Electrolytic silver has to compete with the older sulphuric acid method of parting. The latter is easy to operate and ties up less silver, but it will not make a product so low in gold as the electrolytic. It is still indicated, however, for small plants or for those which are used spasmodically.

In the case of gold refining the question is almost wholly dependent upon the amount of platinum and associated metals present. If the original gold is free from this metal group, there is no object in tieing up the gold several days for electrolysis and further increasing the opportunities for theft. When but very small quantities of platinum and palladium are present, they may be satisfactorily collected by wet methods instead of by electrolysis at about equal expense. When the quantities are larger electrolysis is indicated.

Electrolytic lead has to compete with the very efficient Parkes process of refining. When all factors are considered, the justification for electrolysis appears to rest almost entirely upon the quantity of bismuth present in the bullion to be treated. This objectionable impurity is not satisfactorily removed by the Parkes process and special treatments such as Pattisonizing are expensive, while the electrolytic method readily separates the bismuth from the lead and converts it into a marketable byproduct.

Nickel, iron and zinc may be readily refined by electrolysis, but in ordinary times the value of the refined product, except in a very limited quantity, is not sufficiently above that of the crude to pay for the refining. Tin offers a special field for impure ores which are difficult to handle by fire processes.

In leaching, both nickel and zinc have strong competition from chemical and pyrometallurgical processes and this whole field is still in a state of flux.

In general, we can say that electrolysis enjoys no such absolute monopoly in other fields as it does in copper refining and that each proposed application must, therefore, receive full consideration upon its merits.

ACID RADICAL

While several salts of copper are suitable for electrolytic treatment, the sulphate possesses so many practical advantages that it is universally employed. The first requirement for an electrolyte is that the salt of the metal employed shall be readily soluble. The second is that the material which it is desired to collect in the slime shall be insoluble in it. The third is that the cathode should not be redissolved by the electrolyte. Copper sulphate is a readily soluble salt and copper; gold and silver are all practically unattacked by dilute sulphuric acid.

When electrolyzing silver a nitrate electrolyte is employed, as silver sulphate is not a readily soluble salt. The amount of free acid carried is necessarily low, as nitric acid is expensive and decomposes under the conditions of electrolysis. Copper concentrates in the electrolyte and is removed by withdrawals, while gold remains unattacked in the slimes.

In gold refining a chloride electrolyte is employed. Gold chloride is a soluble salt, platinum concentrates in the electrolyte, and although silver, being less noble than gold, dissolves at the anode, after saturation it precipitates as a secondary slime of insoluble chloride.

For lead, chloride and acetate were first tried, but not until Betts developed the fluosilicate electrolyte was the electrolytic refining of lead made a commercial success.

It will, therefore, be appreciated that an entirely new set of chemical conditions as regards behavior of impurities, etc., is encountered with every metal refined.

TEMPERATURE OF ELECTROLYTE

While it is customary to heat copper electrolytes externally, quite opposite conditions obtain in the case of silver, lead and zinc. Nitric and hydrofluosilicic acid show increasing decomposition losses with rise in temperature, asphalted tanks do not stand hot liquors and zinc resolution losses must be limited. In the case of silver, the current may have to be limited to control the temperature; for lead, extraneous heating is abandoned, and with zinc, where the specific resistance of the electrolyte is high, cooling systems carrying circulating water must be employed.

CHARACTER OF DEPOSIT

At moderate densities copper readily gives a good adherent deposit. The same may be said of gold. Silver gives normally a loose crystalline deposit. Nickel is

nodular, while lead and zinc tree very badly. By the proper use of addition agents all of these deposits may be made smooth and coherent. In fact it was not until the value of addition agents was more or less understood that lead could be handled at all.

In the early copper plants a great deal of trouble was had in getting good starting sheets, and it was thought that the addition of ammonium sulphate was a help, the use of double salts being common practice in various electroplating prescriptions. Then the beneficial effect of the presence of wood strips on the edges of the starting blanks led to the introduction of wood tea made from shavings, yielding a complex organic addition agent. Finally the remarkable results following the addition of gelatine were worked out. The irregularities of early practice were due to overdosing and a failure to appreciate the fleeting effect of a single dose. Today a few pounds of common glue dissolved in water and added regularly throughout the twenty-four hours, together with a can of ordinary engine oil, will control the deposit in the tank house of a great copper refinery, permitting the use of higher densities, closer spacing and greater cathode age.

For silver, while adherent deposits can be made in similar fashion, it is customary to collect the silver crystals as such, either brushed to the floor of the tank from vertical cathodes by mechanical scrapers as in the Moebius system or shoveled by hand from the horizontal carbon cathode of the Thum cell. These crystals are readily washed free of electrolyte and fed to retorts for melting.

Lead may be beautifully controlled by addition agents. The exact amount to be added varies from time to time and is determined by experiment and careful watching of the fresh deposit on special strips hung for the purpose.

Zinc is generally plated in coherent form on an aluminum cathode, from which it is peeled every forty-eight hours. There is no reason why zinc starting sheets could not be used as in the case of copper, and in some ways the avoidance of a zinc-aluminum couple would be of advantage. In the development of electrolytic zinc practice, however, there has been great difficulty in controlling resolution at the cathode, and the great advantage of using aluminum sheets lies in the fact that strong corrosion can do no more than leave the starting sheets bare, whereas were they of zinc they might be completely eaten through, causing collapse, open circuits, general demoralization and shut-down of the plant.

Resolution at Cathode

The cathode is never absolutely insoluble in the electrolyte used and a small amount of reoxidation is always in process. In the case of copper with normal electrolytes it is a minor matter—perhaps 2 per cent. Should we allow an accumulation to take place of salts of manganese, iron or any other metal capable of alternate oxidation and reduction at anode and cathode with change of valence, a very serious condition may arise.

In these days copper anodes are so highly refined that the amount of iron contained in the electrolyte is quite negligible, but when electrolyzing liquors arising from the leaching of ore a very different situation exists. Such liquors commonly contain large quantities of ferrous sulphate and a certain proportion of ferric sulphate. Oxidation at the anode tends to increase the latter at the expense of the fomer. (See Addicks, *Trans. Am. Electroch. Soc.*, vol. 28, p. 87.) Experiments show that 0.25 per cent of iron as ferric sulphate in an electrolyte sufficiently agitated will corrode cathode copper at a rate which will require a current corresponding to about 8 amp. per sq.ft. merely to replace the loss. The proper control of ferric sulphate is, therefore, the key to success in electrolyzing copper leaching liquors.

Another interesting example of resolution is in the case of zinc—in fact this is the controlling factor in zinc electrolysis. In the electrolysis of zinc sulphate using an insoluble anode the content of free sulphuric acid gradually increases and unless the cathode is absolutely pure zinc resolution is very active. Perfectly pure zinc is so nearly insoluble in sulphuric acid that it is quite difficult to get it in solution for analysis. But if a nodule of cathode zinc is immersed in dilute sulphuric acid in a test and the nearest trace of almost any impurity is added, a vigorous evolution of hydrogen will start at once. This is probably due to galvanic action, and the whole secret of successful zinc electrolysis lies in the passivity of pure zinc in sulphuric acid. This calls for a degree of purity in the electrolyte which would be quite uncommercial were it not for the fact that zinc dust readily throws down most of the impurities to be dealt with after the liquor from the leaching tanks has been neutralized. The last traces of some difficult elements, such as arsenic, are removed by adsorption upon freshly made ferric hydrate.

Depolarization at the Anode

Anode efficiency plays a relatively small part in normal copper refining; the proportion of impurities present in the anode is small and the useful anode efficiency very high. As soon as a complex or insoluble anode is substituted, however, the oxidizing effect of the current is in part or in whole employed in the solution of anode impurities, the oxidation of suitable salts in the electrolyte or in the decomposition of water with escape of oxygen as such. This introduces several new problems.

A moderate amount of an oxidizable impurity, such as nickel, in a copper anode gives the first and simplest case. The nickel and copper dissolve proportionately at the anode, sharing the current. At the cathode, however, only copper is deposited, so that the copper in the electrolyte is correspondingly depleted. About 2 per cent of the copper deposited is restored by purely chemical solution at the electrodes but beyond that figure soluble copper must be added by leaching shot or scale, and the accumulating nickel must be controlled by withdrawals to a byproduct plant.

The second difficulty arises when the quantity and nature of the impurity in anode causes segregation into two components one of which is more readily dissolved than the other. Then the anode disintegrates unevenly and a large amount of scrap has to be reworked.

A third and more serious condition is met with when the impurity is insoluble, such as lead or antimony, when the anode will become coated with a non-conducting slime. The voltage will then rise until some free oxygen is generated from the moisture underneath. This in turn will burst through the coating and the anode will act normally for a few seconds, when the coating will again form. A voltmeter connected across such a tank will show a wildly fluctuating needle, and this condition, known colloquially as "crazy tanks," is fatal to good refining, entailing as it does excessive gold and silver losses in the cathode, high power cost and a heavy expense for purifying electrolyte. The remedy lies in

properly refining the crude material before casting the anodes.

Finally, we have the extreme case where the anode is by intent insoluble, as where copper is being recovered from leaching liquor. Where no depolarizer is employed, the voltage must of course be sufficiently high to decompose water, and free oxygen is given off at the anode. When the liquor is virtually free from chlorides and nitrates, antimonial lead is generally used as the anode material; when electrolyzing zinc, however, pure lead is required in order not to poison the cathode with specks of antimony. When the liquor is corrosive, either magnetite or one of the ferro-alloys, generally ferro-silicon, is employed. None of these anode materials is wholly free from oxygen attack. Lead peroxidizes and sulphatizes and the iron alloys slowly dissolve, so that a certain replacement charge must be reckoned with.

Where an efficient depolarizer is employed, any of the materials mentioned above or carbon may be employed. Graphite offers peculiar advantages in that 100 per cent of efficiency of oxidation of ferrous sulphate or similar depolarizer is readily obtained by its use. Lead does not give equal results. On the other hand carbon itself will oxidize and disintegrate if not fully protected by the depolarizer. This whole question of a cyclic oxidization at the anode with subsequent reduction at the ore contact is yet in but partially developed form, most of the theoretical advantages being generally offset in practice by the difficulties met with in handling impurities dissolved from the ore.

Use of Esparto in Paper Making

During the European war the scarcity of paper pulp in the Spanish market, caused by the difficulty in securing supplies from the sources formerly relied upon, especially the countries bordering upon the Baltic coast, caused Spanish paper makers to consider the use of esparto to supplement the import supply. Esparto grows throughout extensive districts in the south of Spain, and a poorer quality is found on large areas of poor and sandy lands in Algiers and Tunis. Esparto fiber has been used for centuries in Spain, and the manufacture of matting, baskets and cordage exclusively of esparto dates from the time of the Moorish occupation.

Early Experiments in the Use of Esparto

Esparto was used in paper making in Great Britain as early as 1857. The industry met decided success in Scotland and a few years later the manufacture was started in the south of France, the raw materials being obtained from Algiers and Tunis, but it has never reached a prosperous basis in the republic, due to the inability to compete with the local straw papers. The industry in Spain in the regions bordering on the Mediterranean coast dates from 1869.

The greatest development of the esparto industry is still found in Great Britain, where the fiber has been used for making fine writing paper of great whiteness, and to some extent for newsprint, though for the latter purpose at the prices usually current other pulps are cheaper. Papers made from esparto are of great thickness compared to the weight and have the advantage of not shrinking or breaking when exposed to moisture. They have especial adaptability for the manufacture of lithographs. They are easily filled, absorb ink well, and therefore are particularly adapted for fine printing, especially in color work. Esparto paper is highly esteemed for book making because of its texture and light weight.

Interest in Esparto Revived Prior to the War

Shortly before the outbreak of the European war Spanish interest in esparto began to be revived. In 1910 the Papelera Española installed an experimental plant to use esparto pulp at Arrigorriaga, adopting the best methods which had been developed in Scotland. Because of the difficulties in securing pulp created by the war this plant was later enlarged and by 1917 a daily production of 2,000 kilos was reached and the following year a daily production of 4,000 kilos. Another enlargement of the plant was started in October, 1918, and in the first months of 1919 the daily consumption of esparto pulp reached 16,000 kilos, from which a yield of 8,000 kilos of paper was secured. Two other important plants were installed in 1916 at Aranguren and Renteria, each with a daily capacity of 10,000 kilos of esparto pulp.

In this way the Papelera Española has sought to reduce the necessity of importation of bleachable foreign pulps. During the war the chief preoccupation was to reach the maximum production in the shortest time. The company is now, however, making plans which will allow the placing of this industry on a permanent basis.

Limitations of the Use of Esparto

Though esparto has exceptional qualities for certain uses in paper making, its fibers are not such as will allow its substitution for all the purposes for which wood pulp is used. The fibers are short and weak. The pulp is best used for filling, and is therefore employed largely in mixtures with longer and stronger fibers. Esparto is not suited for the manufacture of wrapping paper. It can, however, be used in larger proportions than has heretofore been the practice in most other grades, and thus make it possible for the Spanish manufacturers of paper to reduce their demands on the foreign market. In documentary papers and others in which great strength is needed not more than 20 per cent of esparto can be used. In writing papers, where light weight is desirable, esparto pulp can be used in large quantities.

For the cheaper grades, especially those in which incompletely bleached pulp is used, the higher price of esparto will, as a rule, make its substitution for bisulphite pulp impossible.

Denatured Alcohol Formula

The Treasury Department, United States Internal Revenue, has recently published Regulation No. 61 dealing with denatured alcohol. Of the various formulas given, No. 4, on page 97, of this bulletin will probably be the one most generally used, and is made up as follows: To every hundredth part by volume of ethyl alcohol should be added two and five-tenths part by volume of approved benzol, five-tenths part by volume of nitrobenzol, two-tenths part by volume of approved pine oil (steam distilled). The old No. 1 formula using wood alcohol has been suspended because so much of this material is being manufactured into formaldehyde, of which there is an acute shortage. The demand for formaldehyde is due to its use in treating grain for smut.

Some Commercial Heat Treatments for Alloy Steels for Structural Purposes*

A General Discussion of Principles of Heat Treatment, Having Especial Reference to a Nickel : Chromium Steel, the Effect of Time in Complex Heat Treatments, and the Development of Simple Heat Treatments From the Complex

BY A. H. MILLER†

ALLOY steels both for tool and structural purposes have had an increasing application for a number of years. The present paper, for its limited purpose, will be confined to a discussion of steels for structural purposes, and will further limit itself to their heat treatment. It will apply directly to the two alloy steels which are probably used to a greater extent than all others combined—namely, nickel and nickel : chromium steels. It is to be borne in mind, however, that the statements to be made in regard to these two alloys are almost equally applicable to all of the structural alloy steels, provided temperature changes are made which correspond to the changes in the critical temperature of these alloys.

In speaking of heat treatments, a fundamental thought must always be held in mind, which is this: All fabricated steels have submitted to a heat treatment. The difference between steels known as heat treated and others commonly spoken of as untreated is merely that the treated steels have supposedly received a preconceived and carefully executed treatment, while the so-called untreated steels have received the variable and generally unknown treatment which is the result of casting, forging and cooling at an unknown and variable rate from the casting or forging temperature.

TIME AT THE HIGH HEAT

In the heat treatment of alloy steels, the three variables which must be controlled for a successful heat treatment are temperature, time and rate of cooling. The influence of mass on these three variables must never be neglected, and it must be borne in mind that an increase in mass may increase the treatment temperature, should increase the length of time held at temperature, and will inevitably alter the rate of cooling.

Too little attention is generally paid to the time element of the heat treatment, whereas it actually is of very great importance. To illustrate this, Figs. 1 to 7 inclusive show a series of photomicrographs of a nickel : chromium steel of composition C 0.35 to 0.40 per cent, Ni 3 per cent and Cr 1.50 per cent, showing the microstructure in a typical forged condition, and after annealing at a proper annealing heat for varying periods of time. It will be noted that this series gives the time held at the annealing temperature from zero (meaning that the piece was brought to temperature and the furnace was immediately shut down) to 10 hr. A study of the photomicrographs shows that the ferrite as contained in the cell outlines of the forged specimen was not dissolved and uniformly diffused until the piece had been held at the annealed temperature for ½ hr. The last photograph shows that there had been a slight growth of the austenite crystals between the time of completed uniform solution at ½ hr. and the end of the run at 10 hr.

This series also shows that a new cell system may grow in steel simultaneously with the breaking up of the previously existent system. The pieces were all cut from the same bar, and were treated by placing all together in a furnace controlled by a thermocouple, withdrawing them one by one at the end of the specified time, plunging each immediately into a box of well aërated lime.

The reason that a considerable length of time is required to produce a uniform structure is probably as follows: After the steel is raised to a temperature above the critical temperature, the iron is in the gamma form, in which the ferrite is soluble. There is, however, a certain length of time required for this solution, and, more than that, a certain added length of time is necessary to allow the solution to become homogeneous; just as, in dissolving a lump of sugar in water, a certain length of time is required to complete the solution, and a certain further length of time for the water to become uniformly sweet. If the iron carbide should be dissolved in the gamma iron, but this solution not have had time to become homogeneous before it be recooled, ferrite will naturally separate out on cooling at the point where the greatest concentration existed in the solution.

COMPLEX HEAT TREATMENTS

The object of alloy steel heat treatment and indeed, with a very few exceptions, of all heat treatment is to produce a grain size as small as possible, with a degree of hardness suitable for the purposes intended, by the simplest possible means. Thus the ill-controlled and generally very poorly-forged structure must first be broken up, and a fine uniform structure established. In steels which are sensitive to heat treatment, of which the nickel and nickel : chromium steels are excellent examples, this object is best achieved in several steps, each of which is designed to break up the structure resulting from the previous step and to bring the material into a more nearly ideal condition.

If the forging conditions are bad, as is the case in most forging processes, especially that of drop forging, a treatment of numerous steps may be necessary. As an example of the most drastic I give the following:

First. Anneal from approximately 1,450 deg. F.
Second. Quench from 1,600 deg. F.
Third. Quench from 1,400 deg. F.
Fourth. Draw at 1,250 deg. F.
Fifth. Quench from 1,400 deg. F.
Sixth. Draw at such a temperature as will give the desired hardness.

*Read before the Washington Section, American Society of Mechanical Engineers, March 31, 1920.

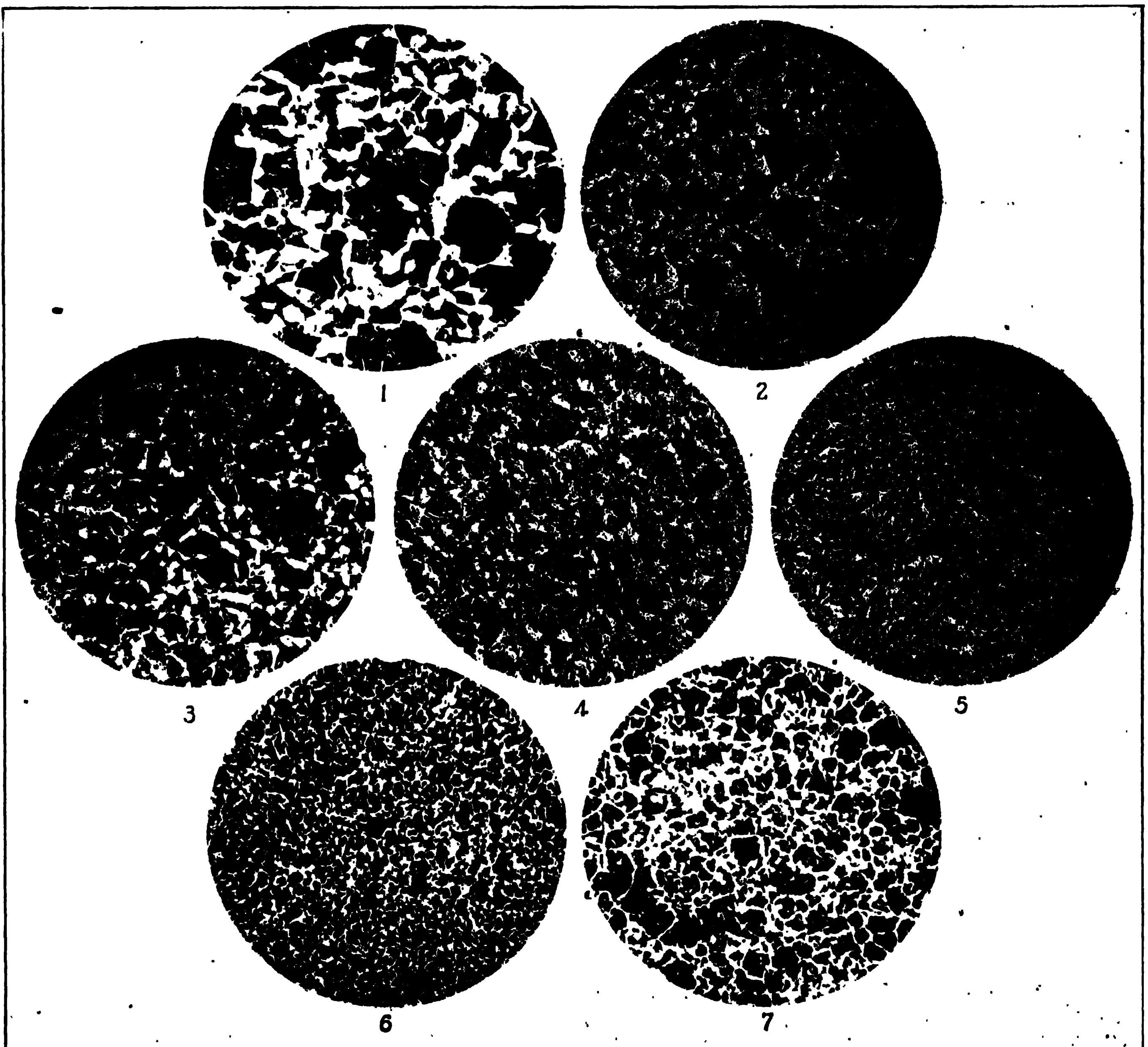
†Bureau of Research, Midvale Steel & Ordnance Works.

This heat treatment is not of unheard length, as it is quite conceivably necessary in many cases. As a matter of fact, in manufacturing pieces which will not subsequently be forged by the purchaser, steel companies very frequently give all of the preliminary steps of this treatment to their regular product. It must be well understood, however, that this number of steps is necessary only to guard against lack of uniformity, due to one piece out of a great number having possibly been subject to a poor forging heat. If the forging temperature can be accurately regulated many of the steps in this treatment can be eliminated.

In much commercial work, with good forging practice, a simple anneal at 1,450 deg. followed by a quench just above the critical temperature and a draw will put the steel in excellent preliminary condition, at which point the steel can be machined to its final shape. If conditions are such that the steel must be extraordinarily hard (as in automobile gears) a final quench with a draw at about 400 to 600 deg. F. is given.

It must be borne in mind when laying out treatments that the time at which the steel is held at temperature during any treatment, whether it be an anneal or a quench, is of quite as great importance as the temperature. This is illustrated by photomicrographs of two pieces cut from the same bar as those previously shown, both of which were placed in the furnace together. One of these pieces (Fig. 8) was drawn from the furnace, and quenched immediately it had reached the quenching temperature (in this case 1,400 deg.). The other, Fig. 9, was allowed to remain in the furnace for ½ hr. and was then quenched. It will be seen that the ferrite areas in the first case had been slightly or completely broken up, whereas in the second case they were very completely dissolved. Again Fig. 10 shows the fine grain resulting from a proper complex treatment.

These photomicrographs differ from a corresponding one in the first series of annealed samples in that there is shown no new grain growth within the old partially broken up system. This, of course, is due to the fact that



FIGS. 1 TO 7. EFFECT OF TIME AT NORMALIZING HEAT (1,450 DEG. F.) FOLLOWED BY SLOW COOLING
Fig. 1. As forged. Fig. 2. Not held, cooled in lime. Fig. 3. Held 5 min. Fig. 4. Held 10 min. Fig. 5. Held 15 min. Fig. 6. Held 30 min. Fig. 7. Held 10 hr. × 80.

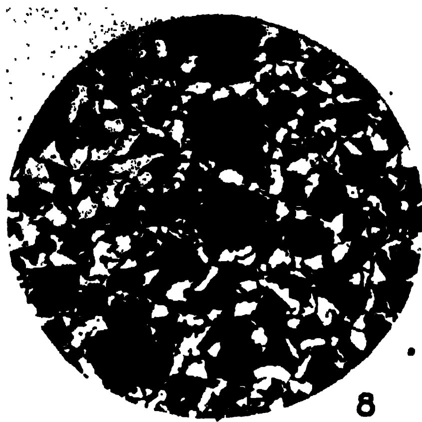


FIG. 8.
Heated to 1,400 deg. F.
Not held, quenched in oil.
Reheated to 1,150 deg. F.
Held 30 min.
Cooled slowly. × 100.

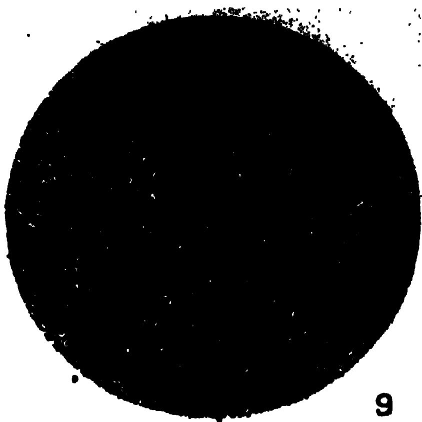


FIG. 9.
Heated to 1,400 deg. F.
Held 30 min.
Quenched in oil. × 100.

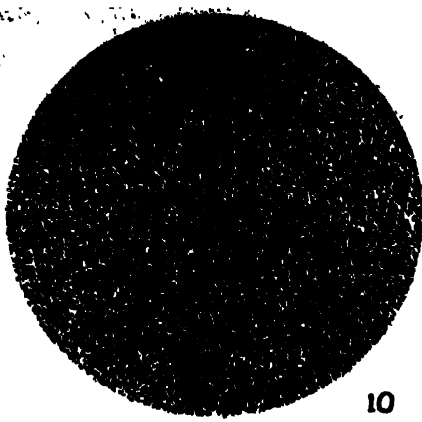


FIG. 10.
Heated to 1,450 deg. F. for 30 min., cooled slowly.
Heated to 1,600 deg. F. for 30 min., cooled slowly.
Heated to 1,400 deg. F. for 30 min., cooled slowly.
Heated to 1,150 deg. F. for 30 min., cooled slowly.
× 100.

in the second case the time element which is necessary for the separation of the ferrite during cooling was not sufficient.

Physical Properties Possible

As a result of a careful heat treatment of nickel : chromium steels Fig. 11 shows a series of curves, showing physical properties of a nickel : chromium steel resulting from proper preliminary treatment and varying drawing temperatures.

The type composition only is given on this curve, because it is a mean of the results of about twenty bars from several heats of slightly varying compositions. The nickel steels of the same approximate carbon content give results which are somewhat inferior to this nickel : chromium curve, whereas the results of another type of nickel : chromium steel, of 3½ per cent Ni, 1½ per cent Cr would be slightly superior to that just shown.

Starting from the extended heat treatment which we have just seen, the development of the cheapest and simplest treatment which will give good results is a matter of intelligently eliminating or altering steps of the ideal heat treatment as conditions permit. For instance, in a certain case which has come to my attention, one in which important drop forgings are manufactured from the grade of nickel : chromium steel shown on the curve, the actual treatment to which pieces were subjected is as follows: The pieces were forged under a drop hammer, and were dipped immediately afterward into a tank of oil which was situated close to the forge. The pieces were kept in this oil for about 4 min., being removed at a temperature between 700 and 900 deg. F. and then buried in ashes as a precaution against cracking. After this the pieces were subjected to a single quench at 1,400 deg. and were drawn at 1,200 deg. They were machined in this condition and received no further treatment. The uniformly excellent results obtained (each of the pieces was separately tested) showed that this very simple treatment had been entirely effective. A little thought will show that the reason for this was that the drop forging was not excessively high, and that the growth of large cell outline was prevented by the quench after forging was completed. The single quench and draw were sufficient to completely refine the steel from the fair condition which was thus produced.

There is this to be observed in all cases of quenching of alloy or indeed any other steels: Following the quench, the piece quenched is in a condition of great strain and is liable to crack. This liability to crack persists until the piece has been drawn, and it is therefore wise to draw the piece as soon as possible after the quenching.

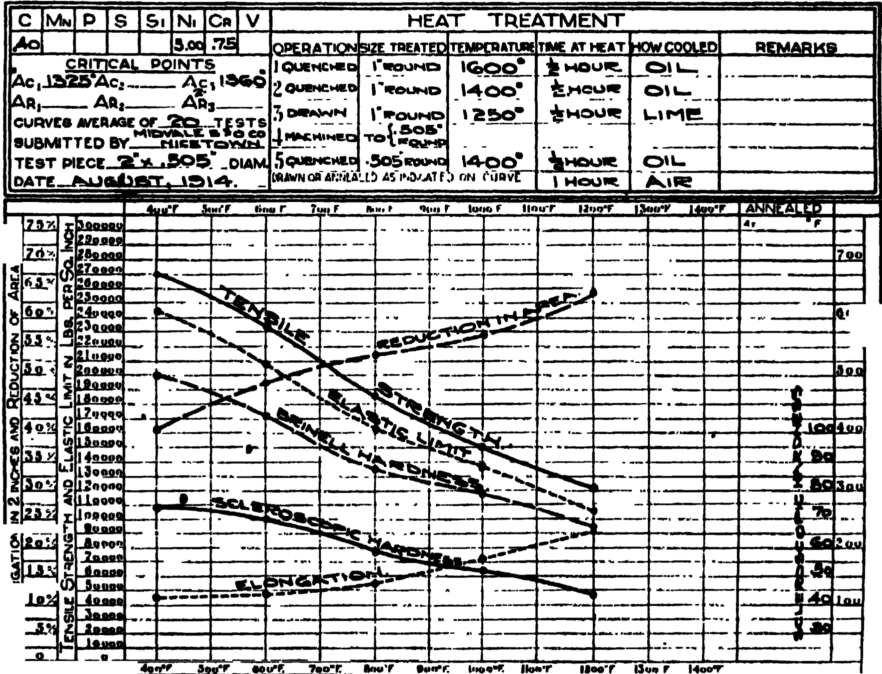


FIG. 11. PHYSICAL PROPERTIES OF A NICKEL : CHROMIUM STEEL RESULTING FROM PROPER PRELIMINARY TREATMENT AND VARYING DRAWING TEMPERATURES

In cases where a drastic quench is advisable it is better to remove the piece from the quenching medium before it becomes entirely cold. By this procedure, the great proportion of the condemnations due to cracking is avoided.

Relation of Fibrous Fracture to Shock Resistance

One of the significant effects of a correct heat treatment on alloy steels, which is indeed a criterion as to the efficiency of the treatment, is the production of a peculiar type of fracture in a broken piece, known as "fiber." This fiber fracture is absolutely distinctive, and cannot be mistaken by one who is even slightly skilled in inspection.

It is produced in all of the well melted shock-resisting alloy steels by proper heat treatments, and is so closely related to impact test values that rejected impact tests can almost invariably be selected from passed impact test bars by the absence of this type of fracture. The ease of producing fiber by heat treatment is a criterion of the value of an alloy for shock-resisting properties. So important is the presence of this fracture that armor plate, which must withstand shock test of the most severe character, is never knowingly shipped without possessing it.

Philadelphia, Pa.

The Coal Industry of Swansea, Wales

Swansea is one of the principal coal-producing centers of Great Britain, as well as one of the leading coal-exporting ports. A large part of the consular district is underlain by the coal fields of South Wales. The coal produced is anthracite, semi-anthracite and bituminous. Swansea is, in fact, the chief anthracite center of Great Britain. It is also the center for the manufacture of patent fuel (briquets and ovoids made from coal dust).

The output of the mines of the district before the war was about 9,000,000 tons for all purposes. The output for 1919, however, was only about 6,500,000 tons. Most of the coal produced in the district is exported to other British ports and to foreign countries. The export (coastwise and foreign) trade of Swansea with its subport of Port Talbot for 1913, 1918, and 1919 was, in long tons:

Articles	1913 *Tons*	1918 *Tons*	1919 *Tons*
Coal and coke	6,743,640	3,845,407	4,434,922
Briquets	1,175,119	1,014,603	1,092,803
Total	7,918,759	4,860,010	5,527,725

The quantity of coke exported was negligible.

Export Quantities and Prices

The Government Coal Control has limited the coal trade of Swansea in two important ways: It has fixed the maximum domestic prices of coal, the present average retail price being about 45s. ($10.95 at normal exchange) per ton delivered; and it has fixed the minimum supply of coal to be delivered for domestic use, thereby limiting the quantity available for export. Since the output has fallen off considerably during the past twelve months (owing to strikes, shorter work days and decreased output efficiency of workers), this means that the quantity of coal now available for export from this district is far less than it was in former years. The total amount exported from Swansea and Port Talbot for the month of April, 1920, was 220,000 long tons, according to the customs returns for the two ports.

No control is now exercised over the price of export coal, and the prices have risen enormously owing to shortage of supply and sharp foreign demand. For instance, the average price of best anthracite coal in October, 1919, was 60s. 6d. ($14.72 at normal exchange) f.o.b. ship, Swansea; for December, 69s. 1d. ($16.81); in May, 1920, 85s. ($20.69). Prices of best steam coal at the same dates were 75s. ($18.25), 88s. 7d. ($21.56), and 117s. 6d. ($28.60). The price to-day for run-of-the-mine grade of soft coal is 107s. 6d. ($26.16). With freight around 50s. ($17.17) to French Atlantic ports (Rouen or Bordeaux) and 62s. 6d. ($15.21) to Genoa, Italy, this would make the c. and f. price on run-of-mine coal at French ports 157s. 6d. ($38.33 at normal exchange, or $30 at current exchange for sterling), and 170s. ($41.37 normal exchange, or $32.38 current exchange) for Italian ports.

Continental Demand Exceeds Supply

Despite these almost prohibitive prices (greatly enhanced by the adverse French and Italian exchange on London), the Continental demands upon the Swansea coal market far exceed the supply of that market. There is ample tonnage at hand, but vessels have to wait an average of sixteen days before securing a berth at the coal piers, so meager is the supply of coal coming to the pier tips.

In view of this condition, and the slight prospect which those interested see of early improvement, many of the local coal-exporting firms are negotiating or have already negotiated contracts with American coal companies for stocks to supply their Continental customers, the coal to be shipped direct from American to Continental ports.

Market for Chemicals in Finland

The total value of the imports of chemicals into Finland during the years 1913 to 1919 is given in the following table, in marks, with the share of each country in this trade during the years 1913 to 1917 (the normal value of the Finnish mark is $0.193, but the present foreign exchange cable rate is about $0.05).

From	1913 Marks	1915 Marks	1916 Marks	1917 Marks	1918 Marks	1919 Marks
Russia	204,117	3,628,396	14,999,789	12,113,125	....	....
Sweden	127,113	10,651,673	26,748,867	21,489,487	....	....
Germany	2,456,262	2,759	652	....	....	....
Great Britain	1,853,290	5,050	2,229	5,769	....	....
Italy	1,576,393	48	....	....	....	....
Belgium	780,113	1,000	....	....	....	....
Netherlands	773,299	21	208	5	....	....
Other countries	79,350	86,121	294,818	5,228,532	....	....
Total	7,849,939	14,374,949	43,260,712	38,831,144	5,213,157	22,728,126

These chemicals consist of potash, alum, ammonia (salammoniac) and salts of ammonia, potassium nitrate (pure and commercial), Chilean saltpeter, soda, sodium sulphate, borax, chloride of lime, copper sulphate, heavy-spar sulphuric acid, hydrochloric acid, nitric acid, sulphur, phosphorus, arsenic acid, compounds of arsenic, potassium chromate, potassium chlorate, magnesium, sugar of lead, cream of tartar, tartaric acid, citric acid, calcium carbide. In addition to these chemicals, dyes, drugs and tanning materials are extensively used. Germany has been the principal source of the chemical supply. Extracts and tanning materials are imported from England and sulphur from Italy.

Statistics are not available as to the value of the imports by countries for the years 1918 and 1919. It is noteworthy that 1916 is the first year in which there is recorded an import of chemicals from the United States. During 1919 almost the entire supply of sulphur came from the United States; also considerable quantities of tanning extracts and some drug supplies.

When a Workman Overdoes Himself

By Chesla C. Sherlock

IT IS not at all uncommon for workmen who are intensely interested in their work, or in a great hurry, to overexert themselves or attempt too much and thereby receive injuries which they ordinarily would not incur under normal conditions. Strains, overexertions, ruptures or hernias are all the logical result of such overexertion. These injuries sometimes are as powerful a contributing cause to the workman's incapacity for work as anything that could be called to mind.

Employers are naturally anxious to know what their legal liability in such cases is, particularly in those employments where workmen are peculiarly liable to suffer such strains or overexertion. Industrial accident statistics place the greatest risk from this nature of injury upon factory helpers—those required to move materials from one place to another, or those engaged in so-called "heavy" work.

Then, again, a strain or an overexertion may be due to the fact that the employer has attempted to make his workmen do a task without sufficient help, one so big that it overwhelmed them. The question arises here, Is the employer liable for his failure to furnish sufficient help to accomplish successfully the object he had in mind?

Is Strain an "Accidental" Injury?

The workmen's compensation acts, as most employers know, provide compensation for accidental injuries received arising out of and in the course of the employment. The principal question which has agitated employers and the courts has been whether a strain can be deemed an "accidental" injury.

In a New York case, the Industrial Commission found "that while claimant was working for his employer at his employer's plant, and was assisting another employee in lifting a barrel weighing about 200 lb., he was seized with a stroke of apoplexy by reason of the strain occasioned by the lifting of the heavy barrel. By reason of the apoplexy, that portion of the brain in which the apoplexy was seated degenerated and while the claimant gradually recovered from the motor paralysis of the left side which immediately followed the apoplexy, there remained a deterioration of his mental faculties due to the above-mentioned degeneration, by reason of which apoplexy and degeneration claimant was disabled from working from the date of the accident to the date hereof and is still disabled." The Commission held that this was a compensable accident.

Where death is caused by reason of the strain or the overexertion, the court in Canada has said: "If an accident necessitates an operation and death ensues, even though it is not a natural or probable consequence, the death may, if the chain of causation is unbroken, be said to have in fact resulted from the injury."

Hernia a Cause of Controversy

Hernia has always been the subject of much controversy. This is probably due to the fact that medical men are not entirely agreed among themselves as to what causes hernia. There are two theories—one that it must be the result of an accidental breaking down of the abdominal walls due to strain or overexertion, the other that such a hernia is an impossibility and that it must always be the result of a disease or a predisposition to hernia.

The Iowa Industrial Commissioner has fittingly stated the general rule of law on the subject when he said: "Hernia may or may not be compensable according to the rules commonly observed in various jurisdictions. Compensable hernia results from specific accident or incident involving unusual condition, such as a strain or a fall or other fortuitous experiences which may be definitely described as to time and circumstance, and attended by demonstrations of distress at the time the injury occurs. In cases where hernia is of gradual development, where alleged injury is unattended by distinct incident and at a date that cannot be definitely fixed, and when the workman is able to continue his service, arbitration cannot be encouraged as giving promise of compensation."

One authority has said: "A hernia, in order to be entitled to any indemnity, must appear suddenly, must be accompanied by pain, and must immediately follow an accident. There must be proof that hernia did not exist prior to the accident."

Opinion of a Medical Authority

A well-known medical authority has said: "The proviso that the injury to the inguinal region must have been due to direct violence, or that the accident or overexertion to which the hernia is attributed shall have been of a character capable of producing a hernia, needs no explanation. Since there might be much discussion of what produces accidents capable of producing hernia, the more specific statements given are welcome aids: Direct violence, slipping or falling while throwing a heavy weight, extraordinary exertion, whether extraordinary in an absolute sense or extraordinary from the standpoint of the physique or age of the individual, or the conditions under which the work was being performed.

"An industrial hernia is undoubtedly always small when it first appears, and to estimate its maximum size as that of an egg can hardly work an injustice. To me it seems less safe to say that in traumatic hernia the inguinal ring is always small, barely admitting the tip of the index finger. Brandenburg considered any ring which admitted more than the tip of the index finger, or the absence of a true inguinal canal, a predisposition to hernia. . . .

"A recent hernia is tender, and painful on manipulation, and an ecchymosis is not infrequently present. Immediate strangulation is common, and it is said that the majority of cases judged traumatic and granted compensation in Germany are cases in which the hernia was strangulated when it first appeared."

The employer cannot be charged with the payment of compensation in cases where the workman is uncertain as to the manner in which he received the hernia. If he cannot fix the time and the place and the manner definitely and to a certainty in the evidence, he has not suffered such a hernia as will entitled him to compensation.

If the hernia is the result of an actual accident, a traumatic injury, then it is compensable; if it appears gradually under circumstances bewildering even to the claimant, then it is not a compensable injury in that it is not accidental.

In those states where the payment of compensation is not based upon "accidental" injuries, but upon

"personal injuries," as in Massachusetts, then hernia will be compensated under circumstances not so favorably received in other jurisdictions where the line is more sharply drawn.

In a Wisconsin case it was held that a violent straining of the muscles, resulting in a rupture or other bodily hurt from physical overexertion in performing work is included within the term "accident" used in the compensation act. Thus, muscular spasm caused by straining the muscles of the right side while attempting to lift a heavy cement block is an accident within the meaning of the act.

In Iowa it was held that death resulting from a ruptured artery was not accidental when a factory workman stood on a chair and reached out to close a window during a rainstorm and did not slip or fall or lose his balance and nothing unforeseen occurred except the bursting of the artery.

In a New York case, the employee suffered from the result of a cerebral hemorrhage induced by overexertion. The claimant's physician testified that the injury was "rupture of the cerebral artery on the right side, producing a clot of blood on the brain and suffering the complete paralysis of the left side." The claimant was awarded compensation.

Electric Heat Treatment of Ball-Bearing Races

The Electric Furnace Co., of Alliance, Ohio, recently placed in operation an automatic electric heat-treating set for treating ball- and roller-bearing races at the Standard Roller-Bearing plant of Standard Steel & Bearings, Inc., Philadelphia, Pa.

This equipment is composed essentially of a through type of pusher furnace, an oil-quenching tank and an oil-drawing bath, all arranged in series for a continuous flow of material. Both the furnace and oil-drawing tank are electrically heated.

The flow of material through the heat-treating set is regulated by a clock contactor, which is shown, together with its electrical control, at the left of the furnace in Fig. 1. The intervals between contacts may be varied over a considerable range to accommodate different classes of material.

The hardening furnace (Fig. 1) is of the Electric Furnace Co.'s standard carbon resistor type, and is



FIG. 1. CHARGING END OF HEAT-TREATING SET



FIG. 2. CONVEYOR LIFTING CONTAINER FOR QUENCHING BATH PREPARATORY TO SLIDING INTO DRAWING TANK

rated at 150 kw. It is equipped with pyrometric control and for average tool steel is maintained at 1,525 deg. F.

The drawing tank has nichrome resistors immersed below the oil surface, and arranged along the sides of the tank, the oil being maintained at a temperature of about 350 deg. F. by means of an automatic temperature controller. About 40 kw. is required for the drawing tank when in operation and handling 1,000 to 1,200 lb. of material per hour.

In operation, rings or other small parts to be hardened are placed in perforated metal trays shown in Fig. 2, holding approximately 125 lb. These trays are then placed on a sill in front of the motor-operated pusher. At intervals corresponding to the setting of the clock contactor, the doors open and the tray is pushed into the furnace. At the same time a tray of material which has reached the correct hardening temperature is pushed out of the far end of the furnace and slides down an incline into oil, where it is quenched.

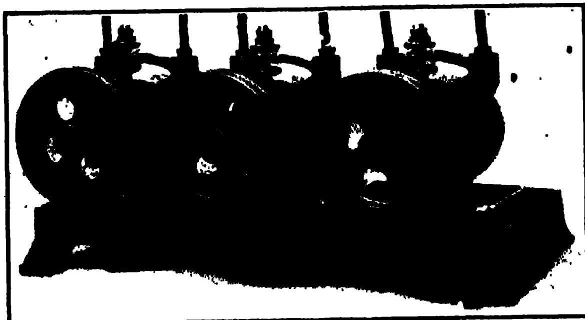
A motor-operated centrifugal pump, started when the door opens, forces a current of oil up through the perforated bottom of the tray almost with sufficient force to float the rings, the object being to chill the rings quickly and to prevent the formation of vapor films or pockets around the heated stock. The length of time the trays remain in the quenching bath is determined by the setting of a small synchronous-motor timing-element by means of which the time can be varied from 1 to 4.5 minutes. At the expiration of this determined time, the tray is removed from the bath by means of a motor-driven inclined sprocket chain shown in Fig. 2, the tray draining of surplus oil until another cycle commences, when a further movement of the chain feeds the tray into the drawing tank. Here, the trays move slowly and continuously forward carried on an independent sprocket chain, which is in turn supported on steel guides. The time required for a tray to pass through the drawing tank can be varied by a gear-set very similar to the speed-changing gears of a lathe.

This arrangement thus gives an exacting control of both time and temperature and is so flexible that it can be quickly changed to fit almost any schedule or conditions required in heat treatment.

New Type of High Vacuum Pump

The Newark Engineering & Tool Co. has recently developed a high vacuum pump. In most all cases, such pumps are immersed in oil to prevent leakage; but in this new design, the engineers have departed from the usual practice of having the pump body immersed in oil. The pump is sealed by means of oil, internally only, thereby saving all the oil used in the outer casing.

Owing to these new mechanical features, from 80 to 90 per cent of the oil can be saved as well as considerable trouble which is coincident with the use of oil.



HIGH VACUUM PUMPS FOR AUTOMATIC EXHAUST MACHINES

This pump was especially designed for use in the manufacture of incandescent lamps, and has proved adaptable for X-ray, rectifying, vacuum furnaces and scientific research.

The single pump weighs 50 lb. It has a 7½-in. pulley for round belt. A speed of between 275 and 300 r.p.m. is recommended with a ¼-hp. motor.

The accompanying illustration shows three pumps, mounted on a common pedestal, adaptable for automatic exhaust machines used in the lamp industry.

New Solder for Aluminum

The difficulties encountered in attempting to solder aluminum are familiar to all who have experimented with the multitude of so-called aluminum solders which have appeared within the last few years. One of the chief sources of annoyance has been the tendency for electrolytic corrosion to set in at the joint, the aluminum being corroded, since the components of these solders are electro-negative to aluminum. This difficulty has been successfully met and a new solder, the components of which are located so close to aluminum in the electrochemical series that electrolytic action is rendered negligible, has been placed on the market by the Rohde Laboratory Supply Co. of New York City.

This material—which is called "Al-Solder"—is applied at a temperature of about 500 to 600 deg. F., so that warping and other mechanical disturbances are avoided. After a moment's heating, an exothermic reaction takes place with the formation of an alloy. Since an alloy is formed with the aluminum, the durability of the joints is permanent and the seams can be made invisible by polishing, which is very desirable in instrument work, etc. Furthermore, the joint may be reheated without injury so that an additional piece may be joined on without any trouble.

Al-solder may also be used in soldering copper. It is a quick and ready oxide remover and flows in any commercial grade of soft solder under the most difficult conditions. It is hygroscopic and consequently must be kept in an airtight container.

Synopsis of Recent Chemical & Metallurgical Literature

Fatigue Strength of Aluminum.—In order that aluminum may maintain its present growth in output, W. A. GIBSON contends that the user should be convinced of the fact that castings and forgings of its alloys may be introduced into places where strength is most desirable, and weight but a secondary consideration. In his paper, "Fatigue and Impact Fatigue Tests of Aluminum Alloys," read before the 1920 meeting of the Society for Testing Materials, he presents the results of a long series of experiments, which show a sharp distinction between the alloys as cast and those as forged, the properties of the former being very sensitive to melting, molding and pouring practice. Testing in a White-Souther machine (rotating cantilever) and plotting stress against cycles on semi-logarithmic paper, the deviation from a straight line is very marked at low loads, bending upward in such a way that extrapolation would be sure to give largely excess safety. Cast aluminum is liable to vary widely as to yield point and proportional limits, yet the maximum stress, hardness, and the fatigue resistance are relatively close, showing that the ultimate depends upon a different combination of properties than the elastic strength. Only one series of cast iron fatigue tests were available, but it is located close to the curves for cast aluminum. Steady pounds are resisted better by ductile materials—thus the Charpy impact test is comparable to ductility measurements. This is not true for alternating non-impact tests, however.

If comparison is made between duralumin and carbon or nickel steel, weight for weight, the aluminum alloys are found to be equal or superior under impact fatigue, a type of stress ordinarily encountered in machine parts.

Nickeling Aluminum and Aluminum Alloys.—Up to the last few years the nickeling of aluminum and of its alloys has been considered impossible of realization with satisfactory results, especially as to good adherence of the nickel coating. LEON GUILLET and MAXIME GASNIER have studied this problem and have presented the results of their work before the French Academy of Sciences (*Comptes Rendus*, May 25, 1920, pp. 1253-1256). Micrographic examinations of nickeled products showed clearly that the adherence of the coating is a function of the efficient penetration of the nickel in the cavities of the product to be nickeled. Very satisfactory results were obtained on sand-blasted parts. The conditions influencing this operation are:

(a) Rapidity of the sandblast, which is a function of the pressure of the air used and of the airpipe.

(b) Size of the grains of sand.

(c) Time elapsed between sandblasting and nickeling.

(d) Thickness of the layer of nickel.

The conclusions to which they arrived are:

1. Best results are obtained by using sand passing through a 0.2 mm. (0.008 in.) mesh sieve.

2. The most convenient pressure for the sandblast is 1.5 kg. per sq.cm. (21.5 lb. per sq.in.).

3. The nickeling is not affected appreciably by the

length of time elapsing between the sandblasting and nickeling.

4. The best adherence is obtained when the thickness of the coating is not more than 0.01 mm. (0.0004 in.).

They have also worked on nickeling by using an intermediate layer of copper. The entire operation consists of:

Sandblasting with 0.2 mm. (0.008 in.) size sand under a pressure of 1.5 kg. per sq.cm. (21.5 lb. per sq.in.); nickelplating to a thickness of 0.006 mm. (0.00024 in.) which requires 0.5 hr. with a current of 0.8 amp. per sq.dm.; copperplating to a thickness of 0.02 mm. (0.00079 in.) which requires 2 hr. with a current of 1 amp. per sq.dm.; polishing; nickelplating to a thickness of 0.005 mm. (0.0002 in.) which requires 1 hr. with a current of 1 amp. per sq.dm.; polishing.

This last method of nickeling gives excellent mechanical and chemical results. The electrolytic baths used were:

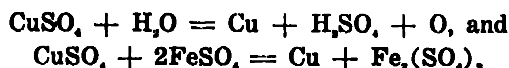
For nickeling: 150 g. nickel sulphate and 50 g. nickel-ammonium sulphate per liter of water.

For coppering: 150 g. copper sulphate and 20 g. sulphuric acid per liter of water.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Electrolytic Process.—In the electrolysis of impure copper solutions such as are obtained in leaching copper ores with sulphuric acid there is usually present ferric sulphate, which has deleterious effects on the efficiency of the operation. The presence of ferrous sulphate is not particularly harmful, however. During electrolysis copper is deposited at the cathode and sulphuric acid and ferric sulphate liberated at the anode:



$$CuSO_4 + H_2O = Cu + H_2SO_4 + O, \text{ and}$$
$$CuSO_4 + 2FeSO_4 = Cu + Fe_2(SO_4)_3$$

The ferric sulphate will combine with the copper deposited on the cathode and is reduced to the ferrous condition:

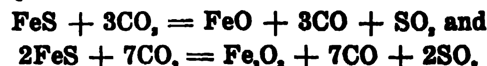


$$Cu + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4$$

The result of these reactions is a loss in current efficiency; if, however the ferric sulphate can be reduced by a comparatively cheap reducing agent, such as hydrogen sulphide or copper sulphide, sulphuric acid is regenerated and the ferric sulphate will not combine with deposited copper, the efficiency of the process being thereby improved.

Apparatus is described whereby the process can be carried out. (1,340,826; WILLIAM E. GREENAWALT, Denver, Col.; May 18, 1920.)

Production of Carbon Monoxide.—In order to reduce to a minimum the amount of carbonaceous material employed in the recovery of metals from their oxides ANTONIUS FOSS and B. J. HALVORSEN, of Christiania, Norway, treat the carbon dioxide obtained from the reduction of metallic oxides or from other sources with metallic sulphides in a suitable furnace. As an example iron sulphide will react with carbon dioxide as indicated in the equations:

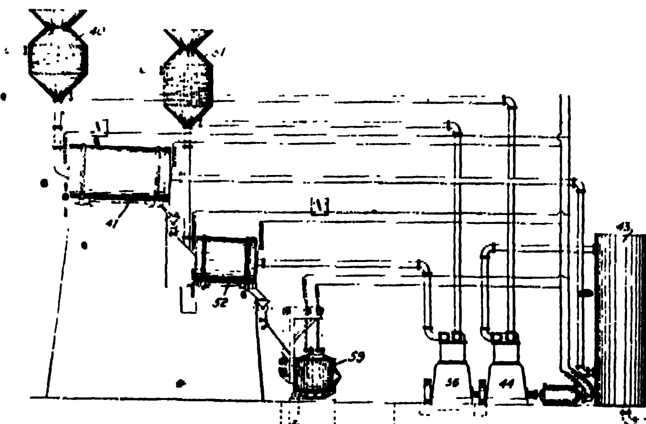


$$FeS + 3CO_2 = FeO + 3CO + SO_2 \text{ and}$$
$$2FeS + 7CO_2 = Fe_2O_3 + 7CO + 2SO_2$$

The reaction commences at about 600 deg. C., but proceeds better at higher temperature up to about 1,000 deg. C., if the sulphide treated is not fused. The sulphur dioxide is removed by scrubbing towers and may be used in the manufacture of sulphuric acid, sulphite of lime or liquid sulphur dioxide, and thus carries a substantial part of the cost of the process. (1,340,480; May 18, 1920.)

Production of Iron Without a Blast Furnace.—The modern blast furnace is the accepted apparatus for producing iron from its ores, but requires large-scale production, necessitating a large capital investment. It is also inefficient in consumption of fuel and in the utilization of relatively small sizes of ore, fuel and flux. GUYON F. GREENWOOD, of Georgeville, Que., has developed a metallurgical method and apparatus for the production of iron which avoids many of the disadvantages of the blast furnace. The essential features are the reduction of iron oxide by means of carbon with the exclusion of air in an electric resistance furnace and at a temperature and pressure favoring the production of carbon monoxide, the latter being used as fuel in a gas engine and generating electric energy utilized in heating the electric furnace.

The process is preferably carried out as illustrated diagrammatically in the figure. The furnace 41 produces coke from coal which is fed into the furnace from hopper 40 and preheated by the heat in the exhaust gases from the gas engine 44. The fuel for the engine is obtained from combustible gases from the coking of the coal after passing through scrubber 43. Ore and flux, together with the coke, are fed into furnace 52, the ore and flux being preheated in hopper 51 by the heat in the exhaust gases from the gas engine 56. The furnace 52 is maintained at a temperature of about 750 deg. C. and at a slight vacuum without the admission of oxygen. The iron oxides are reduced without producing a slag, and carbon monoxide results which is used as fuel for engine 56. The reduced charge is fed into the electric furnace 59, the impurities slagged off and the iron refined. A minimum amount of heat is wasted and sufficient power is developed by the gas engines to furnish the electric energy for the electric furnaces. (1,338,439; April 27, 1920.)



APPARATUS FOR THE PRODUCTION OF IRON WITHOUT A BLAST FURNACE

Coolidge Wrought Tungsten Patent Is Declared Valid

THE Coolidge wrought tungsten patent, under litigation for nearly five years, has been declared valid and infringed in a decision handed down early in July by Hugh M. Morris, Judge of the United States District Court, in the suit brought by the General Electric Co. against the Independent Lamp & Wire Co. of New Jersey.

In the court's opinion the following points in the development of ductile tungsten and the process for producing it were considered:

The history of tungsten for upward of a century after its discovery in 1781 is brief. . . . From the beginning of the nineteenth century efforts were made to cast it, reduce it to plates or draw it into wires, but, with certain possible exceptions which will be hereinafter considered, it was with frequency and uniformity pronounced hard, brittle, unworkable and non-ductile. As late as 1903 Sir Robert Hadfield, a leading metallurgist, in a paper read before the British Iron and Steel Institute, said: "As far as we know the metal tungsten, like chromium, is not malleable. If an absolutely pure metal could be obtained, possibly this statement might have to be modified, but the purest forms which the author has been able to obtain possess hardness, brittleness, and are not ductile either in the ordinary or heated condition." . . . Chemists and metallurgists continued to say that tungsten, whether cold or hot, was neither malleable nor ductile; that it could not be drawn into wires. For instance, in "The Petty Metals, Titanium, Tungsten, Molybdenum." by Truchot, published in 1905-6, it is said: "Like chromium, tungsten is not malleable or ductile, whether cold or hot. When pure, it is hard and brittle." In Roscoe & Schorlemmer's Treatise on Chemistry, revised by Sir H. E. Roscoe, F.R.S., and Dr. A. Harden, in 1907, it was stated: "The purest forms of tungsten at present obtainable are hard and brittle, and are not ductile either at ordinary temperatures or when heated." Even as late as 1910, in "Illumination and Photometry," by Prof. Wickenden of the Massachusetts Institute of Technology, this statement occurs: "The metallurgy of tungsten is very complex and the metal when refined is non-ductile." Consequently a problem remained to be solved. It was said: "The elimination of this excessive brittleness is the crux of the tungsten lamp problem."

Coolidge Revolutionizes Uses of Tungsten

The specific problem was how to make ductile a metal naturally and normally non-ductile. To the solution of this problem the lamp manufacturers in Europe and America bent their every energy. Coolidge solved it and produced wrought tungsten or "Coolidge metal" having properties differing most radically from those of the normal or natural tungsten metal. Tungsten is non-ductile, Coolidge metal is remarkably ductile; tungsten is absolutely brittle at ordinary temperatures, Coolidge metal is pliable and flexible; tungsten is fragile and easily broken, Coolidge metal is stronger than steel. The new metal is so ductile it may be drawn into wires uniform in quality miles in length; it is so flexible that it can be tied in a knot or used as a thread to sew on buttons; its tensile strength may run as high as 600,000 lb. per sq.in., while the tensile strength of steel piano wire, the material next in strength, is only about 400,000 lb. to the sq.in.

The announcement of the Coolidge achievement caused much comment. The United States Geological Survey Report for 1910, "Mineral Resources of the United States," published in 1911, says:

> No important new uses for tungsten came to the notice of the Survey during the year, but such wonderful improvements were made in the manufacture of tungsten incandescent electric-lamp filaments as to make their use amount almost to a new one. The General Electric Co. so developed the drawing of tungsten into fine wire that, as now made, it is about as strong as steel wire. This has made possible not only the shipping of tungsten lamps with a very small loss from breakage of the filament, but railroad trains and automobiles now carry tungsten incandescent electric lamps. To railroads this means a very great saving in electric power, with a consequent lessening of the weight of storage batteries used or a lengthening of their period of service per charge; or it means that a smaller dynamo will light the train. . . . The toughening of the filament has also made more practicable lamps of large candle power. Tungsten lamps are now used almost everywhere electric lighting is used.

. . . The ductile tungsten filament has gone into general use and has in large measure if not entirely supplanted all other filaments, including that of Just and Hanaman for incandescent electric lamps. It is less expensive to produce, yet it has far greater durability and utility than the squirted filament. It is a commercially new product of great utility having properties and characteristics unknown to the natural and normal tungsten, or, in fact, to any other material. . .

Characteristics and Method of Working Tungsten

We may now examine the characteristics of tungsten and the method of working it. A mass of crystalline tungsten, however fine grained, is entirely brittle cold. It may be worked above its annealing temperature, which is exceedingly high, but after being so worked it is still entirely brittle cold. If the mass is worked at a high temperature, but below its annealing temperature, the grains are deformed. This hardens the metal and makes it less workable at the immediate working temperature, but increases its workability at some lower temperature, an entirely new phenomenon. If worked at the lower temperature, the same results follow. At each stage the grains are drawn more and more until a very fibrous structure is produced which is pliable and ductile cold. If the metal is heated to its annealing temperature at any working stage or after the working has been completed, it reverts to its crystalline condition in which it is entirely brittle cold. The most workable condition of other metals is the least workable condition of tungsten and *vice versa.*

It is thus seen that the characteristics of tungsten are peculiar to it and that the method of working tungsten is an exact reversal of the metal-working processes of the prior art, although heat and mechanical forces are used in each. Never with the exception of tungsten have heat and mechanical forces produced ductility in a metal. Furthermore, tungsten is made ductile by working it under its annealing temperature, a method by which brittleness in other metals is uniformly produced.

The Important Thing in the Patent

The important thing in this patent, at least so far as the process claims are concerned, is, therefore, a method of procedure, not the particular means by which the method shall be practiced, yet the specifications point out not only the method of procedure but also complete mechanical devices whereby the method can be put into

operation, though the mechanism is not claimed by the patentee. Working tungsten was the ultimate problem, not the preliminary one. It was first necessary to produce the tungsten in a proper condition, next get it into a mass such as an ingot, billet or slug suitable for working, and lastly to work that ingot into the desired filament or wire.

Each problem presented innumerable difficulties. Coolidge's first discovery consisted in finding that a small filament of tungsten prepared in a particular way could be hammered at high temperatures and its form thereby changed. Upon becoming cool the metal so hammered was still brittle. Experiments disclosed that the brittleness was due not to impurities, but was inherent in the nature of the metal itself. Coolidge attempted to draw a filament through wire-drawing dies. He failed. Subsequently, by heating the filament, the die through which the filament was being drawn and the tongs by which it was being drawn, he succeeded. He succeeded in putting the filament through a second die with a draft a fraction of a thousanth of an inch less than that of the first die. The process was continued with die after die. Eventually he discovered that the remarkable thing had been accomplished, yet the filament so ductilized was little more than a laboratory curiosity owing to the smallness of the original mass. The process, though it produced the new product, produced it only in small quantities and at great cost. It seemed inherently inapplicable to ingots of substantial size. Nevertheless Coolidge through years of effort and failure evolved a process by which masses of tungsten substantial in size could be converted into filaments ductile when cold. The method so evolved is the process that revolutionized the electric lamp industry and is the preferred process of the patent. . . .

Defendant Attempts to Show Anticipation

The solution of the tungsten problem involved invention. The defendant, however, cites certain publications and patents to show anticipation of the Coolidge invention. Among the most important of these is the publication of Moissan, an eminent French scientist, who, in his work "Le Four Electrique," published in 1897, translated by Lenher, when referring to tungsten, said: "When it is porous, like iron, it has the property of being welded by hammering much below its melting point." Moissan placed in a carbon crucible a mixture of tungsten oxide and carbon and heated it by an electric arc. The outer portion of the resulting mass contained carbon absorbed from the crucible and was very hard and brittle. The inner portion of the mass was the porous tungsten of which Moissan speaks. Coolidge tried the Moissan process. He testified: "We were able to take from the center portions which were very porous which could be, by hot working with a hammer, compacted to a certain extent. Upon attempting to really hot-work these pieces—that is, in the sense of elongating them—they cracked all to pieces. It seemed clear to me from Moissan's publication that all he had done was to produce a porous mass of tungsten which could, by hammering, be compacted to a certain extent, and when we, with excellent facilities, tried to go further and make some use of this material, we were unable to do so." . . .

Moissan's Contribution a Laboratory Experiment

Moissan's contribution was a laboratory experiment that has never proved of any value in practice. Apparently it taught the world nothing. It is inconceivable that Just and Hanaman could have attained fame by their inferior fragile squirted tungsten filament if those skilled in the metal-working art had learned from Moissan years before how to work tungsten. Dr. Liebmann testified that he performed the Moissan operation and says: "I obtained a product which tallied exactly with the description given by Moissan." But where Moissan stopped, there Dr. Liebmann stopped. I look in vain among defendant's exhibits for a filament drawn from the porous tungsten of Moissan. I am constrained to conclude, therefore, that the Moissan metal cannot in fact be worked and that Moissan did not in truth discover that tungsten is susceptible of being worked. But this conclusion is not supported by inference alone, for enlarged photographs of the Moissan metal hammered by Dr. Liebmann show very little, if any, deformation but do show very large cracks. Manifestly Moissan did not teach Dr. Liebmann how to work tungsten.

Court Rejects Anticipation Plea

Again, it expressly appears from the record that to be workable the tungsten mass must be coherent, not porous. To convert the porous mass into a coherent mass "welding must take place." Yet "under the most ideal conditions commercially available at the present time" tungsten cannot be welded. It would seem that Moissan's hammering closed only a few pores in the spongy mass. We have seen above what Sir Robert Hadfield in 1903 said of tungsten. Moissan failed to teach him to perform the process or make the product covered by the Coolidge patent. Just and Hanaman and Dr. Coolidge, as well as Sir Robert Hadfield and Dr. Liebmann, were uninstructed by the Moissan publication. In fact I do not find that the disclosure of the Moissan publication was sufficient to enable any one to perform the process or make the product covered by the ductile tungsten patent. It necessarily follows that if the Moissan publication did not instruct how to work tungsten in a practical sense it did not disclose that tungsten could be so worked, or that Moissan discovered that it was susceptible of being so worked. "Novelty," says Walker in his work on patents, Sec. 57, "is not negatived by any prior patent or printed publication, unless the information contained therein is full enough and precise enough to enable any person skilled in the art to which it relates to perform the process or make the thing covered by the patent sought to be anticipated." . . .

Dr. Liebmann was formerly an employee of the General Electric Co., where he also worked in its laboratory "on the problem of developing the ductile tungsten filament." He left the employ of the plaintiff about August, 1910, when Coolidge's work had been substantially completed, and went to Europe, where he was employed until October, 1912, in connection with the manufacture of carbon lamps and squirted filament tungsten lamps. He returned to America in October, 1912, and "started at once to install modern machinery for the manufacture of tungsten lamps in the factory of the Independent Lamp & Wire Co. (the defendant), and also to proceed with the manufacture of ductile drawn wire for these lamps." Hence it appears that Dr. Liebmann learned how to draw tungsten according to the plaintiff's method. . . .

For the foregoing reasons that main product and process claims are in my opinion valid. . . . All the claims of the patent therefore will be held valid and infringed.

Current Events
in the Chemical and Metallurgical Industries

Minerals Separation-Miami Contempt Proceedings Dismissed

On July 13, Judge Morris in the United States District Court, Wilmington, Del., gave an order dismissing the petition of Minerals Separation which sought to punish the Miami Copper Co. for contempt of court and restrain that company from continuing to operate its processes which, according to affidavits of Minerals Separation experts, are not more than a mere colorable change in the plaintiff's process. In making the order, the court said:

> The plaintiff now charges by petition that the processes employed by the defendant since it stopped using the three processes heretofore adjudged to be infringements are also infringements and prays that the defendant be adjudged guilty of contempt and/or that a further injunction be issued specifically enjoining and restraining the defendant from using such processes.
>
> The defendant by its answer denies that the new methods infringe the patents sued upon and moves that the rule to show cause be vacated and the petition dismissed upon the ground that, due to the character of the new processes, the present procedure is inappropriate for the determination of the questions raised. The plaintiff contends that it appears from the facts alleged that the new methods are the same in principle as those adjudged to infringe and that the defendant has made only a substitution of equivalents resulting in a mere colorable change in the process, while the defendant contends that those facts disclose that it no longer uses the agitation of the patent. Much testimony touching the processes in question has been introduced by the plaintiff before the master upon the accounting now being had. In fact, it is conceded that little testimony of any other nature has so far been presented.
>
> The present issues do not seem to make necessary a review of the cases upon contempt or those in which the procedure by supplementary injunction has been recognized. Although embarrassed by the fact that I do not possess the full knowledge of the intricate facts of this case that might have been gained had the testimony and argument in the main cause been heard by the court as now constituted, I am, nevertheless, satisfied that the facts set up by the petition are not of the character required to sustain a judgment of contempt. Nor do I find that the practice of enlarging an injunction or granting a supplementary injunction has been adopted in this circuit. But, be that as it may, in view of the nature of the new processes used by the defendant as charged by the petition, the questions raised thereby, and the decision of the Circuit Court of Appeals in this case, 244 Fed., 752, I am of the opinion that the plaintiff must obtain the relief to which it is entitled, if any, touching the new processes, either through the proceedings now being had before the master and the decree to be entered thereon, or by a new bill and not otherwise.

On the same day the court gave the following order relative to making Minerals Separation North American Corporation a party plaintiff in addition to Minerals Separation, Ltd.

> I have considered the application of plaintiff for leave to file a supplemental bill, submitted with the motion, setting up the filing of a disclaimer as to claims 9, 10 and 11 of patent No. 835,120, and making Minerals Separation North American Corporation an additional party plaintiff, together with the several objections made by the defendant to the filing of the proposed bill, and am of the opinion that it would be in furtherance of justice to grant the leave to file but without prejudice to the defendant to renew its objections, in a manner then suitable, to the bill when filed, if it be so advised. An order so providing may be submitted.

Progress in the Federated American Engineering Societies

The Technical Club of Dallas, at its meeting June 2, made application for membership in the American Federated Engineering Societies, being the first local organization to apply. At its recent annual meeting held in Montreal, June 28, the American Institute of Chemical Engineers discussed favorably the question of becoming a member of the F.A.E.S. and referred the matter to the Council for definite action at its meeting on July 25. The opinion was expressed, however, that the Institute should be a member of the new organization, even if an assessment was necessary to meet the financial obligation. The board of directors of the American Institute of Electrical Engineers adopted a resolution at its meeting at White Sulphur Springs, W. Va., June 30, approving membership of the Institute in the F.A.E.S., but deferring action on account of the fact that a new board will be instituted Aug. 1. The board of directors of the American Institute of Mining and Metallurgical Engineers discussed the matter favorably on June 25, and referred it to the finance committee to devise means of meeting the financial requirements. The Civil Engineers are expected to consider the report of their delegates to the Washington Conference at the annual convention of their society at Portland, Ore., Aug. 10 to 12.

Eastman Kodak Co. Purchases Plant at Kingsport, Tenn.

The American Wood Reduction Plant at Kingsport, Tenn., has recently been purchased by the Eastman Kodak Co. This plant, located on a 35-acre site, was built during the war and taken over by the Federal Government for the manufacture of wood alcohol. Original cost of the plant is said to have been $1,100,000.

As the Eastman Kodak Co. is one of the largest users of wood alcohol and has had to depend on the outside market, it has decided to manufacture its own supply. Engineers and officials of the company are said to be now considering the advisibility of enlarging the plant to manufacture other chemicals used in photography. The price paid for this property by the Eastman interest is not stated, but it is understood to be about $1,000,000.

The immense potential possibilities of the South as a source of power, raw materials and plant sites have only recently begun to be appreciated. As an instance of the effect of establishing a large industry in the South it might be stated that the town of Kingsport, which in 1910 had a total population of 200, now boasts of over 10,000 inhabitants. If more industrites could be interested in the possibilities of the South, a great deal could be done to develop its natural resources.

Federal Trade Commission Hearings at San Francisco in Minerals Separation Case

Hearings for the purpose of obtaining further testimony in this case were conducted in San Francisco July 6 to 10, 1920. These were a continuation of the hearings begun in New York on April 7 and were to be continued in Salt Lake City, Utah, July 13 to 17, and in Denver, Col., July 19 to 24. The charges against Minerals Separation and other respondents are the suppression of competition by oppressive license agreements and falsely claiming exclusive rights in excess of actual rights in respect to apparatus and processes used in the separation and concentration of ore. They are also charged with discriminating between different users of their apparatus and processes.

E. H. Nutter, chief engineer, and Messrs. Quigley and Roberts, of the San Francisco engineering office of the Minerals Separation North American Corporation, were interrogated regarding the methods used in obtaining lists of companies which were probable or possible infringers of the M. S. process, together with the uses made of these lists and the attitude and action of the field representatives toward infringers. The testimony brought out the fact that no methods which could be considered as threatening or oppressive were in use by the employees or had been in use during the period covered by the indictment. Instruction had been explicit to field representatives to state their connection with Minerals Separation and the object of the intended visit to the plant of a probable infringer, also that the field men should get permission from the official in charge of the plant to inspect the flotation operations.

Other witnesses expressed their opinion as to the terms of the license and the amount of royalty charged licensees. These were declared to be oppressive and excessive. But counsel for respondent brought out the fact that a profit could not be made from the material treated by any other process known to the witness.

Mr. Hoover's Testimony

The most interesting testimony was that of Theodore J. Hoover, now head of the department of mining and metallurgy of Stanford University. Mr. Hoover was general manager of the Minerals Separation London company from September, 1906, until the end of 1910, or during the period in which the flotation process of the company was being developed. At the time of leaving the employ of Minerals Separation Mr. Hoover took with him files containing information for his guidance in the capacity of consulting engineer to the company. This office he did not fill, and as a result of ex parte proceedings all documents and papers taken by Mr. Hoover were examined by officials of Minerals Separation Company and an agreement reached upon those to be returned.

According to Mr. Hoover's testimony he entered the employ of Minerals Separation under a contract which stipulated that during or after his employment he could not impart to any third party any information regarding the flotation process. These terms were considered at the time to be oppessive in that they restricted his possible future activities. This clause in the contract was also the subject of discussions between Mr. Hoover and Mr. Ballot, president of Minerals Separation, during the term of Mr. Hoover's employment with the company. These terms were never receded from by contract but are evidenced in certain letters to Mr. Ballot written by Mr. Hoover in which he expressed what he considered to be fair terms. The Minerals Separation Company has not modified or released Mr. Hoover from the terms of the contract since he left its employ.

Among the exhibits requested in evidence from Mr. Hoover was a manuscript written by H. S. Sulman and H. K. Picard, consulting engineers and two of the inventors of the Minerals Separation flotation process, on the theory of flotation. This manuscript was among the papers which were inspected by the Minerals Separation officials, but was not discussed in particular at the time of the legal proceedings nor was its return mentioned subsequent thereto.

Considers Company's Claims Excessive and Fraudulent

In August, 1919, Mr. Hoover entered the employ of the Miami Copper Co. as consulting engineer. As a result of the knowledge gained through investigation of the evidence afforded in the Miami case, Mr. Hoover became convinced that the claims made by Minerals Separation for its process were so far in excess of the claims made by certain of the inventors of the process as set forth in their treatise as to "constitute an attempt to perpetrate a fraud upon the court." Mr. Hoover resigned his position with the Miami Copper Co., and after consulting legal opinion and obtaining advice from brother engineers, Mr. Hoover considered it to be his public duty to offer the manuscript in evidence. This manuscript was the same one that was submitted in evidence in the flotation litigation between Minerals Separation and the Miami Copper Co., upon which we commented editorially in our June 30 issue.

T. A. Rickard, editor of the *Mining and Scientific Press*, testified that the effect upon the mining industry which resulted from the company's policy of preventing the publication of information regarding the flotation process was to retard development both of the industry as a whole and the process in particular.

Shortage of Anhydrous Ammonia

A serious shortage of anhydrous ammonia, which may occasion great losses of foodstuffs which must be placed in cold storage during the summer, is reported by the Bureau of Markets of the Department of Agriculture. There is no shortage of raw materials. The scarcity of the finished product is attributed to a number of reasons.

During the war large quantities of ammonia were sent to France in drums. The priorities which have existed on ocean freights have precluded the return of these drums. For a long time manufacturers withheld orders for new drums, expecting from week to week that arrangements would be made for the return of the drums in France. Finally when nothing definite could be learned as to when the drums could be returned, orders were placed for new drums. This was about the time of the steel strike and a long delay resulted before delivery could be made. The drums had no more than begun to arrive when the coal strike cut down the output of byproducts from the coke ovens. The next difficulty to arise was the switchmen's strike which has retarded deliveries so as to round out an unusual combination of difficulties which accounts for the fact that there are no reserve stocks of ammonia.

The Bureau of Markets is taking steps to acquaint all users of ammonia with the situation and will urge them to do all possible to prevent waste and to make efficient use of the supplies which they have on hand.

Convention of the American Electroplaters' Society

The large attendance at the convention of the American Electroplaters' Society, held in Rochester, N. Y., July 1 to 3, 1920, and the willingness of the platers and chemists present to discuss their problems and to impart information, augur well for the future of the American Electroplaters' Society, of which this is only the eighth annual convention. The noticeable dearth of technical papers may be accounted for in part by the unsettled business and labor conditions which have no doubt prevented many platers from trying out new or improved methods or of perfecting them to the point for publication. In future conventions such papers probably will be more numerous; in fact they must be, if the society is to progress. To this end the manufacturer should encourage and assist his plater to develop and apply new methods and thus avoid stagnation. In those plants where both chemists and platers are employed, they should work together in a spirit of co-operation, to improve processes and to secure more exact knowledge of existing methods. If for example in each of twenty-five such plants, definite data upon some phase of plating were secured each year, there would be no dearth of papers for future conventions, and a mass of reliable information would soon be accumulated.

Use of Hydrofluoric Acid in Nickel-Plating Solutions

The subject which received most consideration in the technical sessions was the use of hydrofluoric acid in nickel-plating solutions. This substance has been used so successfully by E. G. Lovering of Detroit that he has christened it the "magic fluid." A preliminary report from the Bureau of Standards described the results of experiments upon the application of hydrofluoric acid in nickel baths used for the electrolytic production of printing plates in the new plant of the Bureau of Engraving and Printing.

This paper was discussed at length by Messrs. Lovering, Allen, Woodmansee, Herrick, Madsen, Hogaboom, Slattery and others. From the paper and its discussion it seems to be clearly established that nickel can be deposited from solutions containing hydrofluoric acid (or ultimately nickel fluoride or fluoborate) more rapidly than from the ordinary solutions. These deposits are brighter and have a finer structure and higher tensile strength, and are harder but less ductile than deposits produced in the customary baths. The fluoride deposits are therefore more difficult to buff, but for the same reason they show greater resistance to abrasion. Such deposits are likely to be especially valuable in electroplating, or for the nickel plating of objects subject to abrasion in service. The whole subject is greatly in need of more exhaustive investigation, and the chief value of this discussion was to emphasize the great possibilities involved in the study of even such well-known baths as are used in nickel plating.

Other Papers—Plants Visited

Other papers discussed in the meetings were:

"Anode Hooks," by H. F. Sperry.

"Nickel Plating on Zinc and Die Castings."

"Sanitation in Plating Rooms," by G. Wilson.

"Ball Burnishings," by R. Hazucha.

"Oxidizing (i.e., coloring) Aluminum," by F. J. Hanlon.

Among the plating plants visited were those of the Eastman Kodak Co., the Taylor Instrument Co., the Bausch & Lomb Optical Co., the Northeast Electric Co., the Van Bergh Silver Plating Co. and the General Railway Signal Co. These manufacturers are to be congratulated upon their broad-mindedness in permitting such inspection, thus advancing the educational aims of the Electroplaters' Society.

Broadening of Membership Discussed

The most important business before the convention was the question of admitting assistant foreman platers to associate membership in the society. At present active membership is restricted to actual foreman platers; associate membership is restricted to persons who were formerly foreman platers but are now salesmen for plating supply houses, and to chemists or metallurgists interested in electroplating. After lengthy discussion, the amendment to admit assistant foremen as associate members was referred to a referendum vote of the society. The decision upon this question will be of great importance, not alone to the electroplaters, but also to the chemists and manufacturers, since the future progress of the whole electroplating industry depends upon an intelligent and sympathetic education of those younger men, who will in time become the actual foremen and superintendents.

Co-operation in Standardization Agreed Upon

The society accepted an invitation from the Metal Finishers Equipment Association to co-operate with it in the standardization of materials and supplies used in electroplating. Clear definitions of terms and materials in some cases (with tentative specifications of purity or quality) will be valuable alike to the electroplaters and their employers, and will enable purchasing agents to secure on the open market supplies of adequate and uniform quality, and will permit chemists connected with plating plants to conduct more intelligent control work than when supplies are purchased with no definitions or specifications. The committee on research and standardization, to which this matter was referred, can render great service through such co-operation.

Aid for Research Work

To the same committee was referred the matter of securing, for manufacturers interested in plating, financial support for research work, to augment the limited funds now available for such work at the Bureau of Standards. In this discussion it was emphasized that such support should be viewed by each manufacturer, not as a contribution, but as an investment, certain to yield results of value to him as well as to the whole plating industry.

Social Features

The entertainment and social features of the convention were very successful and enjoyable. In thus supplementing the business and technical sessions by social gatherings, the delegates and guests not only were entertained, but were also afforded that opportunity for acquaintance and for intimate discussion of their daily problems which is after all one of the chief advantages of a convention, especially for a society which is still almost in its infancy, but showing a healthy growth. Ten years ago such a gathering would have been unheard of in the plating industry. With the spirit shown at this meeting, there is no question of the still greater growth and development in the next decade.

Fertilizer Manufacturers Seek Government Aid to Relieve Car Shortage

Strong representations have been made to the Interstate Commerce Commission and to the committee on car service of the American Railway Association in an effort to secure more cars for the fertilizer industry. Between now and the middle of September, 40,000 carloads of mixed fertilizer should be distributed. In addition 25,000 carloads of fertilizer raw materials must be moved in the near future. It was pointed out that fertilizers were given the benefit of priorities during the war, and that the need for their use is greater now than then.

As a result of persistent efforts farmers have been induced to place their fertilizer orders early this year. This was done with the idea of lowering the peaks in the distribution of fertilizer. The plan worked out more successfully than had been anticipated, but the distribution cannot be carried on in the required volume, as cars cannot be obtained in sufficient number to take care of the transportation.

Due to inability to secure phosphate rock many acid plants have been forced to close, the committee on car service was told. Practically every plant in the country is receiving its supplies in a hand-to-mouth manner. Not less than 250 cars daily are required to handle the necessary phosphate rock from Florida. About 50 per cent of the cars needed are being furnished at present. The same is true of the car supply on the Louisville & Nashville, over which most of the Tennessee phosphate rock reaches fertilizer plants.

The committee which came to Washington to take up the matter of car supply was composed of Spencer L. Carter, Virginia-Carolina Chemical Co.; DeWitt Brown, Armour Fertilizer Works; Robert B. Allen, Smith Agricultural Chemical Co.; T. A. Bosley, Virginia-Carolina Chemical Co.; A. S. Key, Federal Chemical Co.; H. Braunlich, American Agricultural Chemical Co.; J. W. Hoyt, International Agricultural Corp.; D. A. Dashiell, F. S. Royster Guano Co.; Douglass Ober, G. Ober & Sons; A. D. Whitamore, American Cyanamid Co.; Frank G. Moore, Davison Chemical Co.; J. W. White, International Agricultural Corp.

The committee was accompanied by representatives of the Bureau of Soils.

Industrial Research Laboratories in America

A bulletin just issued by the National Research Council lists more than 300 laboratories maintained by industrial concerns in America, in which fundamental scientific research is carried on. The bulletin gives a brief account of the personnel, special equipment and particular kind of research carried on in each of the laboratories listed.

Industrial research laboratories have increased notably in number and activity, both in America and Great Britain, since the beginning of the war, because of the lesson vividly taught by the war emergency. It was only by a swift development of scientific processes that the Allies and America were able to put themselves in a position first to withstand and then to win a victory over Germany's science-backed armies and submarines. And it is only by a similar and further development that America and the Allies can win over Germany in the economic war-after-the-war, now being silently but vigorously waged.

Cellulose Section, A. C. S., Considered

Under the able guidance of Jasper E. Crane, a Cellulose Symposium was organized as a part of the program of the Division of the American Chemical Society last April. One of the objects of this symposium was to ascertain whether a Cellulose Section, if formed, would secure the interest and support of a sufficiently large number of chemists. The object of such a section would be to promote intercourse and co-operation among the chemists in the various cellulose industries. This group constitutes one of the largest and most important of American industries; all branches of it are intimately concerned in the problems of cellulose, and it seems highly desirable to promote technical activity in this country along these lines. The proposed section would serve as a clearing house for papers and information on cellulose technology, and should also play an important part in promoting research on the chemistry of cellulose.

The symposium at St. Louis was distinctly successful. The interest shown was so great that it was voted to hold a second Cellulose Symposium under the auspices of the Industrial Section at the Chicago meeting during the week of Sept. 6. At this time the advisability of forming a permanent Cellulose Section will be considered. An interesting program is being arranged, and a large attendance of those interested in cellulose is anticipated.

Titles of papers or suggestions for the symposium should be sent to G. J. Esselen, Jr., 30 Charles River Road, Cambridge, 39, Mass.

Foundrymen's Exhibit Grows

The growing appreciation of the important work that the American Foundrymen's Association is doing manifests itself in the increased demand for exhibition space at the Convention and Exhibit to be held at Columbus, Ohio, Oct. 4 to 8. Already 51,000 sq.ft. of exhibition space has been contracted for, with 85 per cent of last year's exhibitors to be heard from.

A number of new exhibitors will be on hand this year, especially in the general shop equipment and machine tool lines, as there is a growing appreciation of the extraordinary purchasing power represented in the A. F. A. attendance, aside from strictly foundry requirements. This is due to the fact that many of the men interested in the foundry meetings also operate machine shops.

A striking feature of these annual shows is the large percentage of operating exhibits demonstrating the equipment by duplicating actual working conditions. Last year more than 50 per cent of the 208 exhibitors used power, 170 motors being in operation and 31 exhibitors using compressed air for demonstrating purposes.

Golden Mine Experiment Station Moves to Reno, Nev.

The Secretary of the Interior has approved the transfer of the Golden Mine Experiment Station to Reno, Nev. The station in the future will be known as the Rare and Precious Metal Station and will be conducted in co-operation with the University of Nevada, which will construct a building especially designed for the use of the station. The building is to cost at least $30,000. Dr. S. C. Lind will continue in charge of the station at its new location.

Personal

F. T. AGTHE has resigned as plant engineer of the Missouri mills of the Atlas Portland Cement Co., Hannibal, Mo., to join the staff of the Hardinge Co., at York, Pa.

Dr. SCOTT E. W. BEDFORD of the University of Chicago spoke before the Chicago Chemists' Club recently on the organization of the Army educational system.

Dr. W. D. COLLINS, formerly in charge of the analytical reagents laboratory of the Bureau of Chemistry, is now in charge of the U. S. Geological Survey, Quality of Water Division, succeeding R. B. Dole. Dr. Collins will continue as chairman of the American Chemical Society committee on standardized reagents and apparatus.

Dr. F. G. COTTRELL, director of the Bureau of Mines, has been designated to succeed Van H. Manning as a member of the interdepartmental defense board of the Council of National Defense.

Dr. P. M. GIESY, formerly of the dyestuff research department, Grasselli Chemical Co., is now in charge of the beta-naphthol control laboratory of the Calco Chemical Co., Bound Brook, N. J.

ELMER ALLEN HOLBROOK has assumed the position of assistant director of the Bureau of Mines, succeeding Dr. Cottrell, who is now director of the bureau. Mr. Holbrook entered the bureau in 1917 as supervising mining engineer at the Urbana station, during the first half of 1919 was made acting chief engineer and in July, 1919, was made superintendent of the Pittsburgh Experiment Station, where he was until called to Washington, July 1, 1920.

Dr. LYNN HAROLD HOUGH has resigned from the presidency of Northwestern University, Evanston, Ill., on account of ill health.

M. O. LEIGHTON and Major C. T. CHENERY, members of the American Society of Civil Engineers, and A. C. OLIPHANT, associate member of the American Society of Mechanical Engineers and the American Institute of Electric Engineers, have formed a copartnership under the name of M. O. Leighton & Co., with offices at 700 Tenth St., Washington, D. C., for the purpose of engaging in general engineering practice and industrial representation before the Federal departments. Mr. Leighton and Major Chenery will continue for the time being as chairman and secretary of the National Public Works Department Association, while Mr. Leighton and Mr. Oliphant will continue service in the Washington office of Engineering Council pending the displacement of that body by the Federated American Engineering Societies.

H. C. MILLER, formerly superintendent of the Round Valley Tungsten Co. of California, is now petroleum production engineer with the Standard Oil Co. at Taft, Cal.

CLIVE SEYMOUR NEWCOMB, metallurgical engineer, has resigned his position with the Dorr Co. to become consulting engineer with the Mutual Chemical Co. of America and the Phosphate Mining Co. His address is 55 John St., New York City.

G. ARNCLIFFE PERCIVAL, chief chemist, The Edison Swan Electric Co., Ltd., Ponders End, Middlesex, England, has returned to England after spending several weeks visiting chemical industries of the Eastern United States.

J. LEONARD REPLOGLE, president of the Replogle Steel Co., sailed for England on July 1.

GUY C. RIDDELL, consulting metallurgist, formerly in charge of metallurgical and mining problems for the U. S. Tariff Commission, is now secretary and consulting engineer of the Wah Chang Trading Corp., 233 Broadway, New York City.

G. C. SPENCER has succeeded W. D. Collins, in charge of the analytical reagents laboratory of the Bureau of Chemistry, Washington, D. C.

Bureau of Mines Strengthens Its Chemistry Department

The chemical side of the investigations being conducted at a number of the Bureau of Mines experiment stations is to be greatly strengthened. The personnel at the stations has been arranged so as to make this possible, with O. C. Ralston at Seattle, L. H. Duschak at Berkeley, C. M. Bouton at Salt Lake City, Dr. Thomas B. Hine at Tucson and Dr. S. C. Lind at Reno.

Current Market Reports

The Iron and Steel Market

Pittsburgh, July 16, 1920.

Shipping conditions at the blast furnaces and steel mills have been still poorer in the past week, due to car shortage, the increase in which is generally attributed to the operation of order No. 7 of the Interstate Commerce Commission according to priority to the coal mines. A large steel interest reports its shipment during the first twelve days of this month less than in the same period of June by an amount equal to about 20 per cent of its productive capacity, but such an experience is probably unusual. A rough guess would be that shipments are at about two-thirds of production, assuming that all the steel made is carried through to finished form according to customers' specifications, the fact being that the amount of steel held in unfinished or semi-finished form is increasing.

The iron and steel interests have objected to order No. 7, not so much to the essence of the order as to the terms by which it has been interpreted, as the average railroad has interpreted the term "coal car" in the present circumstances to include all flat-bottom gondolas measuring more than 30 in. high inside. Partly no doubt on account of the representations of the iron and steel industry, the Interstate Commerce Commission, while extending the order for another thirty days, from July 21, modifies the terms whereby coal cars shall include only those gondolas that are 36 in. or more inside measurement. The industry is of opinion that the difference means a very considerable number of cars, and a corresponding increase in car supplies is to be expected.

Among the representations before the commission there was a statement that in four districts, not including the East or the Chicago district, there was an accumulation of steel awaiting shipment amounting to 1,416,727 tons. Including the districts not taken into the reckoning, and allowing also for steel accumulated, for convenience, in unfinished or semi-finished form, the total of the steel accumulations seems likely to be in the neighborhood of 2,500,000 tons. In this report of a fortnight ago estimates were mentioned ranging from 2,000,000 to 3,000,000 tons.

FINISHING DEPARTMENTS CLOSED

The tendency is stronger to close finishing departments and accumulate steel in ingot or semi-finished form. There is little if any voluntary curtailment of steel ingot or of pig-iron production. At one large plant approximately half the finishing mills are closed at a time, but work is alternated, week about, so as to give all the men some employment. At another large plant there is the exceptional case of practically all finishing departments being closed since the first of the month, to resume next week, while the production of pig iron and steel has continued.

In the case of finished steel there is the double difficulty that storage facilities are already taxed, and that steel made to customers' specifications may prove quite unacceptable at the late date at which the steel will be shipped. When that time will be no one ventures to predict, since shipments are still below production and the beginning has not yet been made in clearing off the accumulations.

The Steel Corporation's increase of 38,351 tons in unfilled obligations in June is small compared with the average

of 550,000 tons a month increase of twelve months preceding, but on the other hand it is remarkable that there should have been any increase when the steel market was so dull. The independents as a whole did not boom nearly as much as they produced, nor even as much as they shipped. Month by month the disparity in order books between the Steel Corporation and the independents has increased, on account of the divergence in prices quoted. In actual orders the independents probably do not have on books a tonnage equal to more than two or three months additional of production, though they have made various arrangements with customers to supply them for later periods on the basis of "price ruling at date of shipment." The Steel Corporation, on the other hand, had 10,978,817 tons of unfilled obligations July 1, this of course including something like three-quarters of a million tons of steel produced but not shipped and therefore not invoiced. The corporation's output at 90 per cent of capacity up to April 1, 1921, would be about this same tonnage.

Steel Prices Practically Stationary

The stocks of steel made to customers' specifications but not shipped are perhaps the best preventive possible of price cutting. At any rate, the large independents show no disposition to reduce prices. On bars, shapes and plates their prices are, respectively, 3c., 3.10c. and 3.25@3.50c., as they have been for months past. There has been the still higher market, made by smaller mills for prompt shipment, and this market continues to trend downward. In plates there is approximately a parity between prompt shipment and any shipment the independents can make. The Steel Corporation's prices for the three products remain at 2.35c., 2.45c. and 2.65c., respectively.

Pig Iron Advancing

With pig iron accumulating at the furnaces on account of lack of shipping facilities, with deliveries very scant and prices for early deliveries advancing, the pig-iron market appears to be riding for a fall, but it is a market that has furnished surprises before. Both bessemer and basic have sold in the past week at $46, valley basis, an advance of $1 a ton over the previously quoted market. Foundry iron remains nominally at $45, valley, but may easily show an advance if any prompt demand of consequence develops.

While pig iron is high relative to steel and shows a greater spread over its pre-war average than do commodities in general, the price must be considered low when Connellsville furnace coke is bringing $18 per net ton at ovens for spot or prompt shipment. Why furnaces are willing to pay such a price, even on the very limited tonnages they buy, is not explained, and every week it is reported that the furnaces will no longer patronize the market.

Shipments of Lake Superior iron ore down the lakes in June amounted to 9,233,566 tons, a fair showing for the month, but on account of the backset in April and May the season total to July 1 is only 16,440,505 tons, against 16,008,419 tons in the same period in 1919, whereas a large increase is desired on account of the heavier operation of blast furnaces this year. There is, however, no danger of an actual shortage of ore, and once more the expressed fear of a shortage is seen to be groundless.

The Chemical and Allied Industrial Markets

New York, July 16, 1920.

The break and sudden decline in prices, frequently predicted to occur in other markets, has hit the crude rubber trade and stopped all business. A member of the trade recently returned from Akron on a tour of inspection in company with a man representing English interests reports that matters are in the worst possible condition and that after having seen numerous tire manufacturers he is convinced that there will be no activity until late fall and possibly not until next year.

The present situation is directly traceable to several causes, viz., the enormous quantities of war surplus material in the Indian market brought about a reversal of form, to the extent that the spot market was quoted below future delivery. This being an unhealthy condition, buying interests realized that a drop was bound to come and held off waiting for a decline. Tire manufacturers by the vast expansion and additions to their plants had given promise of increasing their output about 10,000 tires a day each, which would necessitate a considerably larger amount of rubber. These plans, however, were abandoned when automobile manufacturers cancelled their rubber contracts because of inability to deliver automobiles by freight.

These conditions are verified by a report of the failure of one of the largest and oldest firms engaged in the crude rubber trade. This concern has on its books *Para*, upriver, bought at 55c., and some idea of the amount of money involved can be gained by comparing that price with current quotation of 35c., which it is not beyond reason would be shaded to 32c. on a large order.

General Chemicals

There has been no change in the position of the chemical market during the current week, buying interests still holding off for lower prices. Despite the lax demand, supplies have not appreciably increased and although there have been some drops, noticeably on *acetic acid*, glacial, which is being generally quoted at $14.50@$15.50 per cwt., a quotation on a 5-ton lot as low as $13.50 per cwt. has been heard. The market has preserved a tone of firmness in the main. Some other items that have changed during the period are *tannic*, tech., now listed at 60@70c. per lb. on car lots, and *ammonium carbonate*, powder, which has come up from 17½c. to 18c. per lb. The demand for *copperas* that has been so strenuous lately seems to have fallen off slightly and as a result stocks are somewhat improved, but sales ranging as high as $3.50 per cwt. are still being placed. Both *sodium* and *potassium chlorate* have been advanced by producers and the new levels are 11@12c. per lb. for the former and 15@17c. for the latter, while *sodium bichromate* changed in the other direction, with the low mark at 24c., against 26½c. of the previous week. The pressure of increased demand has forced *calcium chloride*, fused lump, up slightly, and it is now difficult to obtain this material at less than $25 per ton, while the average price seems to be about $30; in sympathy with this the *granulated* grade also rose, with 3@3½c. per lb. the prevailing quotation at present. Spot supplies of *aluminum sulphate* are giving way under the heavy buying pressure, with 5½c. per lb. for commercial and 6½c. for iron-free grade being asked for material in second hands. Producers are behind in their contracts and are consequently unable to take any new business.

Coal-Tar Products

The recent 5c. flat rise on crude bases put into effect by producers seems to have had the effect of strengthening the market. The improvement in the money situation has also helped in this matter, and although there has been no general increase, nevertheless the downward tendency noticed on several items for the past two weeks has stopped. *Naphtha*, flake, is still unobtainable at a reasonable figure, but for those who must have this material it can be obtained on the spot market at 20c. per lb. One large producer is still delivering on contracts written at 9c., and upon arrival it immediately goes into second hands, probably changing three or four times before reaching ultimate consumer. *Alpha naphthylamine* is somewhat easier and it is possible to locate material at 53c. and lower, while *aniline oil* and *salts* are firmer, although there has been no change in price.

Naval Stores

The present volume of business, which vastly improved over the last month, would be still greater if the matter of delivery from the South could be adjusted. The low scale of prices on *rosins* prevailing at present is due to the arrival in the primary market of the new crop, which for the present has relieved the pressure in this market. As can be seen from the table, there is slight increase over last week's prices and the listed prices are those which are expected to be in effect for some time. *Turpentine* came up slightly during the week and is now quoted at $1.58 per gal., against $1.49 of the previous period.

The Baltimore Market

Baltimore, July 14, 1920.

There is still considerable doubt in the minds of fertilizer manufacturers as to whether they will be able to secure sufficient labor and cars to fill their orders, and the situation during the next few months will be a question of production rather than of selling. This applies particularly to acid phosphate, and the dry mixers who have not yet covered for their wants will doubtless experience difficulty in inducing producers to take on further commitments for car shipments.

Acid Phosphate. The market remains very strong, and the various producers are still more closely sold up than they have been for some time past. It is next to impossible to place orders for car shipments for any important tonnage, and on account of the labor situation none of the producers is disposed to take on business for shipment in buyers' bags either for July, August or September, as it is doubtful whether they will be able to secure either sufficient cars or labor to fill orders from their regular customers. The nominal quotation for 16 per cent grade in bulk remains at $20 per ton f.o.b. cars, with run of pile testing 17 to 18 per cent being quoted for water shipment at $19 per ton, basis 16 per cent A.P.A. However, there is very little buying interest manifested by such buyers as are in position to take delivery by water. The market seems stationary at present level, and producers are more concerned in securing crude materials and filling orders now on their books than in market fluctuations.

Tankage. While the Chicago market remains firm at prevailing levels of $7.75 and 10c. f.o.b. Chicago, with apparently no anxious sellers, there has been a slight easing up in the nearby Eastern markets, where producers are not in position to carry large stocks, and some sales have been made during the past week as low as $8 per unit of ammonia and 10c. per unit of B.P.L., basis c.a.f. Baltimore, which is considered somewhat below the general market, and any important inquiries would doubtless have the effect of driving prices up to $8.15@$8.25 and 10c. Baltimore.

Nitrate of Soda. While little buying interest is being manifested, the market remains firm, with prices for summer and fall deliveries ranging from $3.85 to $4, depending upon tonnage and deliveries, and January-April shipments nominally quoted at $4.10@$4.15. In view of the fact that the production of sulphate of ammonia, on account of the coal situation, is not up to expectations, some of the manufacturers are inclined to show interest in nitrate.

Potash. Up to the present time the new schedule on the Alsatian product for delivery over the balance of this year has not been announced, and in the absence of this manufacturers are showing little interest in the German product, on which prices were fixed some weeks ago. There is considerable speculation as to whether there will be any difference between the Alsatian and German products, although it is generally conceded that higher prices will rule than prevailed last season. There is very little demand for spot potash, and muriate is being firmly held at $2.65 per unit, with very small stocks of either kainit or manure salt. There is a vessel due late this month from which muriate is obtainable at $2.50@$2.60, kainit at $2.25@$2.35, and manure salt at $2.15@$2.25. For August-September arrival these prices could be shaded about 5 per cent.

Fish Scrap. The prevailing prices on this article have proved so attractive and so much higher than the fish factories have realized for their product for some years past that quite a number of contracts have been booked, subject to catch and "if made," thus assuring producers of at least $7.50 and 10c. for the dry scrap, f.o.b. their factories. Fish scrap on this basis figures lower than other animal ammoniates.

Bone Meal. **The market is practically bare of both raw and steamed bone meal, but such small stocks of 3 and 50 per cent as are obtainable are being held as high as $54 per ton, in buyers' bags, f.o.b. Baltimore, and even at this price there is only a limited tonnage offered. While the demand for 4½ and 45 per cent raw bone meal is light, resale lots are offering at $63 per ton, packed in second hand bags, f.o.b. Baltimore, but on account of price being so high buyers are going very cautiously in their purchases.**

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0 65 - $0 75
Acetone	lb.	$0.15 - $0 20	21 - .22
Acid, acetic, 28 per cent	cwt.	3 50 - 3.75	4 00 - 4 50
Acetic, 56 per cent	cwt.	6 50 - 7 50	8 50 - 9 50
Acetic, glacial, 99½ per cent. carboy	cwt.	13 50 14 00	14.50 - 15 00
Boric, crystals	lb.	.15 - .15½	.16 - .19
Boric, powder	lb.	15 - 15½	.16 - .20
Citric	lb.	.80 1.00	1.17 - 1 18
Hydrochloric (nominal)	cwt.	2.00 - 3 00	3.10 - 4 00
Hydrofluoric, 52 per cent	lb.	.12 - .14	.14½ .1½
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - 16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - 07
Molybdic, C. P.	lb.	4.00 - 4 50	4.50 - 5 00
Muriatic, 20 deg. (see hydrochloric).			
Nitric, 40 deg.	lb.	.06 - .07	07½ - .08½
Nitric, 42 deg.	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.60 - 65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.25 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 16.00	
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	16 00 - 17.00	18 00 - 20.00
Sulphuric, 66 deg., drums	ton	26 00 - 28.00	-
Sulphuric, 66 deg., carboys	ton		-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35 00	40.00 -
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.60
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.		.80 - .85
Tungstic, per lb. of WO	lb.		1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.		3.25 - 3.30
Alcohol, Methyl, pure	gal.		3.50 - 3.55
Alcohol, denatured, 188 proof (nominal)	gal.		1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.		1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05	.05½ - .06
Alum, potash lump	lb.	.07½ - .08¾	.09 - .09½
Alum, chrome lump	lb.	.15½ - .18	.19 - .20
Aluminum sulphate, commercial	lb.	.02 - .03	.03½ - .05½
Aluminum sulphate, iron free	lb.	.03 - .04	.04½ - .06½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ - .10¾	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ - .13½	.13½ - .14½
Ammonium nitrate	lb.	.09 - .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ -
Amylacetate	gal.		5 00 -
Amylacetate tech	gal.		4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .23
Barium chloride	ton	150 00 - 160 00	
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.09½ - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Brimstone (see sulphur, roll)			
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3 55	
Calcium carbide	lb.	.04½ - 04½	.04¾ - .05½
Calcium chloride, fused, lump	ton	25 00 - 30 00	35.00 - 45.00
Calcium chloride, granulated	lb.	.01½ - .01¾	.02 - .03½
Calcium hypochlorite (bleaching powder)	cwt.		4.50 - 6.50
Calcium peroxide	lb.		1.50 - 1.70
Calcium phosphate, monobasic	lb.		.75 - .80
Calcium sulphate, pure	lb.		.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	12 - .13	.13½ - .15
Carbonyl chloride (phosgene)	lb.		.80 - 1.05
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.		2.00 - 2.05
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.		.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.	1 35 -	1 40 -
Ethy Acetate pure (acetic ether 98% to 100%)			1 75 -
Formaldehyde, 40 per cent (nominal)	lb.		.57 - .65
Fusel oil, ref	gal.		5.25 - 6 00
Fusel oil, crude (nominal)	gal.		
Glauber's salt (see sodium sulphate)			
Glycerine	lb.		.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4 40 - 4.45
Iron oxide, red	lb.		03 - .20
Iron sulphate (copperas)	cwt.		2.75 3.50
Lead acetate, normal	lb.		.13½ - .16
Lead arsenate (paste)	lb.	.11 - 12	13 - 17
Lead nitrate, crystals	lb.		.90 - 1.00
Litharge	lb.	.14 - .15	15½ - .16
Lithium carbonate	lb.		1.50 -
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.		3.25 - 3.60
Nickel salt, double	lb.		.14 - .16
Nickel salt, single	lb.		.13 - .14
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.		.35 - .37
Potassium bichromate	lb.	.40 - .45	.46 - .47

	Unit	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 - $0 56	$0.57 - $0.58
Potassium bromide, granular	lb.	.80 - .85	.90 - .95
Potassium carbonate, U. S. P.	lb.	..... -	.47 - .50
Potassium carbonate, crude	lb.	.20 - .25	.26 - .28
Potassium chlorate, crystals	lb.	.15 - .17	.18 - .20
Potassium hydroxide (caustic potash)	lb.	.30 - .33	.35 - .38
Potassium iodide	lb.	...... -	3.35 - 3.60
Potassium nitrate	lb.	.15 - .17	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 - ......
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$225.00 - 240.00	...... - ......
Rochelle salts (see sodium potas. tartrate)		...... -	...... - ......
Salammoniac (see ammonium chloride)		...... -	...... - ......
Sal soda (see sodium carbonate)		...... -	...... - ......
Salt cake	ton	...... -	40.00 - 50.00
Silver cyanide (nominal)	oz.	...... -	1.25 - ......
Silver nitrate (nominal)	oz.	...... -	.74 - .76
Soda ash, light	100 lb.	-	3.50 - 3.60
Soda ash, dense	100 lb.	-	3.55 - 3.65
Sodium acetate	lb.	.08½ - .09	.09½ - .12
Sodium bicarbonate	100 lb.	2.45 - 2.60	2.75 - 3.50
Sodium bichromate	lb.	.24 - .27½	.28 - .29
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 10 00
Sodium bisulphite Powered	lb.	.06 - .06½	.07 - .10½
Sodium borate (borax)	lb.	09 .10	.11 - 12
Sodium carbonate (sal soda)	100 lb	1.50 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	11 12	.12½ - 13
Sodium cyanide, 96-98 per cent	lb.	.25 .30	.32 - .35
Sodium fluoride	lb.	.18 -	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	...... -	6.50 - 7 50
Sodium hyposulphite	lb.	......	.03 .04
Sodium molybdate	lb.	2.50 -	3.25½ - ..
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	16 - .18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03¾ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - 32
Sodium silicate, solution (40 deg.)	lb.	.01½ .01¾	.02 - 02½
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.04 - 05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 - 1.70	1.75 - 2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½ - .10	.10½ - .11
Sodium sulphite, crystals	lb.	.03½ -	.04 - .06
Strontium nitrate, powdered	lb.	.17½ - .18½	.19 - 20
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	25.00 30.00	.... - ....
Sulphur dioxide, liquid, cylinders	lb.	.09	.10 - .12
Sulphur (sublimed), flour	100 lb.	...... -	3.80 4 35
Sulphur, roll (brimstone)	100 lb.	...... -	3.40 3.90
Tin bichloride (stannous)	lb.	.42½ - .44	.45 - .46
Tin oxide	lb.	...... -	...... - ......
Zinc carbonate, precipitate	lb.	.16 - .18	.18 - .20
Zinc chloride, gran	lb.	.13 - 13½	.13½ - .17
Zinc cyanide	lb.	.45 - .49	.50 - 60
Zinc dust	lb.	.11 - .12	.13 - .15
Zinc oxide, U. S. P.	lb.	.10½ - .13½	.. .. -
Zinc sulphate	lb.	.03½ - .03¾	.04 - 06

Coal-Tar Products

NOTE --The following prices are for original packages in large quantities:

	Unit			
Alpha naphthol, crude	lb.	$1.40	-	$1.50
Alpha naphthol, refined	lb.	1 60	-	1.70
Alpha naphthylamine	lb.	.53	-	.55
Aniline oil, drums extra	lb.	.34½	-	.36
Aniline salts	lb.	.41	-	.45
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10
Benzidine, base	lb.	1.35	—	1.40
Benzidine, sulphate	lb.	1.15	—	1.25
Benzoic acid, U.S.P.	lb.	.90	—	1.00
Benzoate of soda, U.S.P.	lb.	.80	—	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35	—	.40½
Benzol, 90%, in drums (100 lb.)	gal.	.33	—	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate (nominal)	lb.	3.50	—	4.00
Beta naphthol, sublimed (nominal)	lb.	....	—	....
Beta naphthol, tech (nominal)	lb.	.80	—	.88
Beta naphthylamine, sublimed	lb.	2.25	—	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23		.25
Cresylic acid, 97-99%, straw color, in drums	gal	1.05	—	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00	-	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65	—	.75
Dichlorbenzol	lb	.08	—	.10
Diethylaniline	lb.	1 50	—	1.60
Dimethylaniline	lb.	1.35	—	1.45
Dinitrobenzol	lb.	.30	—	.37
Dinitroclorbenzol	lb.	.32	—	.35
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.40	—	.45
Dinitrotoluol	lb.	.40	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal	.38	—	.40
Diphenylamine (nominal)	lb.	80	—	.85
H-acid (nominal)	lb.	2 25	-	2.50
Metaphenylenediamine	lb.	1.23	-	1.30
Monochlorbenzol	lb.	.18	—	.20
Monoethylaniline	lb.	2.00	—	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	—	..
Naphthaline, flake	lb.	....	—	.19
Naphthaline, balls	lb.	....	—	.19
Naphthionic acid, crude	lb.	.75	—	.85
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.50
Nitro-toluol	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.35	—	.45
Para-amidophenol, base	lb.	2.50	—	3.00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlor-benzol	lb.	.08	—	.12
Paranitraniline	lb.	1.40	—	1.50
Para-nitro-toluol	lb.	$01.35	—	$01.50
Paraphenylenediamine	lb.	2.50	—	2.75
Paratoluidine	lb.	2.00	—	2.50
Phthalic anhydride	lb.	.65	—	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridin	gal.	2.00	—	3.50
Resorcin, technical	lb.	4.25	—	4.50
Resorcin, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	—	.52
Salicylic acid, U. S. P.	lb.	.50	—	.60
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	—	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.35	—	.....
Toluol, in drums	gal.	.38½	—	.40½
Xylidine, drums, 100 gal	lb.	.50	—	.65
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

	Unit			
Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.39	—	.40
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	1 00	—	1 05
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.88
Carnauba, No. 3, North Country	lb.	.36	—	.37
Japan	lb.	.19	—	.19½
Montan, crude	lb.	.23	-	.25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¾	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	—	12½
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½	—	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½	-	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	—	.18½
Stearic acid, single pressed	lb.	.25	—	.26
Stearic acid, double pressed	lb.	.26	—	27
Stearic acid, triple pressed	lb.	.27	—	28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

	Unit	
Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal	1 75
Hardwood oil, f.o.b. Mich., sp. gr, 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

	Unit			
Rosin B-D, bbl	280 lb.	$12.25	—	$16 00
Rosin E-I	280 lb.	16.10		16 75
Rosin K-N	280 lb.	16 25	-	16 35
Rosin W. G.-W. W.	280 lb.	16 50	—	16 70
Wood rosin, bbl	280 lb.	15 00	-	
Spirits of turpentine	gal.	1 58	—	.
Wood turpentine, steam dist	gal.	. .	.	. . .
Wood turpentine, dest. dist	gal.	.....	—	..
Pine tar pitch, bbl	200 lb.	.....	-	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	-	15 00
Retort tar, bbl	500 lb.	15.00	-	15.50
Rosin oil, first run	gal.	.67	—	...
Rosin oil, second run	gal.	.70	-	..
Rosin oil, third run	gal.	.87	—	.. ..

Solvents

	Unit	
73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

	Unit			
Para—Upriver fine	lb.	$0.34½	—	$0.35
Upriver coarse	lb.	.24	—	.24½
Upriver caucho ball	lb.	.26	—	.26½
Plantation—First latex crepe	lb.	.32½	—	.33
Ribbed smoked sheets	lb.	.33	—	.33½
Brown crepe, thin, clean	lb.	.32	—	.32½
Amber crepe No. 1	lb.	......	—	.35

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

	Unit			
Castor oil, No. 3, in bbls	lb.	$0.17	—	$0.18
Castor oil, AA, in bbls	lb.	.19	—	.19½
China wood oil, in bbls	lb.	.16	—	.16½
Cocoanut oil, Ceylon grade, in bbls	lb.	.16	—	.17
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.18	—	.18½
Corn oil, crude, in bbls	lb.	.16	—	.16½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10	—	.11
Cottonseed oil, summer yellow	lb.	.18½	—	.19
Cottonseed oil, winter yellow	lb.	.21	—	.22
Linseed oil, raw, car lots (domestic)	gal.	1.10	—	...
Linseed oil, raw, tank cars (domestic)	gal.	1.30	—	....
Linseed oil, boiled, car lots (domestic)	gal.	1.35	—	....

Olive oil, commercial	gal.	3 75 —	
Palm, Lagos	lb.	10½ —	.11
Palm, bright red	lb.	10 —	.10½
Palm, Niger	lb.	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	13 —	.15
Peanut oil, refined, in bbls	lb.	.22 —	.24
Rapeseed oil, refined in bbls	gal.	1.70 —	1 72
Rapeseed oil, blown, in bbls	gal.	1.80 —	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb	16 —	16½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	.11

FISH

Winter pressed Menhaden	gal.	$1 17 —	$1.18
Yellow bleached Menhaden	gal.	1.20 —	1 22
White bleached Menhaden	gal.	1.23 —	1 24
Blown Menhaden	gal.	1 30 —	1 32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton*	$22 00 —	25 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00 —	20 00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8 00 —	10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00 —	25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16 00 —	19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12 00 —	..
Barytes, floated, f.o.b. St. Louis	net ton	26 50 —	28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11 00 —	11 25
Blanc fixe, dry	lb.	05½ —	.06
Blanc fixe, pulp	net ton	60 00 —	80 00½
Casein	lb	15 —	.18
Chalk, domestic, extra light	lb.	.05 —	06
Chalk, domestic, light	lb.	.04½ —	05½
Chalk, domestic, heavy	lb.	04 —	05
Chalk, English, extra light	lb	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o b. mines, Georgia	net ton	9 00 —	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00 —	15 00
China clay (Kaolin) powdered, f.o b. Georgia	net ton	18 00 —	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00 —	12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00 —	40 00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50 —	8 00
Feldspar, crude, f.o.b. Maine	net ton	7 50 —	10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00 —	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00 —	20 00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00	20 00
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00 —	
Fuller's earth, powdered, f.o.b. Fla.	net ton	18 00 —	
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	...... —	01
Graphite (dust facing grade 50%) Ashland, Ala	lb	...... —	02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	...... —	05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	...... —	10
Graphite, crucible, 85% carbon	lb.	...... —	08
Graphite, crucible, 88% carbon	lb.	.... —	09½
Graphite, crucible, 90% carbon	lb.	.... —	10½
Pumice stone, imported, lump	lb.	04 —	50
Pumice stone, domestic, lump	lb.	.06 —	
Pumice stone, ground	lb.	.04 —	07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.... —	10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17 00
Quartz, lump, f.o.b. North Carolina	net ton	5 00	7.50
Shellac, orange fine	lb.	1 40	
Shellac, orange superfine	lb.	1 50 —	
Shellac, A. C. garnet	lb.	1 05 —	1 15
Shellac, T. N.	lb.	1 20 —	1 30
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont.	ton	9 50 —	14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	9 00
Talc, rubber grades, f.o.b. Vermont	ton	9.00 —	15 00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15 00
Talc, imported	ton	60 00	70 00
Talc, California Talcum Powder grade	ton	20 00	35 00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	80	90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45	53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45-	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75-	
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40-	...
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90	
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90-	100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55-	...
Silica brick, f.o.b. Birmingham	1,000	51-	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50-	55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	19 —	22
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	20 —	21
Ferro-manganese, 76-80% Mn	gross ton	190 00 —	225.00
Spiegeleisen, 18-22% Mn	gross ton	75.00 —	....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 50 —	3.00
Ferro-silicon, 10-15%	gross ton	60 00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90 00
Ferro-silicon, 75%	gross ton	150.00 —	160 00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.70 —	.85
*Coke, foundry, f.o.b. ovens	net ton	18.00 —	19 00
*Coke, furnace, f.o.b. ovens	net ton	17.50 —	18.50
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	...	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02	....
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	85	90
Manganese ore, chemical (MnO_2)	gross ton	75 00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	1 00 —	
Monazite, per unit of ThO_2	unit	42 00 —	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	
Pyrites, Spanish, furnace size, c.i f., Atlantic seaport	unit	16½	
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12	14
Pyrites, domestic, fines	unit	12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	15	.25
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7 00	..
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6 50	7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2 75	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb	2.75 —	3 00
Vanadium pentoxide, 99%	lb	12.00 —	14 00
Vanadium Ore, per lb. of V contained	lb.	1.00 —	2 50
Zircon, washed, iron free	lb.	.10	

*Nominal

Non-Ferrous Metals

York arkets

	Cents per Lb.
Copper, electrolytic	19 00
Aluminum, 98 to 99 per cent	33 00
Antimony, wholesale lots	8 00
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	50.25
Lead, New York, spot	8.50@8.75
Lead, E. St. Louis, spot	8 35@8.40
Zinc, spot, New York	8 25
Zinc, spot, E. St. Louis	7 90

OTHER METALS

Silver	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1 75
Platinum	oz.	80@85
Iridium	oz.	300
Palladium	oz.	75@80
Mercury	75 lb.	90@92

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40 00
High brass wire and sheets	30 25
High brass rods	25 00
Low brass wire and sheets	28 50
Low brass rods	29 00
Brazed brass tubing	43 25
Brazed bronze tubing	41 75
Seamless copper tubing	34 00
Seamless high brass tubing	33 00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23 00@23.50
Copper, heavy machinery comp	14 50@15.00
Copper, heavy and wire	14 25@14.75
Copper, light and bottoms	12 75@13.75
Copper, heavy cut and crucible	15 50@16.00
Brass, heavy	9 25@10.00
Brass, light	7 25@ 7.75
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.00
Lead, tea	4 50@ 5.00
Lead, heavy	7 00@ 7.50
Zinc, scrap	5 00@ 5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3 97	$3 47	$5.50	$3 37	$3 97	$3.47
Soft steel bars	4 62	4 12	3.37	5 00	3 27	3 87	3.37
Soft steel bar shapes	4 62	4.12	3.37	....	3.27	3 87	3.37
Soft steel bands	6.32	5.32	4.07	6.25	..	..	..
Plates, ¼ to 1 in. thick	4.68	4.17	3.67	5 00	3 57	4 17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

NAUGATUCK—The Naugatuck Chemical Co. will soon award the contract for the construction of a 4-story, 60x80-ft. plant addition. Estimated cost, $75,000. Lockwood, Greene & Co., Federal St., Boston, engrs.

STAMFORD—The Perfection Enameling & Painting Co., Main and Grove Sts., plans to build a 3-story, 100x125-ft. manufacturing building.

Illinois

BUCKLEY—The Bd. Educ. plans to build a 1-story, 82x115-ft. high school. An experimental laboratory will be installed in same. Estimated cost, $65,000. J. N. Coleman, 6257 St. Lawrence Ave., Chicago, archt.

CHICAGO—The Great Western Smelting & Refining Co., 600 West 41st St., plans to build a smelting plant consisting of three large 1-story units and an office building on Union Ave. and 51st St. Estimated cost, $1,000,000. Henry L. Newhouse, 4630 Prairie Ave., archt.

Indiana

PORTLAND—The Portland Oil & Refining Co. plans to build a refinery. H. J. McConoley, secy. and treas.

Iowa

BAYARD — The Consolidated School Dist. is building a 2-story, 75x187-ft. grade and high school here. A chemical and physical laboratory will be installed in same. Estimated cost, $180,000.

IOWA CITY—The State Bd. Educ. plans to build a library and chemistry building at the University of Iowa. Estimated cost, $2,000,000. W. H. Bates, secy.

OTTUMWA—The Bd. Educ. is having plans prepared for the construction of a 3-story high school here. Chemical laboratories will be installed in same. Estimated cost, $700,000. Croft & Boerner, 833 Palace Bldg., Minneapolis, archts.

WOODWARD—The city rejected all bids for the construction of a disposal plant here. Estimated cost, $25,000. M. I. Evinger, Davidson Bldg., Des Moines, engr.

Kansas

PAOLA—The city has awarded the contract for furnishing filters to the Pittsburgh Filter Co., 429 Rialto Bldg., Kansas City, Mo., at $10,900.

Kentucky

LOUISVILLE—The Dixie Belle Refining Co., 701 Inter Saw Bldg., is receiving bids for the construction of a refinery on Western Parkway. Estimated cost, $500,000. C. B. Haun, archt. Noted July 7, 1920.

Massachusetts

CAMBRIDGE—The city is having preliminary plans prepared for the construction of a filtration plant. Estimated cost, $600,000. Johnson & Benham, 150 Nassau St., New York City, engrs.

EAST EVERETT—The Boston Varnish Co. will soon receive bids for an addition to the varnish manufacturing building here. Estimated cost, $30,000. Charles L. Betton, 31 Exchange St., Lynn, archt.

SPRINGFIELD—The Brightwood Brass Fdry., 365 Birnie Ave., will build a 1- and 1½-story, 52x72-ft. foundry addition. Estimated cost, $15,000. Work will be done by day labor. Noted May 19.

SPRINGFIELD—The Davitt Iron Fdry., 191 Liberty St., will build a 1- and 2-story, 55x105-ft. foundry. Estimated cost, $15,000. Work will be done by day labor.

WATERTOWN—Lockwood, Greene & Co., archts., 60 Federal St., Boston, will soon receive bids for the construction of a 1-story, 200x230-ft. foundry at the plant for the Walker & Pratt Mfg. Co., 31 Union St., Boston.

WORCESTER—The Worcester Pressed Steel Co., Barber Ave., will build a 2-story plant addition. Estimated cost, $25,000. Work will be done by day labor.

Michigan

KALAMAZOO—The Bd. Educ. plans to construct a junior high school. A small chemical laboratory will be installed in same. R. A. LeRoy, 122 Pratt Bldg., archt.

Minnesota

MINNEAPOLIS—The Bd. Educ. will soon receive bids for the construction of a 4-story, 220x300-ft. senior high school on 20th Ave., N. E. and Quincy St. A chemical and physical laboratory will be installed in same. Estimated cost, $700,000. E. H. Enger, 3018 Third Ave., S., archt.

RENVILLE—The Bd. Educ. will receive bids about Aug. 15 for the construction of a 2-story, 146x273-ft. high and grade school. A chemical laboratory will be installed in same. Estimated cost, $280,000. Croft & Boerner, 833 Palace Bldg., Minneapolis, archts. Noted May 19.

New Jersey

SHILOH—The School Bd. of Hopewell Twp., care of W. S. Garrison, Roadstown, plans to build a 2-story, 60x122-ft. high school addition on Salem Bridgeton Rd. A chemical laboratory will be installed in same. Estimated cost, $90,000. H. A. Hill, Broad St. Bank Bldg., Trenton, archt.

New York

LONG ISLAND CITY—The Stein Hall & Co., Inc., 61 B'way, New York City, has awarded the contract for the construction of a 4-story factory on 6th St. and Jackson Ave. to the Turner Constr. Co., 244 Madison Ave., New York City. Estimated cost, $400,000.

WEST POINT—Congress, Wash., D. C., appropriated $18,000 for labor and material for the construction of a new dry cleaning, sterilizing and disinfecting building at the Military Academy here and $12,000 for the purchase and installation of machinery and equipment in same.

Ohio

CINCINNATI—Readings, Panzer & Martin, archts., Palace Theatre Bldg., will soon award the contract for the construction of a 1-story, 100x157-ft. chemical warehouse on Dana Ave. for the E. K. Shannon Chemical Co., Dana Ave. and the Cincinnati, Lebanon & Northern R.R.

EATON—The city plans to construct a filtration plant for the local waterworks including filters, etc. Estimated cost, $27,500.

LIMA—The city is having preliminary plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, $1,000,000. Fuller & McClintock, 170 B'way, New York City, engrs.

South Dakota

MITCHELL—The Sisters of the Presentation Order will soon receive bids for the construction of a 3-story, 40x160-ft. hospital. A chemical laboratory will be installed in same. Estimated cost, $125,000. Edwin H. Lundie, 530 Endicott Bldg., St. Paul, archt.

Virginia

HARRISONBURG—The city plans to construct a 3,000,000-gal. filtration plant, etc. Estimated cost, $500,000. Roberts Eng. Co., Charleston, W. Va., engr.

Quebec

LEVIS—The Levis Pulp & Paper Co. will receive bids until Aug. 1 for the construction of a 100-ton pulp mill on St. Romuald Rd. Estimated cost, $500,000. G. Breakey, Breakeyville-Levis, engr.

MONTREAL—The Standard Iron & Chemical Co., 524 Ambrose St., will soon receive bids for a 4-story addition to its plant here. Estimated cost, $100,000.

Ontario

BELL RIVER—The Fraser & Brysow Lumber Co., Ltd., Castle Bldg., Ottawa, will soon receive bids for the construction of a ground wood pulp mill. Estimated cost, $300,000.

CHATHAM—The city is having plans prepared for the construction of a pumphouse including mechanical sand filters, etc. Estimated cost, $50,000. E. A. James Co., 36 Toronto St., Toronto, engr.

FORT WILLIAM—John G. Sutherland, archt., Dayton, O., will receive bids until Aug. 1 for the construction of a pulp and paper mill at the mouth of the Mission River, for the Fort William Pulp & Paper Co., Ltd. Estimated cost, $1,000,000.

KINCARDINE—The Town Council will receive bids about Aug. 2 for the construction of a filtration plant. Estimated cost, $15,000. Mr. Dallyn, Parliament Bldgs., Toronto, engr.

PORT ARTHUR—The Nipigon Fibre & Paper Mills, Ltd., will receive bids until Aug. 15 for the construction of a 40-ton pulp mill in the Nipigon Dist. Estimated cost, $200,000. J. A. Little, engr.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Colliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Co-ordinating Chemical Conventions in 1921

AN EXCELLENT suggestion relative to a group of chemical meetings in the fall of 1921 is made by Dr. HERTY in the July issue of the *Journal of Industrial and Engineering Chemistry.* It appears that four events are scheduled in which chemists generally will be interested. The British Society of Chemical Industry will come to this country for the first time in many years. The Canadian Institute of Chemistry, the American Chemical Society and the National Exposition of Chemical Industries will also hold their customary conventions. These events will prove so attractive that many chemists will undoubtedly wish to attend all of them, but will find it impossible to do so unless the meetings are held at approximately the same time.

The suggestion is that the four organizations co-ordinate their plans and hold a two-weeks' meeting—during the Exposition and immediately following. This would give ample time for the programs of the three technical societies and for inspection of the exhibits at the Exposition. More than this, it would give an opportunity to create closer professional relations among British, Canadian and American chemists and would strengthen Anglo-Saxon as well as professional bonds.

Subsequent to the war there was much talk touching on the probable Anglo-Saxon supremacy in world affairs. To such a prospect we have always given hearty assent and have welcomed every opportunity to promote its accomplishment. Consequently in this group of chemical conventions we see an opportunity to forward Anglo-Saxon unity and solidarity as well as chemical knowledge. The Chemical Exposition being a fixed festival, it would seem appropriate for its promoters to take the initiative in an attempt to realize this very delightful prospect.

Chemists in Public Life

WHEN the President appointed Dr. BOGERT as a member of the Tariff Commission, chemists generally welcomed the action as tangible evidence of the appreciation of the important part which a chemist could play in such an organization. Although Dr. BOGERT found it impossible to accept the appointment, there is no doubt that the profession should be represented on this important board, which bears such a vital relation to chemical industry. It is to be hoped that a chemist will yet be found to take the post.

Another evidence that the chemist is participating in public affairs is noted in the nomination of Dr. E. F. LADD as North Dakota's Republican candidate for the Senate. Dr. LADD is a chemist, having previously been professor of chemistry in the North Dakota Agricultural College, of which he is now president. Without knowing to what extent Dr. LADD may represent the socialistic ideas of the Non-Partisan League of his state, we may nevertheless express the hope that, if elected, he will bring to bear on public affairs a mind trained in that kind of straight thinking which is developed by scientific education. When Dr. LADD'S example is multiplied several fold, we can begin to look for benevolent effects in modifying the views of lawyers and professional politicians.

The I.C.C. Rivals Pandora

WHEN the Interstate Commerce Commission started a series of priorities for coal it opened a box of troubles for this country which makes Pandora's box of fairy fame seem quite insignificant. To be sure, coal is fundamental to all industries and a shortage of coal is perhaps as serious a matter as can readily be imagined for any community, but the cure chosen by the I.C.C. bids fair to establish more problems demanding immediate attention than a dozen such commissions can care for. In fact, it seems likely the disease would be preferred to the cure which has been devised.

Recently it was reported that all Japan was experiencing a financial disturbance approximating panic simply because of the collapse in the silk market. Here it was a dominating industry upsetting all the rest. In this country we seem in a fair way to establish a similar period of hard times by the collapse of transportation facilities resulting from excessive diversion of freight cars into coal traffic.

More serious even than this industrial disturbance is the possibility of direct hazard to whole communities which are just now reporting that they cannot even get the necessary chemicals for water purification. Such a situation, involving contaminated city water, would be even more serious than temporary fuel shortages for our vital public utility concerns.

Not only are important chemical supplies being thus disturbed, but essential road building is altogether interrupted, construction work is at a standstill and we are in a fair way toward hard times for much of our industrial fabric simply because raw materials are not available and the product of our factories cannot be moved from the storeroom. All this, too, is the more regretted when there is certainly some question as to whether there has actually been any general serious coal famine threatening in this country this year.

The total quantity of fuel required in the United States is rather accurately known. We have had shortages in production below the average estimated requirements, and locally throughout the country there have

been deficiencies in supply that threaten interruption of gas, electric and street railway service and industrial activity of less direct public importance. However, the method chosen to correct this difficulty seems to have resulted simply in a topsy-turvy industrial situation.

Unfortunately the tremendous powers of the I.C.C. under the 1920 transportation act have been used simply to give cars for coal movement. There seems to be no machinery available, certainly none actively in motion, for the elimination of unnecessary fuel uses or the increase of efficiency of fuel utilization. Either of these two limitations would doubtless be adequate if means for their accomplishment had been available. It is time for the technical man to give thought to these matters, especially to the question of increasing the work done per pound of fuel supply. It is a problem of greatest national concern and one to tax the ingenuity of our most clever engineers and chemists.

Study of Failures The Road to Perfection

DEFECTIVE metal furnishes a fascinating field for metallurgical investigation—gripping the huntsman instinct in the searcher and rewarding him with information of utmost importance to one really striving for reliability in manufactured products. Human life so often depends upon stanch reliability, yet every now and then a failure occurs in such a most mystifying way that the onlooker is apt to exclaim, "A plague on all your pseudo-science!" Yet why should a new cast-steel bridge seat suddenly fail at a critical moment, precipitating a whole span into the river, although under lower stress than it withstood many times during erection? Who can convince his fellow of the real reason for the epidemic of flakes, as soon as Americans tried to make gun forgings in quantity? Why are transverse fissures in rails, where do they originate, and how can they be avoided? Until such questions as these are answered, metallurgists are far from that ideal which they should hold in common with physicians: "Each ailment must be susceptible of accurate diagnosis." This is evidently prerequisite to the ultimate goal of "preventive medicine."

One naturally likes to talk more about his successes than his failures, even though he is taught far more by one shortcoming than by a hundred victories. The metallurgist will point with pride to the tremendous tonnage which fulfills its expected service in a satisfactory, if not an unexceptional, manner, far rather than dwell upon the faulty material which also slips through. Here is the very trouble! A defective heat, or a defective ingot, or a defective beam, bar, rail or rod may exert its influence so subtly as to be unobserved and only recognized so long after the event that the details of its manufacture cannot be recovered —in fact, it was apparently made under exactly the same conditions as its predecessors and successors, all acceptable.

It is only natural that the steel maker should blame the service to which his metal has been put, and that the user should blame the manufacturing processes. Both periods in the piece's history are so very intricate that usually it has been impossible to locate the exact trouble—at least so far. But this "passing the buck" gets absolutely nowhere. Progress certainly would result should we all adopt Dr. GIOLITTI's suggestion, made on page 149 of this issue, that each destructive abnormality, or even suggestive observation, should be recorded immediately with all possible collateral evidence, and then given the widest publicity. Successful manufacturing processes are so extraordinarily complex that systematic research designed to synthesize a correct procedure is well-nigh impossible. Evidently greater hope lies in the study of a great mass of data on individual occurrences which are known to affect the quality of the product. CHEMICAL & METALLURGICAL ENGINEERING welcomes such material, believing firmly that along this road lies success in the effort to make good metal better.

A Noteworthy Case of University Industrial Research

IT HAS been but a year since the evaporator experiment station at the University of Michigan was completely equipped, but in that brief space of time investigations of a fundamental character have been made in the phenomena of heat transfer. The actual factors entering into industrial operation are being sought out and intimately studied one by one. The investigators have the advantage of being in the proper environment. They are away from the multitude of interferences such as the plant investigator invariably has to contend with. They can be autocrats, for the evaporating equipment is to serve them and their work only.

In the end they will deduce practical theories on evaporation and evaporator design which at present rest almost wholly on a pure-science basis, without cognizance of many practical factors. The student chemical engineer who undertakes an investigation under these conditions has quite as much incentive for work as his brother chemist in the research laboratory. He will not be frittering his time away on a toy machine with no more satisfaction than a child gets out of his electric train. And when he finishes his work he will hold rank in accordance with his academic accomplishments. If he is endowed with tact and other natural qualities, he can advance rapidly in an organization that has use for his kind of special training.

Full-sized steam plants have been part of the equipment of almost every institution where mechanical engineering is taught. It would be too much to expect every department of chemical engineering to follow this example and erect full-sized equipment in adequate variety to offer as complete facilities as are given in mechanical engineering. On the other hand, might it not be possible for different institutions to emphasize certain operations, and equip their laboratories accordingly?

For post-graduate work, at least, this plan would offer excellent facilities. There is much to be said both for and against full-sized equipment in school laboratories. It is seldom necessary for purposes of instruction only, but where industrial investigations are to be made, it may be impossible to interpret results gained in any other than large-scale apparatus. The Michigan example is an interesting one and should be suggestive to other institutions where chemical engineering is taught and where the lead may be taken in at least one field of industrial research.

Ceramists' Dream Of the Future

IF YOU will wander, some fine day, out into the hills with the geologist, he may point to this and that example of differential weathering on the rocks and say: "It took ten million years for these few inches of rock to wear away, or one hundred million years to erode that gully." All of which, aside from giving you the impression that our historians have been remiss in recording the total period of world existence, will prove that natural silicates stand the weather pretty well. Then if you sit right down on the hillside and think about it out there in the clear sunshine, there may come a real dream of the greater part that ceramic materials must play in our future structures, and how the eroded dust of these rocks lying in clay beds on the plain below may be re-covered and re-formed to rocks with wearing characteristics equal to the natural product.

The clay worker may exceed the works of nature as regards refractoriness and strength and fabrication to any shape until the day will come that even the metals will be displaced in some of the useful arts, and the ceramist comes into his own at last.

Obstacles to Prosperity

PROSPERITY and progress, when applied to a people, are almost synonymous terms. No difficulty should be experienced in distinguishing from mere activity. Business can be very active without there being real prosperity or actual progress. Men may be working hard all day without being efficient and without producing lasting and useful results. It is easier to have business activity, merely as activity, than to have the kind of activity that makes for prosperity and progress.

These remarks are intended to have a particular bearing on the subject of new construction. A certain amount of construction is needed to make up for natural depreciation, and a certain amount in addition is needed for progress. Of late there has been much more activity than progress or true prosperity. In particular there has been little new construction.

There are four major obstacles, or difficulties, in the way of construction work, those that represent an investment intended to yield annual returns as well as eventual replacement of the principal. There are: (1) High interest rates for capital. (2) Indifferent performance of workmen. (3) Poor rail transportation service. (4) Unreasonable prices.

High interest rates for capital are naturally a deterrent to investment construction, since they offer the investor another form of investment. We are in a little danger just now, by the way, of getting a fallacious idea as to interest rates, for it has been contended seriously in some quarters of late that since both wages and commodity prices have gone up the interest rate ought to go up too. The misleading expression "cost of capital" is used. There is really no comparison, for capital goes by an interest expressed in percentage. One would not argue that, in the case of a factory, a larger percentage of the income should be used to buy raw materials than before the war, a larger percentage should be used to pay wages and a larger percentage should be left for profit, for the total can be only 100 per cent. If capital does command an unusually high percentage rate, that is merely an indication that there is something unsound, and a serious deterrent to construction work is furnished.

As to the performance of workmen, the barrier or obstacle may not be as great as is often supposed. Performance is a relative matter, moreover, and when one considers the making of an investment that involves the employment of labor he must compare present labor efficiency with prospective efficiency, not past efficiency.

The poor rail transportation service now furnished is a great obstacle to construction work, for various materials must be assembled, and if one is lacking, the whole work suffers and the cost of the job is increased.

In calling unreasonable prices the fourth obstacle to construction work the word "unreasonable" is used advisedly. For a few months after the Armistice there was much arguing that we had inflation of various sorts, hence prices would have to be high, but there have been great divergences. It is not reasonable that some prices should be double their pre-war average, others triple, and still others up only 50 per cent. Granting that the average is right, some prices are too high and some are too low. The investor can see these discrepancies and naturally concludes that while everything may not be wrong, some things are wrong, and he is disposed to wait until there is a better balanced price structure.

The Industrial Nurse As an Asset to Industry

NURSES are beginning to appear in industrial establishments, and the reports of them are generally favorable. Where plants are isolated and the workers live in company houses or in proximity to the works, there is the same need for the industrial nurse that there is for a district nurse in any community. Under such circumstances she is a regular visiting nurse whose business is to temper mercy with judgment; yet always to abound in mercy; to be part doctor, part priest, part lawyer, all nurse and then some more. She must be singular in her very multiplicity of qualities. The right woman on the job has a nose for trouble in its brewing, does not tell tales, has the confidence of everyone and knows how and when to give advice to all sorts and conditions of men and women. Her price is above rubies. And the wrong woman on the job can cause more trouble than a brimstone match.

In other establishments, no matter how centrally located, such nurses are engaged to be on call in the works during business hours. Not only where women are employed but also among men she knows just how to handle minor accidents, how to patch and bind up fingers, to look after sanitation, to make a gentle fuss if things get foul anywhere and to give good advice to grown up, strong, burly children. Then, too, in case of a major accident, she knows just what to do until the doctor comes, and also when to send for the doctor, which is an art in itself. She has a keen eye for septic conditions even in little scratches, and under workmen's compensation laws her precautions often save large sums of money as well as fingers and hands and arms or toes and legs and even lives. There is a National Organization for Public Health Nursing, with headquarters in Cleveland, Ohio, that is providing special training for nurses in the industrial field. The work is useful and the women are needed.

Western Chemical & Metallurgical Field

Company Reports

Anaconda Copper Mining Co.

Though the year 1919 was one of uncertainty in the non-ferrous metal industries and one of reduced production, the Anaconda Copper Mining Co. has retained its organization and taken advantage of the curtailment of operations to carry out extensive improvements in the mines at Butte, to continue and largely complete construction under way at the various plants and to advance, without interruption, the South American undertakings. Definite steps have also been taken in enlarging the company's field of activity.

The smoke treatment plant at Anaconda, consisting of twenty Cottrell treater units, was put into commission during the year and has demonstrated its efficiency. A special reverberatory furnace with Cottrell treaters was also completed for smelting the dust from the main treaters and satisfactory recovery of the copper, silver, gold and arsenic is obtained. Construction of an arsenic refining plant of 400 tons monthly capacity was begun and partially completed and when finished will refine the arsenical dust from the treaters on the special reverbatory.

An experimental 25-ton tower acid plant has been constructed and its operation demonstrated this new system of producing sulphuric acid to be an unqualified success. This type plant will be used in connection with the production of acid for the treatment of phosphate rock at Anaconda. The erection of an experimental plant to produce about thirty-five tons of a product containing 48 per cent of soluble phosphoric acid was begun. The product is to be marketed under the name of "Treble Acid Phosphate." To supply the phosphate rock a deposit near Garrison, Mont., was acquired and development work undertaken. The right to purchase a large deposit of high-grade phosphate rock in Caribou County, Idaho, has been acquired. About 25,000,000 tons of rock can be mined from this deposit through tunnels. Plans have been made to install the necessary machinery and townsite facilities to begin active operations.

An additional rotary converter was installed at the Great Falls electrolytic zinc plant substation in order to have a spare unit when operating the plant at full capacity.

A plant for the production of white lead made by an electrolytic process is being erected at East Chicago, Ind., adjacent to the plant of the International Lead Refining Co. This plant will be operated by the Anaconda Lead Products Co.

Considerable development work has been carried on in South America by the Andes Copper Mining Co. More than 12,000 feet of churn drilling has added 33,000,000 tons to the reserves, making a total of 120,000,000 tons of ore having a copper content of 1.48 per cent developed. Work on the main water supply and on the townsite has progressed satisfactorily. The Potrerillos railway was completed in May, 1919. General drawings of the reduction works have been completed and a pilot plant, located at the mines, has been put in operation. In this working unit tests are being conducted and the problems which arise in the application of the process are being worked out.

Consolidated Mining & Smelting Co. of Canada, Ltd.

The plant at Trail is becoming an increasingly important factor in the development of the natural resources as well as in the industrial expansion of western Canada. Various departments have been enlarged, new departments have been added and marked progress has been made in the recoveries of metals and in the concentration of ores during the past year. The present electrolytic copper refinery has a capacity of twenty tons of refined copper per day. This is being increased to fifty tons per day capacity to take care of the production of the Canada Copper Corp. A copper rod mill of the same capacity is being built. Improvements in the efficiency of the electrolytic lead refinery have reduced the cost of producing lead by this method below that of a Parkes process plant operating on the same tonnage. The gold and silver refinery has been practically rebuilt and is now thoroughly up to date. A new method of concentrating the ores from the Sullivan mine has been developed which consists of low-temperature roasting and wet magnetic separation; the concentrator has been recently completed. This will result in decreasing the cost of producing electrolytic zinc by providing a more satisfactory product for the plant. The sulphuric, hydrofluoric and hydrofluorsilicic acid plants are in satisfactory operating condition. A flotation mill of 200 tons daily capacity was run for several months on Rossland ore and its operation proved that this can be concentrated at reasonable cost and with good recoveries. A 1,500-ton mill is planned.

The company is expanding its activities particularly with the idea of increasing the production of copper and with this end in view has acquired controlling interests in the Coast Copper Co. and the Sunlock Mines, both on Vancouver Island.

Production for fifteen months ended Dec. 31, 1919, was: Gold 59,605 and silver 1,782,025 oz.; lead 41,711,147, copper 6,933,962 and zinc 30,743,461 lb.

Water Power Act Regulations Being Drafted

Regulations to be used in carrying the Water Power Act into effect are being drafted by Oscar C. Merrill, the executive secretary of the Federal Power Commission; General Enoch H. Crowder, representing the War Department, and Herman Stabler, representing the Interior Department.

Applications for permits under the new act now approximate 1,000,000 hp.

Lieutenant Colonel William Kelly of the Engineer Corps has been appointed by the President to serve with the Power Commission as Engineer Officer. Much of Colonel Kelly's experience in the Engineer Corps has been in California, where he has been brought in contact with water power problems. He was in France with the 117th Engineers.



COCONUT GROVE

Philippine Industrial Material, Products and Resources Available to the United States

A Review of the Greatly Diversified Agricultural, Mineral and Other Resources in the Philippine Islands, and the Opportunities to Increase Their Supply — Manufacturing Possibilities and Advantages of Locally Developed Industries

BY DR. ALVIN J. COX*

THE people of the United States have been so busy with their own affairs and the development of their own natural resources that they have given too little time to the study of their neighbors and trade possibilities on the Pacific. San Francisco, which could best handle and make use of the raw materials from Pacific Coast tributary countries for manufacturing development, especially on account of her location and climate in which work can be carried on uninterruptedly throughout the year, has been insufficiently active; and California generally has been so interested in agriculture that it has given much too little thought to industrial achievement.

Information concerning Philippine commercial and industrial possibilities has been given out periodically in the United States, but at no time has received the attention it warranted. The Philippines is not a foreign country, but is under the flag of the United States, and, while not an integral part of the United States, her judicial tribunal is maintained under American auspices, a condition which greatly facilitates business transactions with this country. The Philippine Government is doing everything possible to improve its harbor and docking facilities by the construction of additional piers, coal and oil depots, etc., to accomodate shipping. The mercantile and financial interests of the United States, including manufacturing, agriculture, shipbuilding, the export and import business, oil, mining and timber industries, transportation and public service interests, etc., should awake to Philippine possibilities.

The development of the Philippines will be an important asset to the section of the country accomplishing it and large profit will accrue not only to the business concerns directly interested but also the business community generally in attracting, centralizing, facilitating and increasing industrial and economic trade development. In my opinion the United States should bid especially for the foreign raw materials and business of the nations and their dependencies of the Pacific, and particularly for those products of the Philippine Islands suitable for export.

Many products now made from imported Philippine raw materials could be produced more cheaply there and the finished product imported, thus relieving our labor shortage. Exporters must join the importers in any development drive, for it should be realized that money spent there goes into a country where it is to our advantage to increase the purchasing power of each resident, for that increase largely will be spent for the purchase of American manufactured materials, if we adapt our methods to the needs and desires of the customers. Furthermore, by buying raw materials in the Philippine Islands, we are building up a line of supply that will not be interrupted by European wars. Why not build up a dependable supply not subject to those interrupting conditions?

AGRICULTURAL PRODUCTS

The Philippine Islands at no time have produced sufficient rice for local consumption, preferring, or finding it more profitable, to bring forth their well-known agricultural export products, such as abacá (Manila hemp), tobacco, coconuts and sugar cane, which always afford an excellent investment. With the shortage of binder materials during the last few years the producer of abacá has reaped a particularly valuable harvest. Even in ordinary times the supply of abacá

*Director, Philippine Bureau of Science, 1912-19.

is insufficient and the plant is peculiar in that it cannot be grown elswhere than in the Philippine Islands. It is believed that there will be a shortage for many years to come; for that reason the U. S. Bureau of Agriculture is endeavoring, by a special representative, to stimulate the production of sisal and maguey as a secondary Philippine supply. Many of the tobacco lands of the world have been turned to the production of essential food crops. Although tobacco was profitable before the war, the prices are now much higher, and probably will continue so for several years. The dried meat of the coconut is marketed for the production of oil. Coconut oil yields more glycerine than any other similar substance and has found an excellent market during the war period. However, coconuts will prove to be an exceptionally valuable crop at any time, for there is less likelihood of finding a chemical substitute for coconut oil than for any other Philippine product.

The exports of sugar from the Philippines in 1918 exceeded those in 1917 by more than 147,400,000 lb. During the last year there has been a great stimulus in the construction of sugar centrals, but even yet the production by native methods of the much less profitable raw sugar greatly exceeds that of centrifugal sugar. Many regions in the Philippines are ideally suited to the growing of sugar cane and on account of the great profit the production of sugar by modern methods will continually increase. Abacá, tobacco, coconuts and sugar cane largely have export markets. In 1918, there were exported 374,000,000 lb. of abacá, 360,000,000 cigars and 57,200,000 lb. tobacco in other forms. Also there were exported 121,000,000 lb. of copra (dried coconut meat), 253,000,000 lb. of coconut oil, 140,800,000 lb. of centrifugal sugar and 462,000,000 lb. of raw sugar. These had a value of about $59,000,000, $7,000,000, $6,000,000, $5,000,000, $31,500,000, $6,000,000 and $10,000,000 respectively.

Although there has been an unusually large increase in the exports of abacá, tobacco, coconuts and sugar cane since American occupation of the Philippines, still there is under-production and the cultivation of each can with profit be greatly increased. There is every evidence that the selling price of these products will continue at a fairly high level for years to come, particularly in view of the increased uses and the utilization of what formerly was waste product. For many months the copra market has been steady with a price more than three times that at which it formerly was profitably produced.

Besides the multiplication of these well-established products there is a wealth of natural and industrial possibilities that it is the purpose briefly to discuss here.

Philippine Alcohol and Beverages

There is a shortage of alcohol for industrial purposes, partly due to diminished production. The curtailment of consumption by the enactment of prohibition laws has not equalled the increased industrial demand. There are three of the cheapest sources of alcohol in the Philippines—namely, discard molasses from sugar-cane mills, tuba (sap) from the flower stem of the nipa palm and possibly from the coconut palm, and starch from the starch plants. Almost the entire insular production, about 10,000,000 proof gallons per annum, is made from the tube of the nipa palm. This palm grows wild in tidewater swamps. There are large areas of nipa-palm swamps that have not been developed. The collection of discard molasses is now difficult, owing to the production of sugar in many small mills; but when central mills are in general use, about 7,000,000 gal., capable of producing 5,000,000 proof gallons of alcohol, will be available annually. The growing of starch plants for the production of alcohol is very encouraging. Both cassava and arrowroot give much better yields and are just as easy to handle as ordinary potatoes, which have been found to be a cheap source of alcohol in continental Europe. With development, the Philippines practically could obtain a monopoly of the alcohol industry.

Most of the alcohol at present produced in the Philippine Islands is used locally for fermented drinks. Distilled spirits from the fermented sap of nipa and coconut palms, stored for five years in casks, are named "Philippine coco palm brandy" and "Philippine nipa palm brandy." Analyses made by the Bureau of Science show that these products conform to the requirements of good brandy.

Palm Sugar

Excellent sugar has been made from the sap of several palms, but the product is absorbed by the local markets. The buri palm is too scattered to be a great commercial source, but the nipa palm, which grows in immense areas on tide land in various parts of the Philippine Islands and yields a sap which is now the source of alcohol, is available. Nipa sap has a composition similar to that of the juice of sugar cane and it can be used more profitably for the production of sugar than for alcohol. There are large areas of nipa swamp that have never been developed. The fronds are used for thatch.

Coconut Shells and Charcoal

Coconut shells were not exported in large quantities before the declaration of war, although scientists long have used them for producing high gas-absorption-power charcoal. In 1918 more than $500,000 worth of coconut shells and $125,000 worth of coconut-shell charcoal were exported. It is hoped that this industry so nicely started may be maintained. Charcoal also has been made from mangcono wood and lumbang and pili shells, with a view to determining the efficiency of charcoals made from materials available in commercial quantities in the Philippine Islands. Results indicate that pili-nut-shell charcoal has a higher gas-absorption power than any other charcoal made.

Philippine Fibers and Binder Materials

Abacá, besides being exported as such, is used in the rapidly growing Philippine cordage industry. Frequently maguey and other fibers are cheaper than abacá, and they are as satisfactory for many cordage purposes. In 1918 the cordage exports amounted to more than $1,100,000.

The fiber extracted from the petioles of the buri palm is used for making buntal hats, which are marketed in the United States as Bangkok hats. The buntal hat is one of the best hats of the Philippine Islands. Fine hats made from bamboo fibers are marketed under the name of Batavia hats. Several fibers are used in the manufacture of high-grade hats similar to Panama hats. Hats made from buri palm leaves are cheaper and better than the cheaper hats sold in the United States. Abacá affords an abundant supply of excellent raw material which is woven into women's hats.



FIGS. 1 TO 9

Fig. 1. Abacá plantation, Malita, Davao. Fig. 2. Maguey in fruit, La Carlota, Occidental Negros. Fig. 3. Coconut grove and pile of nuts. Fig. 4. Coconut tree in fruit. Fig. 5. Bamboo bridges connecting tuba coconut trees. Fig. 6. Nipa palms. Fig. 7. Carica papaya trees in fruit. Fig. 8. Para rubber plantation trees, Basilan. Fig. 9. A tapped Castilloa elastica tree.

The commercial rattans of the Philippine Islands are derived from the climbing palms. The many species in the Philippine Islands belong to three genera. The stripped material of some species is very tough; it has great tensile strength, does not break easily in bending, and can readily be bleached. There is no reason why a considerable export trade in Philippine rattans should not be developed.

There are various species of trees and certain small shrubs represented in the Philippine Islands that have between the wood and the bark a tough fibrous layer known as bast fibers. These have extensive local use as substitutes for abacá.

Coconut husks yield a valuable fiber known as coir. In the Philippines a new and profitable industry can be established by using coir for the manufacture of brushes, ropes, doormats, etc. In the coir industry all the processes employed are simple, and machinery need not necessarily be used. In beating out the fibers two classes result—the coarse brittle fiber averaging 12 in. in length and the finer mattress fiber. The latter may be spun into coir yarn. One thousand coconuts will produce from 66 to 77 lb. of brittle fiber and about 308 lb. of mattress fiber.

True cotton is cultivated and made into various articles for local use. Pineapple fiber and some of the above-enumerated fibers are manufactured into cloth for which there is a certain export demand. Cloth known as piña, made from the pineapple fiber, is similar to very fine linen, and is used especially in making fine embroidery. Sinamay, made from abacá, is similar to crinoline and is used for similar purposes. The so-called Ilocano cloth, made from cotton, has a characteristic weave and coloring and is popular for curtains, pillow covers, etc.

Tree cotton, kapok, while of too short a fiber to be of use as textile material, is a superior filling for pillows and mattresses. The fibers are oily and, therefore, do not become easily water soaked. For this reason kapok is a suitable filler for life preservers, life jackets, etc.

Resins, Terpenes, Perfumes, Edible Nuts and Vegetable Oils Other Than Coconut Oil

Elemi, balao, apitong, almaciga and copal find application in the varnish industry, and in the making of resin soaps. The essential oils of ylang-ylang, champaca, vetiver, lemon grass, orange, cinnamon and ginger are used in the perfume industry, and several of them are used in the manufacture of non-alcoholic beverages and fruit flavors.

The pili nut is very delicious and has a flavor similar to that of the Brazil nut. It is very rich in oil.

Important vegetable oils are produced in the Philippine Islands from the physic nut, peanut and pili nut, and from the seeds of lumbang, kapok, cato, cashew, castor bean and cotton. Lumbang oil has good drying qualities and is used in the varnish and linoleum trades. The Indian variety of castor bean grown in the Philippines gives a high oil content. Cultivation is simple and does not involve so much actual work as does the growing of other staple crops, and returns are certain.

Commercial Plant Products

Coffee grows well in several parts of the Philippine Islands, and beans of excellent quality are produced, especially in the highlands of Luzon. Scientific cultivation is probably necessary to increase the output.

First-class cacao is grown to limited extent in many localities, and the production could be readily increased to export proportions.

Papaya gum of as great activity as the best on the market has been and can be produced in the Philippines, and offers an industry new to the islands.

Strychnine can be extracted from the seeds of *Strychnos ignatii*, a plant indigenous to the Philippines.

The leaves and the seeds of *Datura alba*, which grows wild in the Philippines, are valuable as an asthma remedy and for other medicinal purposes.

Several species of Philippine plants yield a high percentage of starch. The most promising of these are cassava, or camoting cahoy (*Manihot utilissima pohl*), and tapioca. Among other possible sources of starch are arrowroot (*Maranta arundinacea linn.*), sincamas (*Pachyrhizus erosus urban*), the Polynesian arrowroot (*Tacca pinnatifida forst.*), yams (*Dioscorea*), the seeds of *Cycas circinalis linn.* and the sugar palm (*Arenga saccharifera labill.*).

Natural vegetable dyes are used locally. More than $400,000 worth of sapan wood was exported in 1918.

Rubber and Gutta-Percha

The indigenous Philippine rubber-producing plants are vines and are scarcely adapted to cultivation. The cultivated rubber trees, the plants that produce so-called para, ceara and castilloa rubbers are, without exception, native of tropical America. All of these species have been introduced into the Philippines and do exceedingly well. In 1917 I was shown 7-yr.-old para trees on a plantation near Isabela de Basilan that were said to yield 2.25 kg. of rubber per tree per year. The *Castilloa elastica*, a tree native of Mexico, seems adapted to the Philippine Islands because it is not attacked by wild hogs. There have been some remarkable rubber yields from 4-yr.-old trees of this species. Castilloa is given no cultivation and is frequently planted in a new clearing. The cultivation of rubber trees on a large scale will probably prove eminently successful in those parts of the Philippines outside of the typhoon belt, where there is a uniformly distributed rainfall—that is, in southern Mindanao and the Sulu Archipelago.

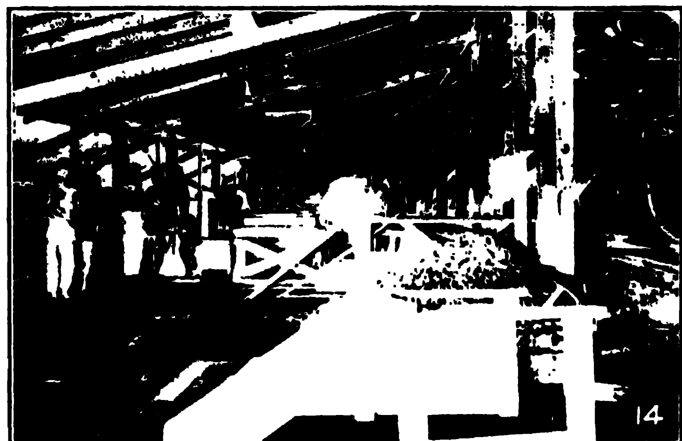
Lumber, Tanbark and Leather

An entire bureau of the Philippine Government is devoted to forestry and is in charge of forest administration. The virgin forests of the Philippines cover more than 40,000 square miles, and in addition there are about 20,000 square miles of second growth forests. The principal virgin forests are dominated by trees of the *Dipterocarp* family, and the stand of these may be estimated roughly at 18,000 board feet per acre, although several times this amount is not unusual. Practically all the timber belongs to, and is administered by, the government. At present there are about thirty-seven sawmills operating in the Philippine Islands, of which six cut over 25,000 board feet per day and five from 12,000 to 20,000 board feet per day. The total cut of the mills of the Philippine Islands in 1918 was about 70,000,000 board feet. There are large quantities of timber in the Philippines suitable for interior finish, furniture, cabinet wood, heavy construction and for special uses. A supply of timber for almost any purpose is readily available.

The area of the mangrove swamps of the Philippine Islands is estimated to be 511,500 acres. The bark










FIGS. 10 TO 17

Fig. 10. Rudimentary method of stripping abacá. **Fig. 11.** Drying abaca. Fig. 12. Opening coconuts for sun drying. Fig. 13 Native copra (dried coconut meat) press. Fig. 14. Modern coconut oil plant. Fig. 15. Native sugar-cane mill in operation. Fig. 16. Filipino women making buntal hats. Fig. 17. Filipino preparing rattan for use in making chairs.

from the mangrove yields an excellent tanning material. Cutch, the evaporated water-extract of tanbark, is imported into the United States in large quantities. This is extensively used in tanning leather, and is supposed to be the basis of khaki dye. The value of tanning materials imported into the United States is nearly $2,000,000 per annum and tanners are becoming each year more dependent upon imported material. Bark from the better species of Philippine mangrove trees contains 30 per cent of tannin. A net profit of from $25 to $30 per ton can probably be made on tanning material derived from the mangrove swamps in the Philippine Islands. Piles, firewood and the products of wood distillation could be made in connection with the cutch industry. The bark of Benguet pine and of palo maria can be also utilized as tanning materials. Forest regulations prevent the cutting of palo maria exclusively for its bark. The scope and possibilities of the tanning industry in the Philippine Islands may be inferred from the fact that about $2,500,000 worth of leather is used annually. More than half of this demand is met by importation. In 1918 more than $2,000,000 worth of leather and manufactures thereof were imported into the Philippine Islands. Some high-grade leather is produced locally, and there is no reason why the entire supply should not be produced in the islands.

Paper Pulp

One of the bamboos, known as cana boio, has been shown to be especially suitable for the making of paper pulp; it grows in sufficiently large and pure stands to make possible the commercial production of paper pulp. Abacá waste, cogan, talahib, rice straw, etc., are other materials from which the Bureau of Science has made strong paper pulp and which it should be possible to utilize commercially for the same purpose. There is a Philippine law authorizing a bonus for the establishment of a paper-pulp factory in the Philippine Islands.

Insect Products

Wild bees are plentiful in all of the wooded portions of the Philippines. There is a considerable local trade in excellent honey and wax, which are collected by the crudest methods. Apiculture with domesticated bees should be developed. It could be carried on in connection with farming to the extent of excluding imported honey, and the pollenation of all plants would be improved.

The Bureau of Science has introduced silkworms into the Philippine Islands, and has developed a hybrid which has nine generations yearly. The worms do well in the Philippines. Their food, the mulberry, grows most luxuriantly in all part of the islands and is free from pests. An acre or 440 trees will feed about 3,000,000 silkworms per annum, and the leaves may be harvested two years after the cuttings have been planted. There is an excellent market for all the silk that can be produced.

Sea Products

Among the marine products that have commercial possibilities are trepang (beche de mer), tortoise shell, top-shell (trochus) and other button shells, pearl and pearl shells, window shells, sponges, shark fins, edible seaweed, isinglass, crocodile skins, sardines and other sea fishes, etc.

The trepang industry could be spread readily to various northern islands, although now the catch is confined almost wholly to the Sulu Islands. About $500,000 worth of turban and top-shells were marketed during 1918 and certain of the Manila button factories were forced to close due to the scarcity of shells. It is believed that there are many untouched beds of these shells that might easily be exploited. The pearling industry is well established in the southern part of the Philippine Archipelago. Window shells are used locally in the place of window glass. They can be made into attractive screens and lampshades. The collection of sponges in Philippine waters is comparatively a new industry. The elephant's ear sponge collected in the territorial waters is of great value. The export of shark fins amounted to $60,000 in 1918, and this could be greatly increased. Practically all the marine products could be greatly increased.

Sardines are found in Manila Bay and in certain other localities in the Philippine Islands in abundant quantities, sufficient to warrant the establishment of canneries. In addition to the true sardines, there are large numbers of small clupeoid fishes (small herring) which are allowed to be labeled "Sardines." There are found in the Philippines the tuna and a number of other fishes, such as the Spanish mackerel or king fish, Japanese mackerel and several species of the pampano family, that are well adapted to canning purposes. Coconut oil, which is manufactured in the Philippine Islands, could be used for a local sardine product, for the temperature everywhere is above the solidification point of the oil. Olive oil and soya-bean oil for this purpose should cost about the same as in the United States. There are large quantities of peanuts grown in the Philippine Islands, and some of the oil companies plan to manufacture the oil, so this too might be available for canning purposes. The Filipinos prefer their sardines in tomato sauce. Tomatoes grow well in the islands, and this would be the cheapest material to use. Salt is produced locally in quantity from sea water. With this opportunity and these advantages for the establishment of a cannery in the Philippine Islands, $2,500,000 worth of fish and fish products were imported in 1918 simply because no one had taken the initial action in starting this new industry.

Minerals, Metallic and Non-Metallic

The production of gold steadily increased from 1910 to 1916, when a value of $1,408,320 was marketed. The output in 1917 was $1,059,500. Silver is found alloyed with gold in practically all of the gold deposits, in the ratio of one part silver to four parts gold. Silver is found associated with galena in Bulacan, Paracale, Mindanao and Marinduque. There are said to be extensive deposits of comparatively pure galena on the latter island. Copper deposits are known to exist in Batangas, Pangasinan and Benquet Provinces; Mountain Province, Mindoro, Masbate, Panay and Mindanao. Some of these have been worked for years. There are several valuable deposits of iron ore in the Philippines and some of them are exceedingly well located for economic handling of the ore. An unworked laterite iron-ore deposit in Surigao, Mindanao, has been estimated to contain over 500,000,000 tons of available ore, averaging approximately 50 per cent iron. Manganese occurs as psilomelan, pyrolusite and wad in Ilocos Norte, Panga-sinan, Bulacan, Tarlac and Masbate. Several thousand tons of manganese have been shipped in the last few years.

Petroleum is known to occur in Luzon, Cebu, Iloilo, Capiz and Leyte Provinces, and in Mindanao Island.

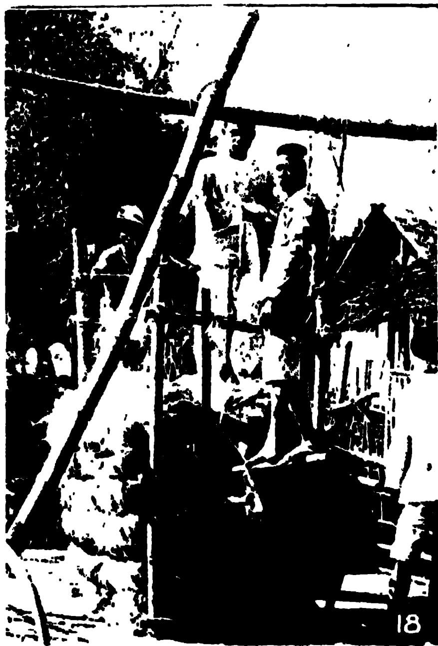
The beds of Bondoc Peninsula, Tayabas Province, Luzon, have been especially studied, and are believed to be worthy of exploration by drilling. The oil has a paraffine base and is practically free from sulphur. Commercial quantites of asphaltic materials and bituminous limestone exist in Leyte.

Coal to the value of $2,330,000 was imported into the Philippine Islands in 1918. Almost every island in the Philippine Archipelago and the majority of the provinces are known to contain coal or lignite, and some of these deposits are now being developed and mined.

Desirable raw materials for the manufacture of portland cement occur in the Philippine Islands. Some of these are adjacent to undeveloped coal fields, the fuel from which is suitable for burning cement. Excellent coralline and crystalline limestones suitable for the manufacture of lime occur throughout the archipelago. Asbestiform minerals are widespread in the Philippines. Bat guano occurs in caves in nearly every province. Salt to the value of $250,000 is each year manufactured in the Philippine Islands by evaporating sea water by solar heat. The Philippines also contain mineral resources of fireclay, abrasives, sulphur, stone and artesian and mineral waters, etc.

The principal manufactured products of the Philippine Islands are coconut and other oils, soap, tobacco products, cordage, hats, fertilizer ingredients, buttons, tanned products, embroideries, woven articles, matches, etc. The Rizal Cement Co. has a small modern plant at Binangonan. However, the imports of cement in 1918 were $498,500.

The lime heretofore produced in the Philippine Islands is of inferior quality, and much of that used for sugar manufacture and for other chemical purposes has been imported. The increased production of sugar by modern methods has so augmented the demand for lime that there is now a need for the outpnt of large kilns. The price would be sufficient to insure a handsome profit for good lime. Hydrated lime should find extensive use for road-building and for waterproofing concrete. In the sixteenth annual report of the Director of the Bureau of Science for the year ended Dec 31, 1917, I pointed out that in lime, sand-lime brick, salt, caustic soda, bleaching powder and chloroform there is a group of allied industries that should be successfully operated together in the Philippine Islands. The success of a caustic-soda plant depends rather on the development of local consumption than on its produc-











FIGS. 18 TO 22

Fig. 18. Native abacá press, Albay Province. Fig. 19. Hauling sugar cane (bull carabao). Fig. 20. Wild bees in Cementerio del Norte, Manila. Fig. 21. Cano boho, especially suitable for making paper pulp. Fig. 22. Calumbugan sawmill. Mindanao.

tion for export; and, in addition to utilizing it in the manufacture of soap, thus increasing the consumption, a paper factory and glass industry should be developed. Each of the latter presents an excellent opportunity. The experiments in the Bureau of Science in glass making prove that bottles, demijohns, glass jars, drinking glasses, lamp chimneys, etc., of good quality can be manufactured of Philippine raw material, and the results obtained in the manufacture of paper from Philippine raw materials are also very encouraging.

Clay products and various byproducts from the ash of tobacco wastes, copra cake and other plant wastes present excellent opportunities. Byproducts which up to the present time are largely being wasted but which, if properly developed, may become a source of income to the islands are glycerine, molasses, bromine, iodine, tannin, bleaching powder, chloroform, acetic acid and its derivates, wood alcohol and several other products derived from the dry distillation of wood, etc.

The Philippine industrial materials available to the United States are far greater than is generally understood to be the case. A few of these are now imported, but there are opportunities to increase the supply of these and develop others. The undeveloped ones and a large supply of all may be produced by engaging in attractive production enterprises in the Philippine Islands in addition to the utilization or importation of the raw materials. In all of the agricultural industries there are excellent commercial opportunities and there is a large amount of virgin fertile soil that could be cultivated.

Alizarine Dyes in South India

The following article regarding the supply and distribution of dyes in South India recently appeared in a Madras paper:

"It is well known that alizarine dyes were, prior to the war, imported mainly from Germany. In fact, out of 6,469,739 lb. of alizarine dyes imported into British India during 1913-14, as much as 4,637,450 lb. --or 71.7 per cent of the total imports—came direct from Germany, and 804,143 lb. (probably of German origin) from Belgium. Imports from Germany during 1914-15 fell to about half the quantity of the previous year, dwindled to an insignificant quantity in 1915-16, and afterward stopped completely.

"On the outbreak of the war strenuous attempts were made by the British Alizarin Co. to increase its output, but not until the early part of 1918 was the company able to send to India any material quantity of dyestuffs. About April, 1918, advice was received from the British Alizarin Co. that it was shipping to its agents in Madras (Best & Co.) five tons of alizarine and that there was good prospect of regular supplies being received in future. The Board of Trade, however, required Best & Co. to certify in respect of each sale that the dye had been sold to a consumer and not to a dealer.

Government Co-operation Granted

"To enable them to do this and to keep down the prices to a proper level, Best & Co. applied to the government for assistance and co-operation. In May, 1918, the government sanctioned the introduction of a scheme by which collectors of districts were asked to constitute local committees to deal with applications for dyes from bona fide dyers. The committees were to consist of two well-known dyers of the locality, with a government official of standing as president of the committee. The applicant for dyes had to make a formal application, and if it was proved that he was a bona fide dyer he would receive a limited supply at a price fixed by the collector of the district. In the case of Madura alone, which is the chief dyeing center of Madras Presidency, an exception had to be made. The system of certificates was tried there for some time, but had to be given up owing to certain circumstances special to that place. Since October, 1919, the distribution of dyes at Madura has been left in the hands of Best & Co.

German Reparation Dyes—Government Control of Prices

"According to the terms of the peace treaty, Germany is to deliver to the Allies a certain quantity of dyestuffs as part of the reparation for the injuries done to the Allied nations. Out of the German dyestuffs allotted to the British Empire, arrangements have been made to secure the whole of the reparation alizarine dyes for India in addition to a portion of the other reparation dyes. These supplies will be in addition to supplies which would, in any case, have been sent to India by the British Alizarin Co.

"The first consignment of German reparation alizarine dyes for Madras has now been received; it amounts to 200 casks of 4 cwt. each. This consignment and future consignments of alizarine dyes expected from this source will also be distributed in accordance with the scheme referred to above. The stock that has arrived has been allocated to the various agencies of Best & Co. The British Alizarin Co.'s new works at Manchester are expected to be completed by June next, and shortly afterward it expects to be able to supply the total Indian requirements from these factories. Meantime the arrangements detailed above will continue to be in force.

"In conclusion, it may be of interest to the public to know that Best & Co., the Madras agents of the British Alizarin Co., are not at liberty to charge any price they choose. The government fixes the price per pound and Best & Co. have to sell the dyes at that rate; they are allowed a fixed percentage as commission on the net proceeds after deducting duty and handling charges. The sale price of alizarine has now been fixed at 1 rupee 3 annas [38c.] per pound at any of Best & Co.'s depots.

Production of Indigo in Manchuria

The annual production of indigo in Manchuria approximates 4,000,000 to 5,000,000 lb., of which about one-third is disposed of in the Mukden market, reports Consul General Albert W. Pontious. The best quality sold there in May at 26c. per 1⅓ lb., and the cheaper grades at 15c. and 21c. In favorable soil the yield per fifteen acres is estimated at from 20,000 to 25,000 lb. of leaves, from which about 533 lb. of crude indigo is obtainable. Previous to the war foreign artificial indigo was imported into the Mukden consular district to the extent of approximately $700,000, and into the whole of China to the extent of $5,500,000 annually. The increasing price of artificial indigo subsequent to the elimination of Germany as a source of supply has made the vegetable indigo industry very profitable again. While a small amount of the foreign indigo is still on sale, the price of $170 per cask of about 175 lb. is practically prohibitive.

The Chemistry of the Brain

BY CLARENCE JAY WEST*

"THE brain and nervous system control, either directly by nerve impulses or indirectly through the blood stream, the metabolism and activity of all the other tissues of the body. They are, therefore, the master tissue of the body." While the nervous tissue comprises a relatively small part of the entire body, its superior reactivity or irritability enables it to control or set the pace for the other tissues.

The chemistry and metabolism of the nervous tissue are from almost every point of view the most absorbing and interesting of the problems of physiological chemistry. Matthew in his textbook states that the whole of evolution is characterized by the steady development of the nervous system, and by the steady development of no other tissue. The power of adapting the organism to a changing environment has been solved by the development of a tissue of the body which should be most irritable, which should control the other tissues, and which, having memory, could profit by experience. It is by means of his nervous system, and in that respect alone, that man stands at the summit of the animal world.

In spite of the importance and fascination which this study should possess, we know comparatively little regarding the chemical composition of the brain and the properties of the substances which are characteristic of nervous tissue. Much of our present knowledge is due to Thudichum, who worked comparatively unknown and entirely unappreciated, owing to his unusually combative nature, for many years (about 1865 to 1875) in England. The results of his investigations were published in the form of reports during this period, and later were collected in the form of a book under the title "The Chemical Composition of the Brain of Man and Animals." Among the later investigators in this field we may mention Koch, Fränkel, Rosenheim, MacLean, Thierfelder and Levene.

Our methods for analyzing the proximate constituents of the brain are far from satisfactory at the present time because of the complexity of the material in question. The following figures represent in a rough way the composition of the gray and the white matter:

	Gray	White
Water	85.3	70.2
Protein	7.6	8.6
Lipoids	3.1	18.1
Water soluble	0.5	1.4

The composition of the solids of the human brain is given by Koch as follows, the figures being per cent of dry matter:

	Whole Brain (Child)	Whole Brain (Adult)	Corpu Callosu
Protein	46.6	37.1	27.1
Extractives	12.0	6.7	3.9
Ash	8.3	4.2	2.4
Phosphatide	24.2	27.3	31.0
Cerebrosides	6.9	13.6	18.0
Lipoid sulphur	0.1	0.3	0.5
Cholesterol	1.8	10.9	17.1

The protein material of the brain is of the same general composition and nature as that found in the other parts of the body. If there is anything characteristic about it, it is the presence of normal amino-caproic acid. This is a matter probably of not very great significance, and it is unlikely that this acid is found only in brain protein.

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The characteristic property of nerve tissue which differentiates it from all other tissues of the body is the presence of a large amount of ether and alcohol soluble material, which has been called by the collective name lipoids. The scope of this term varies with various investigators, but in general it has been used to include cholesterol, the nitrogen-containing bodies and the nitrogen and phosphorus-containing bodies. It is probable that there also exists a sulphur-containing body in the brain, but whether it contains in addition only nitrogen or whether it contains both nitrogen and phosphorus has not been determined.

CLASSIFICATION OF KNOWN BRAIN SUBSTANCES

The following classification represents our present knowledge of the substances which have been definitely established. The literature of lipoids is very confusing, because names have been given to bodies which are mixtures of two or more of these, or which contain other impurities.

I. Cholesterol. Really this should not be classed as a lipoid, and is included only because it occurs in the alcoholic extract of nervous tissue.

II. Cerebrins. (Nitrogen-containing).
- *a.* Phrenosin.
- *b.* Cerasin.

III. Phosphatides. (Nitrogen- and phosphorus-containing).
1. Ratio of N : P = 1 : 1.
   - *a.* Lecithin.
   - *b.* Cephalin.
2. Ratio of N : P = 2 : 1.
   Sphingomyelin.

IV. Sulphur-containing compound.

Let us first consider the lipoid materials by studying their methods of isolation. The fresh brain matter is carefully freed from the covering tissue, washed, ground in an ordinary meat grinder, and dried *in vacuo*. This drying is usually carried out at 95 to 100 deg. C. The dried material is then ground to a fine powder and thoroughly extracted with hot alcohol. This removes all of the lipoid material, although as the process of purification continues a large part of it becomes insoluble in alcohol. Upon cooling the alcoholic extract, a large amount of the cholesterol and a certain amount of the nitrogen and nitrogen- and phosphorus-containing bodies separate out.

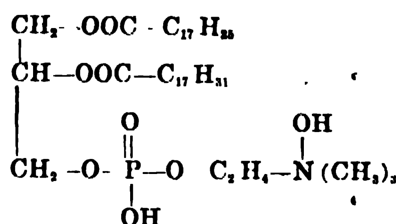
The filtrate will contain the greater part of the lecithin and cephalin. This is evaporated to dryness or to a thick sirup in vacuum and poured into acetone. This procedure precipitates all of the lipoid material and is a means of separating this from the fats and cholesterol. Because of the solubility of the lipoids in one another, this lecithin mixture will contain a considerable amount of the cerebrins and some sphingomyelin. The latter are insoluble in ether, and, therefore, extraction with ether will remove the lecithin and cephalin. Cephalin is insoluble in alcohol, and by dissolving the lecithin-cephalin mixture in ether and pouring this solution into alcohol, we are able to effect a certain separation of lecithin and cephalin. The procedure is very tedious, but finally results in the preparation of a cephalin which is free from lecithin. The preparation of a pure lecithin involves a considerable amount of additional work.

The mixture of cerebrins and sphingomyelins may be separated by a complicated system of precipitation

and fractionation, involving the use of acetic acid, petroleum ether, alcohol, and pyridine. The details of this method have been worked out by Levene and will not be given here.

The sulphur-containing body is found in the same fraction as the cerebrins, and all attempts to obtain a product which is rich in sulphur or which is constant in composition have been unsuccessful.

We thus see that, in general, the lipoid material may be separated into two groups, the solid, almost crystalline (cerebrins and sphingomyelins) and the sticky amorphous lecithin and cephalin. Without going too deeply into the organic chemistry of these bodies, let us look briefly into their chemical composition. Lecithin, which is probably the best known of all of these bodies, is a glyceride which contains one molecule of stearic acid, one molecule of an unsaturated acid, which probably belongs to the oleic acid series, while the third hydroxyl of the glycerol is esterified by means of phosphoric acid, which in turn carries a choline residue. That is, the lecithin molecule may be represented by the following formula:



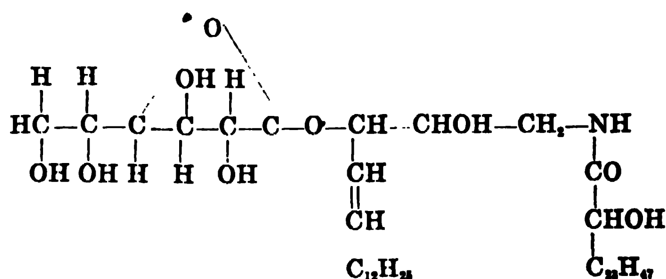
Our knowledge of the chemistry of lecithin was greatly increased by the application of the principle of reduction with hydrogen and palladium, because by this reaction one is able to obtain a crystalline body. Upon hydrolysis of this crystalline lecithin we obtain only stearic acid. This, therefore, does away with the possibility which many investigators have thought probable, that lecithin was a mixture of a stearic acid and a palmitic acid glyceride.

The chemistry of cephalin is much more complicated. Thudichum, who first isolated this body, observed that the carbon content was approximately 60 per cent. The products of hydrolysis were found to be glycerol, stearic acid, an unsaturated acid probably of the linoleic series, phosphoric acid and amino-ethyl alcohol, $NH_2CH_2CH_2OH$. If the composition is calculated from these components, it is found that the carbon should be 66 per cent. Thudicum noticed this discrepancy between the observed and calculated values for carbon, but made no attempt to account for it. Later investigators likewise obtained a cephalin with 60 per cent of carbon, but no attempt was made to explain this difference until Levene started his work. Levene and West spent a year in attempting to so purify cephalin that the carbon content would be raised to 66 per cent, but without success. The attempt to reduce cephalin with hydrogen was at first unsuccessful, but lately reduced cephalin has been prepared. Various derivatives, especially urethanes, were prepared, but these were unsatisfactory because of their amorphous nature and threw no light on the composition of the body in question. Very recently Levene has been able to show that it is probable that during the process of purification there is a certain decomposition of the cephalin molecule and that one fatty acid radical is split off. Either this is the explanation or there occur in the brain two cephalins, one of which contains two fatty acid residues, while the other contains only one.

The cerebrins are a much more satisfactory class of compounds as regards work in the laboratory. They crystallize readily from alcohol and other solvents. Here again we find that we are dealing with a mixture of two substances. By careful fractionation from a number of solvents one is able to obtain a more insoluble fraction, which is found to contain only cerebronic acid. Cerebonic acid is a hydroxy-acid which contains twenty-five carbon atoms, and which on oxidation yields lignoceric acid. Lignoceric acid is familiar to some of us because it has been isolated from the soil and from wood. The other components of this more insoluble fraction, which has been given the name phrenosin, are galactose and sphingosine. Galactose is of course a well-known sugar. Sphingosine has been shown to contain seventeen carbon atoms, two hydroxy groups and one amino group, together with an unsaturated bond. By oxidation of sphingosine it is shown that the unsaturated bond is between the thirteenth and fourteenth carbon atoms, since the product of oxidation was tridecylic acid. Upon reduction and subsequent oxidation pentadecylic acid was obtained. This indicates that the amino and hydroxyl groups are located on the last three carbon atoms. Various attempts have been made to prepare the unsubstituted amine from sphingosine in order to locate the relative positions of the hydroxyl and amino groups. These efforts have been unsuccessful thus far. It has generally been assumed that the amino group is on the last carbon atom, and we may, therefore, express the formula for sphingosine approximately as follows:



The more soluble fraction of cerebrin (cerasin) becomes richer in lignoceric acid as the process of purification proceeds, and since we find no other substance upon hydrolysis, we may assume that the only difference between phrenosin and cerasin is in the nature of the fatty acid. It is, of course, desirable that an absolutely pure cerasin containing 100 per cent of its acid as lignoceric acid should be isolated. We may write the general formula of these compounds as follows:



Upon hydrolysis of sphingomyelin we obtain the following products: Sphingosine, identical with that obtained from the cerebrins, choline, phosphoric acid, and a mixture of fatty acids, one of which is lignoceric acid. The other acid appears to have the composition of a hydroxy-stearic acid, but this is not definitely established because of the difficulty in obtaining this acid in a pure state. It is still an open question as to whether there are two sphingomyelins, one containing cerebonic acid and the other hydroxy-stearic acid, or whether the molecule is a diphosphatide containing both of the fatty acids mentioned.

It is thus seen that the chemistry of the lipoids offers

a large number of unsolved problems. The difficulties in the field are many. The materials are very similar in physical and chemical properties, and are particularly hard to separate because they are so nearly neutral in character. If there was an acid or a basic group from which to prepare characteristic derivatives the hope of separation should be infinitely greater. As it is, one is dependent entirely upon very slight differences in solubility in mixtures of organic solvents. The losses in these fractionations are very great, and it is only when we work with kilograms of the material that we can hope for any success. Even with all of these difficulties, the field is a fascinating one and still offers an opportunity for a real contribution to our knowledge of physiological chemistry.

The British China-Clay Industry

There are signs that the china-clay export trade of England is beginning to revive after the severe blow dealt it by the war and by the exchange and transport difficulties that have hindered its development since the armistice. No other country possesses deposits of china clay similar in character and essential qualities to those found in Cornwall and Devon, although the United States, Germany and Austria have developed their native white earths for use as a substitute for china clay in certain classes of goods. The total production of china clay in Great Britain before the war was approximately a million tons per annum, but the trade is capable of considerable expansion.

England is the only country that exports china clay, the white earths of other countries being in no demand outside their centers of origin, and only to a limited extent there. Roughly, two-thirds of the British trade is export. Of the total production of 964,000 tons in 1912 (the last normal year, 1913 having been the year of the clay strike) over 661,000 tons were exported. In 1917 the total production dropped to 508,152 tons and the export trade to 310,750 tons, while in 1918 the production dropped to 465,325 tons and the export to 232,464 tons. Last year the export rose to 286,543 tons. During the later months of the war the exports to Russia, Germany, Belgium, and the Netherlands, representing in 1914 over 177,000 tons, were wiped out, except for 1,000 tons in 1918, and the exports to America had dropped by more than half—from 320,000 tons in 1914 to 152,000 tons in 1918.

Regaining of American and European Trade

The utilization of American kaolins by manufacturers of the United States has been artificially assisted through war-time freights inflating the price of English china clay, but with the gradual return of freights to normal the regaining of the American market by British clay shippers is only a matter of time. Recent big shipments seem to point to this being the case. As the American market accounts for nearly half of the normal china-clay export trade of the United Kingdom, and was actually more than half in 1914, it is important to the British industry that this business be recovered.

As to the European trade, here again the question of price may have a temporary influence against the recovery of some former markets, especially in countries which possess white earths capable of being used in certain classes of goods, but eventually the superior quality of English china clays will assert itself. Higher production costs in labor and material have forced up china-clay prices to a figure to which exporters are making every effort to accustom their former customers, and the gradual rise in the export trade points to the success of their efforts.

Continental Stocks Exhausted—The Home Trade

The export trade has a lot of leeway to make up before it attains to the normal. In 1912 Russia took 45,000 tons, and there has yet to be recovered the pre-war trade of 94,000 tons to Germany, 67,000 tons to the Netherlands, 58,000 tons to Belgium, 45,000 tons to France, and 21,000 tons to Italy, let alone the 40,000 tons to other foreign countries and the 35,000 tons to British possessions. There is this encouraging feature—that all the stocks of china clay on the Continent are practically exhausted, and that the replacement of those stocks, apart from running supplies, must absorb large quantities in the very near future. [The annual exports of unmanufactured china clay from the United Kingdom to all countries since 1913 have totaled: 1913—629,703 tons, value $3,617,902; 1914—628,620 tons, value $3,677,585; 1915—333,964 tons, value $2,085,709; 1916—393,893 tons, value $2,567,069; 1917—310,750 tons, value $2,339,078; 1918—232,464 tons, value $2,258,786; and 1919—286,543 tons, value $3,712,843. For the first three months of the present year the shipments amounted to 90,236 tons, valued at $1,186,419.]

The home trade also reveals hopeful signs. With the paper mills going at full blast to overtake a large accumulation of unfilled orders, the potteries busily engaged in meeting big demands from abroad, the "boom" in the cotton-textile trade, and the requirements of the chemical trades—all of which industries use china clay at some stage of their work—there is every reason for anticipating a revival approaching pre-war dimensions in the china-clay trade of Great Britain this year.

Fire-Resistant Coatings for Wood*

Fire-retarding paints are the most practical means so far discovered by which small amounts of wood can economically be made fire resistant. The only other known methods of decreasing the flammability of wood are to keep it wet, or to inject into it certain chemicals under pressure. These methods, though more effective than painting, are usually either impracticable or too expensive to be considered.

Ordinary calcimine or whitewash has proved in tests to be as fire resistant as any paint covering tried. It is cheap and convenient to use. Although it will not prevent the burning of wood exposed continuously to a high heat, a good coat of calcimine on wood will decrease the danger of a blaze spreading from burning cigarettes, sparks, matches and similar small sources of fire. Calcimine is, of course, more effective for inside than for outside use.

For exterior use numerous patented fire-retardent paints are available. An effective outdoor paint which has been developed at the Forest Products Laboratory consists of linseed oil, zinc borate and chrome green. This paint has maintained its fire-resisting properties through more than three years of exposure to the weather.

*From Forest Products Laboratory *Technical Notes*, June, 1920.

New Regulations for the Importation of Dyestuffs, Drugs and Chemicals

THE War Trade Board section of the Department of State announces that General Import License PBF 57 (War Trade Board Ruling 825, issued Aug. 15, 1919) as revised and extended now permits the importation into the United States from all countries of the world without individual import licenses of all commodities excepting synthetic organic drugs, synthetic organic chemicals, dyestuffs, products derived directly or indirectly from coal tar, including crude and intermediate products and mixtures and compounds of such products. For the importation of the commodities for which individual import licenses will continue to be required, new regulations have been made, as follows:

All applications for licenses must be made in triplicate on Form M provided for the purpose. The rules and regulations must be complied with strictly.

Dyestuffs From Germany

Licenses for the importation of dyestuffs of German make or origin similar kinds or satisfactory substitutes of which are unobtainable in the United States on reasonable terms as to price, quality and delivery may be granted in limited quantities for use of consumers to meet their own special manufacturing requirements, in conformity with special rules and requirements, as follows:

A letter stating clearly the requirements must accompany the application for license. Allocation certificates must be secured from the War Trade Board Section. On request special forms will be furnished consumers for application for allocation certificates, which when granted will entitle the consumer, on import application therefor to the War Trade Board Section, to licenses for the importation of such German dyestuffs as may be enumerated on the allocation certificates. Such certificates must be transmitted to the War Trade Board section with completed import applications (Form M) for licenses in order to receive attention. Allocation certificates, at the option of the consumer, may be indorsed over to an importer or other person to accomplish such importation, in which case the indorsee should complete and transmit import application (Form M) accompanied by corresponding allocation certificates to the War Trade Board section.

Dyestuffs From Non-Enemy Sources

Import application (Form M) for licenses for the importation of dyestuffs and for intermediates entering into the manufacture of dyestuffs of non-enemy manufacture must be confined to quantities not in excess of six months' manufacturing requirements and must be accompanied by affidavits or signed statements from ultimate consumers to the effect, if true, that the dyes, indicating them, in the quantities asked for are not in excess of their manufacturing requirements for a period of not exceeding six months from the date of receipt, and agreeing to notify the War Trade Board section of the date of their receipt. In completing import applications for licenses definite information must be furnished showing the name of the country in which the dyestuffs or the intermediates were produced and the name and address of the producers in order to have applications receive attention.

Synthetic Organic Drugs and Chemicals From Germany

Licenses are not being granted for the importation into the United States or its possessions of synthetic organic drugs or synthetic organic chemicals of German make or origin if the same drugs or chemicals or satisfactory substitutes are obtainable in sufficient quantities from domestic sources on reasonable terms as to price, quality and delivery to supply domestic requirements. Accordingly, applications for licenses for the importation of such commodities from Germany or of German make must show the chemical as well as the trade name, or the chemical character or composition, as may be, of each article, together with all other information available which will serve to aid in its identification, including the statement, if true, that the article or a satisfactory substitute for the purpose is unobtainable in the United States, or if obtainable, is unobtainable either in sufficient quantities or in required quality or at reasonable terms or delivery; further, that the quantity asked for is not in excess of six months' requirements for domestic consumption. Quantities of these commodities for consumption in manufacturing plants must be accompanied by affidavits or signed statements from the ultimate consumers along the lines indicated. Appropriate statements in accordance with the foregoing from three or more reputable physicians should accompany import applications for licenses for the importation of drugs and medicines of German make or origin.

Synthetic Organic Drugs and Chemicals From Non-Enemy Sources

On receipt of import application (Form M), accompanied by appropriate statements that the quantities are not in excess of six months' requirements for their own use or for purposes of sale to the trade, consideration will be given the matter of granting licenses for the importation, in limited quantities aforesaid, of synthetic organic drugs and synthetic organic chemicals of non-enemy make. Definite information must be given in the import application showing the name of the country in which the drugs or chemicals are produced and the name of the producer abroad, together with the statement that no part of the goods are of German make or origin.

Shipment of Controlled Commodities Prior to Obtaining License

Licenses for the importation of controlled commodities should always be obtained in advance of placing orders, and failure so to do cannot be accepted as a valid reason for granting licenses for the importation of any such commodities through any waiver of the rules and regulations governing such importations.

Native Drugs and Chemicals

Native drugs and chemicals in their earthy state, as mined or grown, and which have been subjected to no chemical treatment whatever, may now be imported into the United States from any country in the world without a license, the same as before the war, and no formalities are now necessary with the War Trade Board section in connection with the importation of such commodities.

Cracks in Ingots

A Demonstration That One Class of Deep-Seated Cracks Is Due to the Generation of Parasitic Centers of Crystallization in Undercooled Regions of the Melt, With the Result That Adjoining Phenocrysts Are of Widely Different Composition

BY FEDERICO GIOLITTI

CRACKS in ingots and castings are the principal things to avoid in steel-casting practice. Without attempting to classify and discuss exhaustively the kinds of defects which appear from time to time, it is sufficient to point out that some of them result from purely chemical phenomena, which develop as a rule during furnace work, while others are caused by distinctly physical reactions ordinarily arising during solidification and cooling of the metal. Inclusions of slag and blow holes belong to the first category; surface and internal cracks, on the other hand, are more commonly thought of as being due to differential thermal expansion during cooling through the solidification and transformation range.

IMPORTANCE OF LOCAL UNDERCOOLING

These phenomena have been carefully studied, but only in a few cases have their exact causes been determined. Unfortunately, flaws and cracks, though of the greatest importance, have been almost exclusively ascribed to hypothetical "internal stresses." This point of view has been accepted with such faith that in many cases internal stresses or a fancied adhesion of ingot to mold has been said to cause surface cracks!

I am convinced that the phenomena of local undercooling and of segregation and their effect on intercrystalline adhesion are far more important than internal stresses in originating flaws in metal, which in turn render the forging or other working of large masses of steel so delicate. Since illustrative cases where defects can be definitely ascribed to certain particular causes are not frequently met with, I believe that it is important that every such instance should be given wide publicity. The following observations, therefore, previously printed in part in *L'Industria*, vol. 29, Nos. 16 and 17, refer to a special case, analogous to many others which have come under my observation, where the interrelation is especially clear between the process of crystallization, its accompanying segregation, and surfaces of deficient strength in the steel.



FIG. 1. TRANSVERSE CRACK NEAR BOTTOM OF INGOT

DISCOVERY OF EXTENDED CRACKS

A 50-ton nickel-steel ingot of the following composition was cast from an acid open-hearth in an octagonal cast-iron mold.

C	0.36	S	0.002
Mn	0.69	P	0.024
Si	0.27	Ni	2.02

Before the ingot was completely cool, it was placed in a reheating furnace, then roughed in a press to a cylinder of diameter but little smaller than across flats, and the top and bottom cropped. Even this early in the history of the piece there appeared some of those baffling defects which certainly are not *exclusively* due to differential thermal expansions. For instance, Fig. 1 shows a thin crust of considerable area which peeled off parallel to the bottom cut, curling out on itself, evidently indicative of a plane of little strength along the parting. Other such surfaces were later found in the same metal.

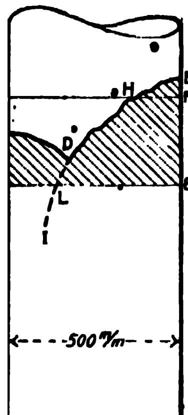


Fig. 2. Sketch of crack across axial core from ingot shown in Fig. 1.

After rough pressing and cropping, a cylindrical core about 500 mm. diameter was cut longitudinally down the axis, which on removal was found to be broken in three parts by irregular cross-fractures. Splitting the end of the core along an axial plane gave a block whose intersection with the lower break is sketched in Fig. 2 by the line *CDE*. A cross-cut *AB* then produced a sample for examination. After careful polishing and etching this surface for about 8 hr. in a 20 per cent H_2SO_4 solution at 60 deg. C., macrostructure of the portion shown cross-hatched in Fig. 2 immediately gave a clue to the cause of failure along an extension of plane *LD*.

Under eye examination, the most evident fact was the notable difference between the structure of part *ACDL* and part *LDHB*. In the left hand part clearly defined large dendrites were well developed, while on the right of *LD* a poorly defined granular structure existed, and the line *LD* itself was well marked by deep pits. All these characteristics were intensified by etching an hour longer, when the appearance was photographed in Fig. 3. Even further extended acid attack did not alter the essential appearance, but even emphasized the difference in structure and dug deeper into the metal at the common boundary.

Under microscopic examination, Fig. 4 shows the structure of the left-hand part, while Fig. 5 shows that of the granular structure immediately adjacent to the

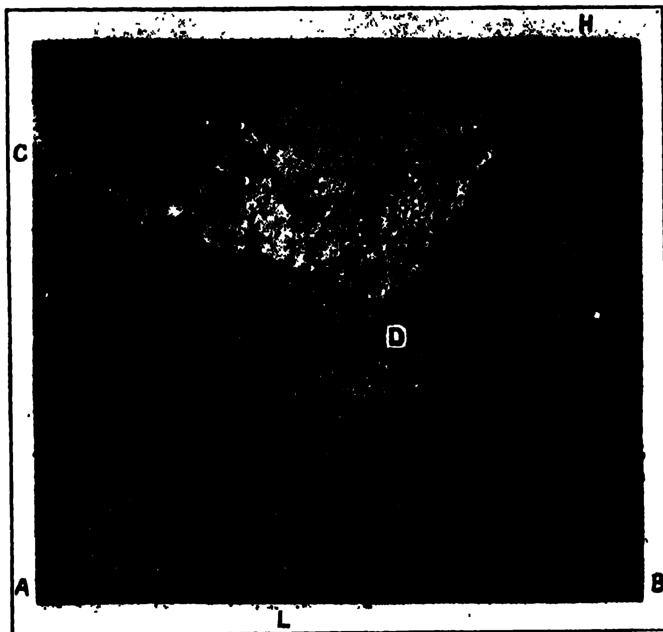


FIG. 3. DIFFERENCE IN MACROSTRUCTURE IN ADJOINING PORTIONS OF INGOT

right (part *LDHB*) after repolishing and etching with at 5 per cent HNO_3 solution in amyl alcohol. The contrast between the relative areas occupied by ferrite and pearlite is extreme. Chemical analysis confirmed the fact that carbon was lower in the right-hand phenocryst, and that the average metal as tapped from the furnace was intermediate:

	Mass *ACDL* (Dendritic)	Analysis of Heat	Mass *LDHB* (Granular)
C	0.44	0.36	0.30
Si	0.26	0.27	0.24
Mn	0.70	0.69	0.62
P	0.034	0.024	0.018
Ni	2.09	2.02	2.03

Manganese and phosphorus are distributed in the same direction as carbon, but not to as wide an extent. Silicon and nickel are substantially uniform, the analytical results being within the limit of error, but even in these cases the dendritic mass seems to have a slight preponderance. Nickel, it should be remarked, diffuses in molten metal with known tardiness, so that it is possible that the heat analysis—made from a 30-kg. ingot taken from the molten stream at about the middle of the tap—may not correspond exactly to the mean concentration of nickel in the ingot.

Cause of Intense Segregation

These data seem to me to indicate clearly the cause of the demonstrated segregation. It is quite significant that the differences in concentration between the dendritic and the granular masses are greatest for those very elements with the greatest difference in composition between the solid and liquid phase at given temperatures during solidification.

A glance at the binary equilibrium diagrams between iron and the usual alloying elements establishes this point. Howe's diagram for carbon (Fig. 6) and Konstantinow's for phosphorus show a very considerable spread between liquidus *AB* and solidus *AE*. A vertical ordinate in the solid-solution range would have a quite long section between intercepts with *AB* and *AE*—which corresponds to the fact that a wide temperature range is traversed between incipient and completed solidification. In addition to this, a horizontal abscissa between 1,500 deg. C. and eutectic temperature would also have a comparatively long portion between intersections, denoting a wide difference in concentration between solid

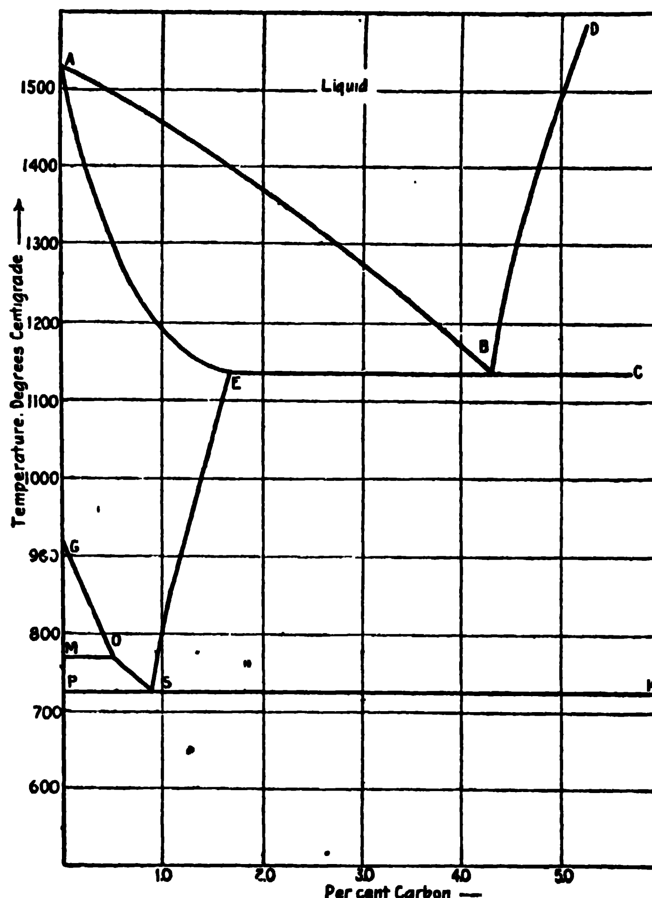


FIG. 6. IRON: CARBON EQUILIBRIUM DIAGRAM ACCORDING TO HOWE[1]

solution and liquid phases in contact and equilibrium at that degree. Segregation of manganese is much less, and the iron: manganese equilibrium diagram shows a smaller spread between liquidus and solidus (Fig. 8), while those alloys which have a yet narrower solidification range—iron: silicon shown in Fig. 9 and iron: nickel in Fig. 10—produce a negligible difference in the analyses.

Such facts are clear indications that the real cause of the internal discontinuity is inherent in the mechanism of separation of solid solutions from the melt.

In the particular case under discussion, the fact that the transition from metal of one composition to that notably lower in carbon and manganese occurred




FIG. 4. MICROSTRUCTURE OF DENDRITIC MASS

FIG. 5. MICROSTRUCTURE OF GRANULAR MASS

[1] "Metallography of Steel and Cast Iron," p. 130.

in an interval of a few millimeters certainly suggests that two crystalline masses must have formed and developed around two different nuclei at different times or rates, and their growth was only arrested by coming into contact with each other, which surface of contact is well developed by the line *LD* in Fig. 3. Considering the size of the phenocrysts, it is evident that but few abnormal or parasitic germs of primary crystallization must have been generated in the interior of the fused metal. Proceeding from these nuclei, large crystalline masses grew into being, whose chemical composition

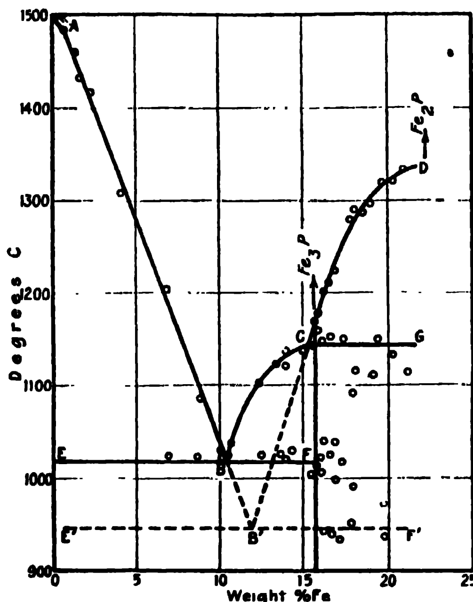


FIG. 7. IRON : PHOSPHOROUS EQUILIBRIUM DIAGRAM ACCORDING TO KONSTANTINOW[8]

varies, center to surface, in an analogous manner to that ordinarily found from the periphery to the axis of an ingot, or from the base toward the head, when crystallization is initiated at the sides and bottom. It seems clear that if two parasitic nuclei appear near each other at different times, or even if two simultaneous germs received accretion at notably different rates owing to a pronounced localized undercooling in the neighborhood of one of them, the ultimate surfaces of contact will separate various stages in the development of the pheno-

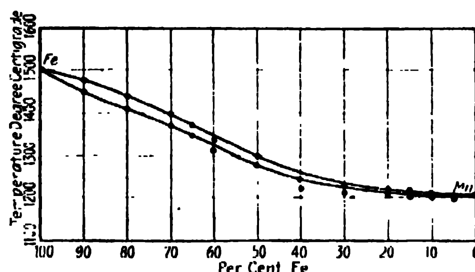


FIG. 8. IRON: MANGANESE EQUILIBRIUM DIAGRAM AT SOLIDIFICATION TEMPERATURES, ACCORDING TO LEVIN AND TAMMANN[9]

crysts themselves, and therefore different stages in the process of segregation with its attendant difference in chemical composition.

If it be granted that in this particular case the

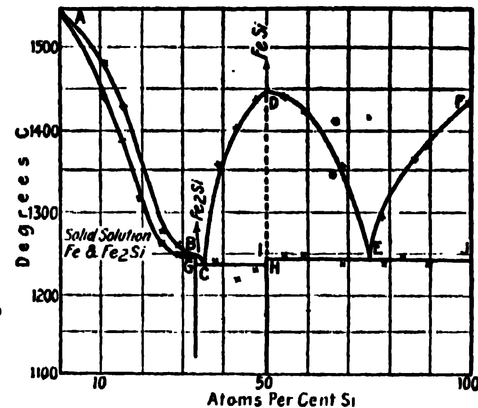


FIG. 9. IRON: SILICON EQUILIBRIUM DIAGRAM ACCORDING TO GUERTLER AND TAMMANN[4]

appearance of parasitic nuclei is responsible for a structural difference in no way connected with the geometric symmetry of the ingot, it follows from the well-known mechanism of solidification that such centers of crystallization will superpose an additional segregation effect upon that due to the ordinary columnar freezing of the main mass. In fact it may well happen that random nuclei may spasmodically appear well within the fused interiors of the mass, in a molten region which has already been enriched in alloying elements by the previous separation of purer solid solution at the superfices. Then the difference between the analyses of the central regions of several phenocrysts corresponding to various nuclei can be comparatively large, even

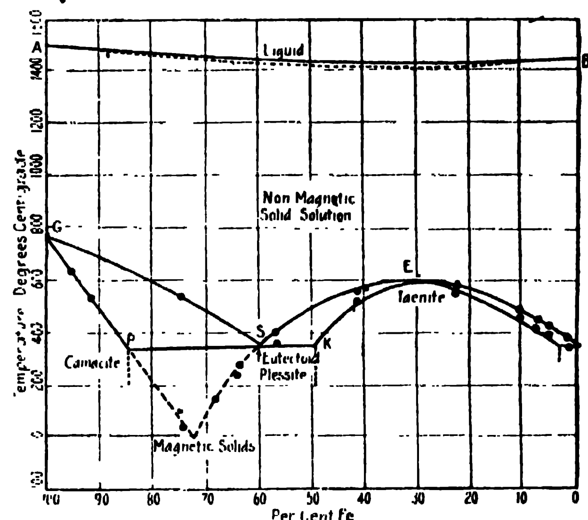


FIG. 10. IRON: NICKEL EQUILIBRIUM DIAGRAM ACCORDING TO OSMOND[5]

greater than the usual differences in concentration, edge to center, of an individual austenite crystal. This last conclusion seems to be verified by the analyses given above. While a minute chemical survey was not made, the macroscopic and microscopic examination amply demonstrates an extensive segregation *before* the formation of parasitic nuclei, a segregation much greater than is apparent within these phenocrysts themselves.

Cursory examination suggests that the contact surface *LH* has been impregnated with impurities. For instance, metal at and near the joint is attacked by

[8]Z. anorg. Chem., vol. 66, p. 209.
[9]Z. anorg. Chem. (1905), vol. 47, p. 136, as reproduced in Gulliver's "Metallic Alloys."

[4]Z. anorg. Chem., vol. 47, p. 163.
[5]Compt. Rend., 1899, vol. 128, p. 304, and Gulliver, "Metallic Alloys," p. 331.



FIGS. 11 AND 12. NON-METALLIC INCLUSIONS AND DISCONTINUOUS STRUCTURE AT INTERCRYSTALLINE REGIONS

sulphuric acid with far greater speed than the body of the grains, etching the latter, but digging deep pits along the former. Microscopic examination of a polished surface confirms the impression, Figs. 11 and 12, showing the character of the non-metallic inclusions located there. Abundant foreign material agglomerated into masses of comparatively large dimension can be seen, much larger than those very small particles of "emulsified slag" which could occasionally be detected within the crystals themselves.

An analogous accumulation of slag and a similar agglomeration into masses notably greater than those found in other parts of the metal are frequently seen in the metal forming the walls of the pipe in steel ingots cooled very slowly; more especially in the proximity of the lower apex of this cone-like cavity. There seems no question that the metal forming the walls of the cone's apex is the last portion of the steel to solidify (at that region of the ingot, at least), and the commonly observed enrichment in insoluble impurities is habitually explained by the assumption that the slag particles, originally distributed in suspension in a substantially uniform manner throughout the melt, are gradually expelled and accumulated in the residual mother liquor, remaining fluid until the end. In other words, the mechanism of slag accumulation is intimately connected with the process responsible for the increase in concentration of elements actually in true solution in the fused steel, and which solidify in primary solid solutions in iron of a concentration less than that which exists in the liquid phase with which they are in equilibrium.

Whereas the separation of mixed crystals has been studied in detail, and there seems to be substantial agreement as to its modus operandi, certainly so much cannot be said as to the extrusion of suspended slag. Still, the explanation just advanced is in conformity with various researches to be published later. But accepting it as a fact that, in cooling, slag particles are accumulated in some manner or other in that part of the ingot last to solidify, it would seem justifiable to call upon a similar train of events to explain the presence of slag particles at the crystalline boundary *LH*, and to consider the cementing metal as the solidified last residue of liquid steel rich in impurities and slag, a mother liquor filling the voids between crystalline intersections.

CRACKS UNRELATED TO PIPING

It should be evident for three main reasons that the surface of weakness we are examining is not caused by the shrinkage pipe; first, because the fracture in question was but 800 mm. from the base of a 5-meter ingot; second, because the core cut from the ingot was sound and free from discoverable discontinuities for three meters beyond the fracture *CDH*, at which point appeared the bottom of the pipe; and third, the surface of weakness under examination traversed the ingot for more than half of its thickness, maintaining its characteristics for that distance without change.

But even if the pipe is related to similar defects, it would hardly alter the conclusions already reached relative to the influence of parasitic nuclei upon sound metal. Such germs evidently cannot form except in liquid metal occupying a core of indefinite size, walled by austenite crystals previously separated from the melt. They can appear simultaneously or in succession, but for maximum segregation it is highly probable that one center of crystallization sprang into existence considerably later than its neighbors, in some region where by reason of eddy currents, gas bubbles or non-uniform radiation the temperature was markedly different from the average of its surroundings. Once germinated, subsequent growth by natural crystalline accretion will account for all the abnormalities noted in the study of this ingot, especially if the phenomenon of undercooling or surfusion occurred before crystallization began, in which case the speed of growth is very largely increased.

DANGERS OF SUCH VARIATIONS IN COMPOSITION

From a technical point of view, the consequences of large heterogeneities are essentially of two kinds.

First, notable differences in the carbon content of contiguous masses in the steel can render difficult or impossible the production of desired and expected results from a heat treatment predetermined for metal of the same average analysis and condition. In particular cases it is clearly impossible to follow general rules, and the best approximate thermal treatment must be studied individually. Practically, it is often the failure of steel parts to respond uniformly in the heat-treatment department which gives the first indication of large-scale segregation.

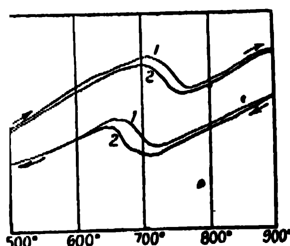


FIG. 13. Curves of expansion and contraction of adjacent crystals possessing considerable difference in composition

Second, as we have already seen in this study, the joint between metallic masses of different composition is ordinarily a surface of weakness which develops dangerous flaws. This weak bond, fracturing under mechanical work, is due primarily to the collection of impurities, and more especially slag inclusions, which originally were substantially uniformly distributed in the melt. Another very important cause of flaws lies in the differential thermal expansion of the adjacent phenocrysts, which effect is especially marked in the transformation range, where there evidently occurs what may be called a mutual "phase displacement."

As a concrete example of the last cause, I have prepared in Fig. 13 the expansion and contraction curves[*] characteristic of the two steels whose composition corresponds to that of the two parts adjacent to surface *LD* (Fig. 3). Upper curve 1 is expansion versus temperature for the low-carbon granular steel, while upper

[*]Obtained optically by the method described by Le Chatelier and Broniewski, *Revue de Métallurgie*, March, 1912, p. 133.

curve 2 is the same curve for the higher-carbon, dendritic metal. Lower curves 1 and 2 are the contraction curves respectively.

From these graphs it is at once evident that the change in volume with temperature on either heating or cooling is practically the same except when passing through the critical range. It follows that when the metal is cooling from 710 to 680 deg. C., one part of the metallic mass may be considerably shrunken while the other has suffered only a small change in volume. A corresponding effect, but to a much less extent, will occur when the procedure is reversed by heating.

Prevention of Large-Scale Segregation

It would be interesting to note the steps which have been taken at various steel works to prevent wholesale segregation by formation of parasitic nuclei, but the matter can only briefly be mentioned here. The writer is acquainted with very satisfactory methods in use at Italian plants largely occupied with munitions which have been maintained secret for several years, and which he is at liberty to mention only in general terms. It must suffice to say the following:

In the first place, one may select steels of such a composition that in them the greatest number of crystallization nuclei appear immediately below the formation of the first primary austenite crystals. Composition has a great deal to do with the existence of parasitic nuclei. Witness the fact that in a 20-point carbon steel containing 2 per cent nickel, manganese must be held lower than 0.4 per cent. If manganese by chance runs higher than this figure, the fact is immediately apparent in troubles with internal cracking at interfaces between crystals of widely differing composition. An important Russian plant utilizes the principle of cooling the steel through the mushy stage with extreme rapidity, while Americans habitually cast their metal at a temperature very close to the liquidus. I am informed that the Russian practice consists in casting in slightly conical molds; then as soon as the metal is walled in sufficiently to stand up, the mold is raised slowly, the hot metal being simultaneously drenched with pressure water from appropriate nozzles as fast as it is exposed. I also understand that a process of mechanically disturbed crystallization has been studied and applied successfully in at least one American plant making high-grade forgings. Such a system of stirring and jarring would work on the same principle utilized in salt technology, where crystallizing pans are equipped with stirrers when a uniform grain size is desired; quiescent cooling will cause extended supersaturation and the formation of crystals of widely differing mass.

Necessity to Record Observations

It would certainly be of greatest technical and commercial interest to collect and co-ordinate a sufficient quantity of experimental data that the crystallization criteria for various types of steels could be established with a fair degree of accuracy, following the general theory of Tammann. Data on the linear velocity of crystallization and on the number and distribution of crystallization nuclei appearing when the metal cools with differing speeds would be the most important. The relation between the width of the mushy stage and the generation of crystalline centers should also be studied. Such a systematic research would undoubtedly allow one to synthesize a procedure capable of preventing such segregation as that just illustrated; it would, however, present such great experimental difficulties as to render its successful conclusion very doubtful. It is therefore opportune to insist upon the importance of collecting the greatest amount of precise and complete data upon such defects as occur in regular works practice. From such a mass of evidence it may be quite possible to deduce the causes by an analysis of the concomitant circumstances, and so prescribe the necessary remedy, and even draw general conclusions of wide application. Certainly there are not lacking examples of complex technical processes—such as the chemistry of the open-hearth—which would be most difficult to elucidate by proceeding with synthetic studies in order to reconstruct the entire process on the basis of systematic data on the underlying elementary principles, yet it has been possible to reach very useful conclusions by following the opposite path, that is, by an analysis of the problem itself as it is in operation commercially.

Wood-Distillation Industry of Canada

The production from wood-distillation plants in Canada in 1918 (the latest year for which statistics are to be had) was valued at $7,634,122, this total including the item of $398,905 for repairs to machinery and plant made by employees.

There are thirteen plants, of which eight were located in Ontario and five in Quebec, with one refinery in each province. The amount of capital invested was $3,612,573, of which Ontario's portion was $2,321,881 and Quebec's $1,290,692.

The amount paid in salaries and wages to 675 male and two female employees was $731,435.

The charges for fuel of all sorts used during the year amounted to $839,966, of which $67,954 worth was of Canadian origin and $772,012 of foreign origin. Miscellaneous expenses totaled $365,789, and included such items as rent, power, insurance, taxes, traveling expenses and ordinary repairs to buildings and plant.

The quantity and cost of all materials delivered at the works during the year were:

Materials Used	Quantity	Cost Value at Works
Hardwoods, cords	128,097	$1,321,893
Lime, bushels	140,420	57,423
Crude wood alcohol for further manufacturing, gal.	1,081,837	1,071,227
Acetate of lime for further manufacturing, lb.	20,868,427	829,675
Caustic soda, lb.	186,900	7,709
Sulphuric acid, lb.	1,050,240	11,527
Soda ash, lb.	234,191	13,637
Other miscellaneous materials, lb.	445,986	6,640
Total		$3,319,731

The quantity and value of the various products of the industry at the point of production are given in the following table:

Products	Quantity	Selling Value at Works
Wood alcohol: Crude (sold as such), gal.	875,024	$981,535
Refined (sold as such), gal.	1,070,928	1,531,356
Acetate of lime, lb.	25,998,139	1,017,465
Acetic acid, lb.	1,772,223	170,173
Acetate of soda, lb.	295,572	51,389
Acetone, lb.	3,458,810	909,570
Formaldehyde, lb.	1,154,902	159,262
Ketone oils, lb.	792,864	211,440
Acetic anhydride, lb.	44,981	60,515
Methyl acetate, lb.	132,121	29,350
Charcoal, bushels	6,472,925	1,575,701
All miscellaneous products		537,460
Repairs to machinery and plant by employees		398,905
Total		$7,634,122

Properties and Constitution of Glues and Gelatines—IV

The Physical and Chemical Significance of "Craze" — Moisture Fluctuations — Relation of "Craze" to Nitrogenous Constitution—Studying Chemical Constitution by Determination of the Groups Characteristic of the Amino Acids—Purified Protein Analysis*

BY ROBERT H. BOGUE, PH.D.

SOME of the low-grade bone glues, after thoroughly drying out by exposure to the air for some time, craze badly. It is believed that this property of crazing not only detracts from the appearance of the glues and lowers their selling value, but also that a crazed product is of less strength in service than a glue of a similar grade which will remain firm. It seemed that an investigation of this peculiar property of crazing might reveal relations which would be of value both from the scientific point of view and from the standpoint of the manufacturer. This study was accordingly undertaken.

MOISTURE FLUCTUATIONS

It was noticed that in several instances low-grade glues would remain firm in the barrels, while those same glues in storage in the cabinet of samples would, after a short time, become badly crazed. This suggested that the water which such a glue would retain, after it had reached equilibrium with the air, was very likely a determining factor. To test this point several glues which were crazed in the cabinet but firm in the barrels were examined for water content. The results showed clearly that the cabinet samples had lost much more water than the firm samples in the barrels. The firm samples were then allowed to dry out in the air of the laboratory, and the water content determined at the time when crazing became apparent. This "critical moisture content" was found to be nearly, or slightly above, that found in the cabinet samples.

TABLE XXXVII. RELATION OF WATER CONTENT TO CRAZING

No.	Firm from Barrels	Crazed from Cabinet	Critical Moist Content
1	16.06	11.04	11.36
2	14.98	11.36	11.84
3	16.98	11.24	11.44
4	16.98	10.88	11.52
5	16.10	10.84	11.24
6	15.80	11.14	11.54

It is apparent, therefore, that the water content of a glue that has reached equilibrium with the air is an important factor influencing the crazing of glues, for it seems that if the water content falls below a certain minimum amount, the low-grade glue will craze.

PROXIMATE ANALYSIS

It was known that of several glues of uniform grade, some would craze and others would not, even when equilibrium with the air had been reached. In order to ascertain if this fact were caused by differences in the proximate constituents of the glues, a number of glues of low grade, some of which were crazed and others not, were analyzed for water, ash, organic matter and nitrogen.

An examination of the results does not reveal any marked or consistent relation between the proximate constitution and craze.

TABLE XXXVIII. RELATION BETWEEN PROXIMATE CONSTITUTION AND CRAZE

	No.	Grade	Viscosity	Water	Ash	Organic Matter	Nitrogen
Crazed glues	1	B7	43	12.74	3.74	83.52	14.58
	3	B8	44	13.62	3.22	83.16	14.64
	5	H9	46	12.34	3.57	84.09	13.98
	7	B8	42	11.86	3.86	84.28	14.78
	9	B9	42	10.72	3.55	85.73	14.60
	11	B8	42	11.21	2.95	85.84	14.85
	13	B9	43	11.44	2.56	86.00	14.52
Firm glues	2	B7	43	13.38	2.57	84.05	14.66
	4	B8	44	12.18	4.12	83.70	14.95
	6	H9	45	11.95	3.84	84.21	13.78
	8	B8	43	11.20	4.24	84.56	14.72
	10	B9	42	10.63	5.13	89.24	14.21
	12	B8	42	11.86	3.29	84.65	14.10
	14	B8	43	11.48	3.07	85.45	14.35
Average crazed		B8	43	11.99	3.35	84.77	14.56
Average firm		B8	43	11.91	3.75	84.44	14.39

RELATION OF CRAZE TO NITROGENOUS CONSTITUTION

Having found no relation between the proximate constitution of glue and the development of craze, the nitrogenous constituents, protein, proteose, peptone and amino acids were next determined in the same series, by the method described in a previous paper[60]. The data obtained are given in Table XXXIX.

TABLE XXXIX: RELATION OF CRAZE TO NITROGENOUS CONSTITUTION

	No.	Grade	Viscosity	Protein N	Proteose N	Peptone N	Amino Acid N
Crazed glues	1	B7	43	47.4	41.0	9.8	1.8
	3	B8	44	44.7	42.5	11.2	1.6
	5	H9	46	52.6	35.8	10.8	0.8
	7	B8	42	23.6	53.6	19.3	3.5
	9	B9	42	30.5	53.0	13.9	2.6
	11	B8	42	34.0	51.7	12.1	2.2
	13	B8	43	39.3	45.5	12.8	2.4
Firm glues	2	B7	43	48.9	39.3	10.4	1.4
	4	B8	44	44.0	43.2	11.0	1.8
	6	H9	45	51.4	41.5	6.1	1.0
	8	B8	43	33.6	51.9	11.8	2.7
	10	B9	42	32.6	48.	15.7	3.5
	12	B8	42	35.4	51	10.9	2.3
	14	B8	43	50.1	36.7	11.1	2.1
Average crazed		B8	43	38.9	46.2	12.8	2.1
Average firm		B8	43	42.3	44.6	11.0	2.1

It will be seen from the data obtained that the firm samples are higher in protein and lower in proteose and peptone than the crazed samples. The amino acid nitrogen is about the same in the two sets. The grades and viscosities of the two sets are identical, as determined by the usual methods.

It was previously concluded[61] that the jell strength was determined by the ratio between the protein and its products of hydrolysis, the corollary of which would be that glues of the same jell strength would contain the

*For Parts I, II and III see CHEM. & MET. ENG., vol. 23, Nos. 1, 2 and 3, July 7, 14 and 21, 1920, pp. 5, 61 and 105.

[60]See Part III.

[61]See p. 107.

same amounts of protein. With the crazed glues, however, we find that glues of the same "grade" do not contain equal amounts of protein. The reason for this seeming contradiction lies in the limitations of the methods commonly employed for testing jell strength and viscosity. For example, grade B_4 will produce a very weak jelly in 1 to 5 solution; grade B_5 will not jell at that concentration. There may be a very wide variation in composition between those two grades. Again, the viscosity of most of these glues is 42 and 43. By the same instrument water has a viscosity of 42. Therefore, at such low values the composition may vary greatly before it becomes measurable by the apparatus usually employed.

The fundamental statement[62], therefore, that jell strength is proportional to the protein content is not contradicted. The crazed glues are actually a lower grade of glue, their jell strength is actually lower, even though it is not measurable by the usual tests, and they consequently contain a smaller amount of their nitrogen in the protein condition.

On correlating these observations with the previously determined fact that glues do not craze until they have been reduced to a certain minimum water content, it seems that the ability of a glue to retain water above a certain minimum amount depends upon its protein content. Crazing is therefore due to an exceptionally great hydrolysis of the protein molecule and the consequent inability of the resulting mixture to retain water above that minimum content below which crazing may occur.

On Chemical Constitution by Determination of the Groups Characteristic of the Amino Acids

The writer has shown[63] that the highest grade first run glues contain about 90 per cent of their nitrogen in the form of protein, while the lower grades, which are the last runs, may show only about 50 per cent of their nitrogen as protein. If the difference lay solely in the degree of hydrolysis of the same protein, it would of course follow that the ultimate nitrogenous constitution of the two would be identical. If, as seemed probable, the later boilings not only contain a larger proportion of their original protein nitrogen in a more or less hydrolyzed state, but have also obtained some of their nitrogen from a source differing from that of the original protein, then the ultimate nitrogenous constitution would probably not be the same in the two glues. The solution of this phase of the problem should be obtained by a nitrogenous analysis of the original glues.

It has been shown by Fischer[64] and many others that the protein molecule is made up of a number of amino acids, about twenty being known, and that these are linked together in the protein molecule by anhydride combinations between the amino group of one amino acid and the carboxyl group of another. Moreover, it appears that the characteristic physical and chemical nature of the different proteins is determined by the type and percentage of the several amino acids present in the molecule. It is, therefore, apparent that in order to make a comparison of the chemical constitution of the protein it is necessary to split them into their constituent amino acids. There is no method known by which the exact manner of combination may be found. Even the very sensitive anaphylaxis reaction is not invariably specific, as has been shown by Wells and Osburn[65]. Neither is there any method known by which each and every amino acid in the protein decomposition product may be determined quantitatively. They may all be isolated and identified by the esterification method of Fischer[66], but besides being very long and exacting the results are in no degree quantitative. The most careful work leaves from a third to a half of the protein molecule still unaccounted for. Hausmann[67] devised a method for the separation of the several groups of amino acids, and this principle has been extended and modified by Van Slyke[68]. By the utilization of this method one is able to separate the amino acids into eight groups, and this separation is quantitative.

The Method

The protein is first subjected to prolonged hydrolysis with hydrochloric acid, after which the ammonia is removed by vacuum distillation, and the melanin filtered off and determined from the Kjeldahl value. The "bases" arginine, histidine, lysine and cystine are then precipitated with phosphotungstic acid. These "bases" after separation from the filtrate are redissolved and determined by their marked chemical differences. Cystine is determined directly by its sulphur content, and arginine by decomposition of the molecule with strong potassium hydroxide. The molecule of arginine breaks up into a molecule each of urea and ornithine. The urea is decomposed into ammonia. None of the other bases are attacked. By determination of the total nitrogen and the amino nitrogen, the non-amino nitrogen is obtained. This is derived from the arginine, which contains three-fourths of its nitrogen in a form which does not react with nitrous acid, and from the histidine, which contains two-thirds of its nitrogen in non-amino form. The histidine nitrogen is, therefore, calculated by subtracting three-fourths of the arginine nitrogen from the total non-amino nitrogen, and multiplying the difference by three-halves. This is easily seen from the following equations, letting A = arginine nitrogen, H = histidine nitrogen, and N = total non-amino nitrogen:

$$\tfrac{3}{4}A + \tfrac{2}{3}H = N$$

$$H = \frac{N - \tfrac{3}{4}A}{\tfrac{2}{3}} = \tfrac{3}{2}(N - \tfrac{3}{4}A) = 1.5N - 1.125A$$

The lysine nitrogen is obtained by subtracting the sum of the nitrogen of the other three bases from the total nitrogen of the bases.

In the filtrate from the bases the amino acids are divided into two groups by a determination of the amino nitrogen and the total nitrogen; i.e., the acids containing only primary amino nitrogen; and those containing nitrogen in pyrrolidine or indole rings.

The eight groups, therefore, which are determined by the Van Slyke method are briefly as follows:

Ammonia, or amide nitrogen, considered to be derived from $-CONH_2$ or CONHOC- groups linked to the carboxyl groups of the dicarboxylic acids in the protein molecule (glutamic and aspartic acids).

Melanin, or humin nitrogen, from the dark colored pigment and slight amount of insoluble matter always formed in the hydrolytic products of acid hydrolysis of

[62] *Idem.*
[63] See p. 107.
[64] "Untersuchungen uber Amminosauren, Polypeptide, und Proteine," Berlin, 1899-1906.

[65] *J. Infect. Dis.*, vol. 12 (1913), pp. 341-358.
[66] *Op. cit.*
[67] Osburn and Harris, *J. Am. Chem. Soc.*, vol. 25 (1903), p. 323.
[68] *J. Biol. Chem.*, vol. 10 (1911), p. 151; vol. 12 (1912), p. 275; vol. 16 (1913-14), p. 121; vol. 23 (1915) pp. 23, 407.

proteins. It has been shown by Gortner and Blish[69] that "in all probability the humin nitrogen of protein hydrolysis has its origin in the tryptophane nucleus." They have found that when tryptophane was boiled with mineral acids in pure solution no humin was formed, but when tryptophane was added to a protein, or when carbohydrates were present, an abundance of humin was formed. They recovered up to 90 per cent of the tryptophane nitrogen in the humin fraction.

Cystine nitrogen.

Arginine nitrogen.

Histidine nitrogen.

Lysine nitrogen.

Amino nitrogen of the filtrate, which corresponds to

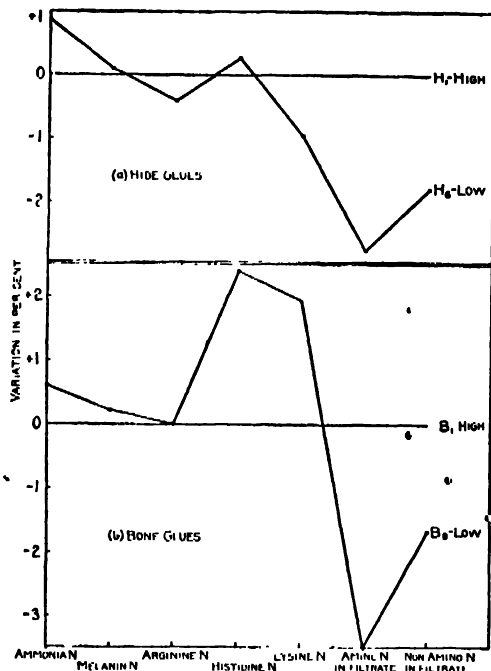


FIG. 18. VARIATION IN THE AMINO ACID CONSTITUENTS ON PASSING FROM THE HIGHEST TO THE LOWEST GRADE GLUES

all of the mono-amino acids except proline and oxyproline.

Non-amino nitrogen of the filtrate, which corresponds to proline and oxyproline, and some of the tryptophane. (Of the tryptophane which is not retained in the humin fraction one-half will appear as amino and one-half as non-amino nitrogen of the filtrate. In exceptional cases a portion of the tryptophane may also be precipitated by the phosphotungstic acid, and be calculated as histidine and lysine[70].)

EXPERIMENTAL

Hide and Bone Glues. This analysis was therefore undertaken, employing for the purpose all of the standard grade hide and bone glues. The results are expressed in Tables XL and XLI. Fig. 18 shows the variation between the highest and lowest grades of hide glue and of bone glue. Fig. 19 shows the variation between the average of the hide and of the bone glues.

The results may be summarized as follows:

The ammonia nitrogen increases as the grade decreases, and is decidedly higher in the bone glues than in the hide glues.

[69] *J. Am. Chem. Soc.*, vol. 37 (1915) pp. 1630-1636; and *Science*, vol. 48 (1919), p. 122.

[70] Van Slyke, *J. Biol. Chem.*, vol. 10 (1911), p. 40.

TABLE XL. HIDE GLUE ANALYSES[71]

Figures show per cent of total nitrogen in each fraction

	H_1	H_2	H_3	H_4	H_5	H_6	Average
Ammonia N	1.63	1.89	3.20	2.15	2.44	2.49	2.90
Melanin N	0.53	0.50	0.74	0.53	0.60	0.63	0.59
Cystine N	0.00	0.00	0.00	0.00	0.00	Trace	0.00
Arginine N	13.27	16.28	13.76	13.72	13.50	12.87	13.90
Histidine N	1.31	1.30	3.19	3.31	2.45	1.59	2.19
Lysine N	8.17	8.50	8.58	7.40	8.00	7.22	7.97
Amino N in filtrate	58.87	55.17	55.00	57.90	58.02	56.10	56.84
Non-amino N in filtrate	17.00	15.53	15.58	15.26	15.24	15.20	15.63
Total regained	106.78	99.17	100.05	100.27	100.25	96.10	100.02

TABLE XLI. BONE GLUE ANALYSES

	B_1	B_2	B_3	B_4	B_5	B_6	Average
Ammonia N	4.43	4.49	4.57	4.49	4.48	5.04	4.55
Melanin N	0.74	1.18	1.03	0.82	0.76	0.95	0.91
Cystine N	0.00	0.00	0.00	0.00	0.00	Trace	0.00
Arginine N	13.32	12.82	13.28	12.74	13.56	13.32	13.17
Histidine N	1.60	0.54	1.52	1.44	1.58	4.02	1.78
Lysine N	7.18	8.23	7.18	8.57	9.42	9.13	8.28
Amino N in filtrate	56.90	58.15	57.30	57.58	54.30	53.40	56.27
Non-amino N in filtrate	16.21	15.18	15.32	14.36	15.90	14.54	15.25
Total regained	100.38	100.59	100.20	99.80	100 00	100.40	100.21

TABLE XLII. ANALYSIS OF DOG HAIR AND GELATINE[72]

	Dog Hair	Gelatine
Ammonia N	10.05	2.25
Melanin N	7.42	0.70
Cystine N	6 60	0.00
Arginine N	15 33	14.70
Histidine N	3 48	4 48
Lysine N	5 37	6.32
Amino N in filtrate	47.5	56 3
Non-Amino N in filtrate	3.1	14 9
Total regained	98.85	99.02

The melanin nitrogen is nearly constant within each series, but it is higher in the bone than in the hide glues.

Cystine appears to be practically absent in all cases, traces only being found in two instances.

Arginine varies slightly from glue to glue, but shows

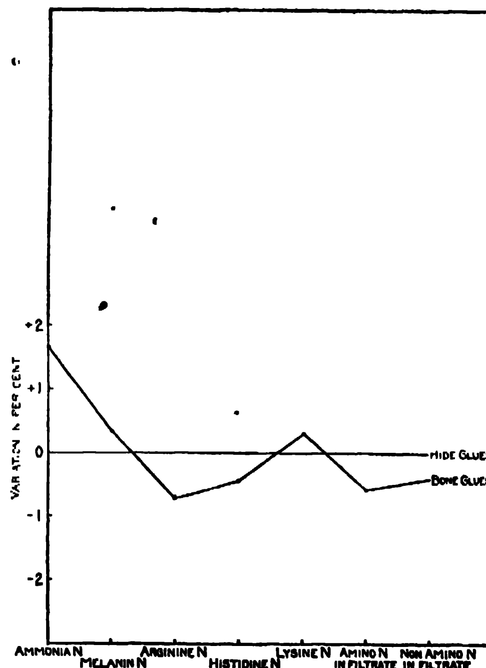


FIG. 19. VARIATION BETWEEN THE AVERAGES OF THE HIDE AND BONE GLUES

no consistent variation with grade. It is somewhat higher in the hide series.

Histidine varies irregularly, but is higher in the hide series except in the case of the pressure tankage from bones where it shows a maximum.

[71] The glues are arranged in order of decreasing jell strength.

[72] Van Slyke, *loc. cit.*

Lysine is fairly uniform in both series, increasing slightly, however, in the lower grades of bone glue.

Amino nitrogen of the filtrate is irregular in variation, but shows a tendency to decrease as the grade, especially in bone glues.

Non-amino nitrogen of the filtrate also shows a tendency to decrease as the grade, and is somewhat lower in the bone series.

CONCLUSIONS

Three conclusions may be drawn from the above summary of results:

There seems to be a sufficiently consistent variation from grade to grade in the case of a few constituents to justify the following conclusion: As boiling of the glue stock progresses, and under the influence of higher temperatures, some proteins of the stock will be hydrolyzed and brought into solution which were not at all or only slightly attacked during the first boilings. The first reaction is unquestionably the hydration of collagen to gelatin, but by the more drastic and continued extraction such substances as chondridin, keratin and mucin may be brought into solution. Whether or not the analyses as performed would show this point to advantage must depend upon the constitution and amount of these hydrolyzed substances so produced. If the constitution of the hydrolyzed chondridin, keratin or mucin were markedly different from that of gelatin, the presence of the former would be easily detected even in small amounts, but if the differences in constitution were but slight, their presence would be detected with difficulty by this method, even if present in large amounts. The only comparable analysis which has been made of any of these substances is one of dog hair, which is largely keratin, reported by Van Slyke[11]. This is given in Table XLII. When it is remembered that only the soluble portion could by any chance get into glue, thereby largely eliminating the high melanin fraction and raising certain other fractions accordingly, it will be seen that the divergence from glues is not striking. However, such differences as exist are in harmony with the variations that actually occur in passing from a high- to a low-grade glue, or from a hide to a bone glue. This does not prove that keratin is present in low-grade glues, but it suggests the possibility, and at least is not opposed to the hypothesis that some foreign proteins such as keratin have been hydrolyzed.

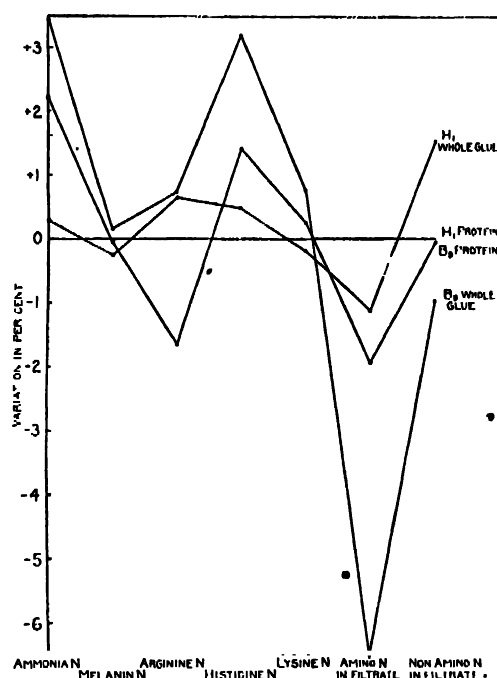


FIG. 20. VARIATION IN THE AMINO ACID CONSTITUENTS BETWEEN THE HIGHEST HIDE GLUE PROTEIN (H_1) AND THE PROTEIN OF THE LOWEST BONE GLUE (B_9). WHOLE GLUES SHOWN ALSO

There is a sufficiently marked variation between hide glues and bone glues to justify the conclusion that the proteins from which they are derived are different, or at least that the ratio of the constituent proteins is different. This is shown most decisively in the ammonia fraction, it being much higher in every instance in the bone than in the hide glues. This indicates a higher content of the dicarbozylic acids, glutamic and aspartic.

The inconsistencies among the results may reasonably be laid to differences existing in original stock from which the several glues were made.

PURIFIED PROTEIN ANALYSIS

In order to determine to what extent the difference between the hide and the bone glues was due to their protein content, as distinguished from the products of protein hydrolysis, a representative high-grade hide glue (H_1) and a low-grade bone glue (B_9) were each subjected to alcoholic precipitation by slowly pouring the dilute glue solution into cold 95 per cent alcohol, redissolving in warm water and reprecipitating four times. These purified proteins were then subjected to the same determinations as the original glues. The results are shown in Table XLIII, and the variations are expressed graphically in Fig. 20.

TABLE XLIII. PURIFIED PROTEIN, FISH GLUE AND ISINGLASS ANALYSIS

	H_1 Protein	B_9 Protein	Fish Glue	Isinglass
Ammonia N..	1 33	3.57	5.15	3.98
Melanin N	0 78	0.74	1.12	0.68
Cystine N .	0 00	Trace	Trace	0,00
Arginine N .	12 61	10 96	13 80	14.20
Histidine N.	0 82	2.24	2 04	2.33
Lysine N. .	8 34	8 60	8 58	6 06
Amino N in filtrate	60 00	58.05	60 20	58 65
Non amino N in filtrate	15.49	15 47	9 66	13 59
Total regained	99 37	99 63	100 55	99 49

The differences between the constitution of these two purified proteins are still large, especially in ammonia, arginine, histidine, and amino nitrogen of the filtrate. However, they are not as great as existed between the original whole glues, and variations which previously existed, as in melanin, lysine and non-amino nitrogen of the filtrate, have disappeared.

HIDE AND BONE GLUE PROTEINS

This seems to show that:

The proteins of the hide and bone glues are fundamentally different in some respects, and are unquestionably derived from protein complexes which are different, or in which the ratio of the constituent proteins is dissimilar.

This is corroborated further by the great difference in physical properties of the two purified proteins. That from hide glue is white, and forms very tough leathery masses which are not sticky, while the bone protein, although white at the moment of precipitation, very rapidly becomes brownish, and is a sticky, soft, gummy

[11]*Loc. cit.*, vol. 10 (1911), p. 47.

mass. Repeated precipitations fail to alter these properties.

The constitution of the whole glues used varies more than that of the isolated proteins, which shows that even more of the "foreign substances" of bone glues, which reduce their value, are present in the proteose and peptone fractions than in the protein fraction.

Isinglass and Fish Glue

It has been claimed by some investigators that the soluble portion of Russian Sturgeon-sound Isinglass was pure gelatin. For the purpose of comparison, it was decided to make a "Van Slyke analysis" of this substance. The results are given in Table XLIII. It will be seen that the arginine nitrogen is higher and the lysine nitrogen lower than in any other analysis. The ammonia nitrogen is high, and the non-amino nitrogen of the filtrate is low, but in general the figures correspond somewhat more closely to Van Slyke's analysis of gelatine[n], shown in Table XLII, than any other glue. It is also apparent that in most of the groups the high-grade hide glues more nearly correspond in value to the analysis of isinglass than the bone glues.

To obtain still further comparative data a fish glue was analyzed. The results are given in Table XLIII. This glue shows higher ammonia, melanin and amino nitrogen of the filtrate, and lower non-amino nitrogen of the filtrate than any other glue, but more nearly corresponds to the low-grade bone glues than to the hide series. Only in its high amino nitrogen of the filtrate does it resemble the latter. The very low non-amino nitrogen of the filtrate in the case of both of the fish products indicates a fundamental distinction from animal glues.

The variations of isinglass and fish glue from the highest grade animal glue protein (H_1) is shown in Fig. 21. The curve for the average of all animal glues is also included. It would seem from this that there is much difference between the constitution of isinglass and the pure animal protein, and if either one of these may be assumed to consist of pure gelatin, the other must of necessity contain considerable impurity.

Summary

The conclusions detailed in this section may be briefly recapitulated as follows:

Hide and bone glues vary slightly in their chemical constitution on passing from grade to grade. This is interpreted to signify that as the boiling of a glue progresses some "foreign substances" as chondridin, keratin, mucin, etc., become hydrolyzed and enter the solution. These have no value in glue, and by adulteration lower the value of the product.

Hide and bone glues differ from each other in their chemical constitution. This is taken to signify that the protein complexes from which the glues are derived are different in the two cases, or that the ratio of the several constituents is different.

Glues of different stock within both hide and bone series show a difference in constitution, which is attributed to variations in the protein complexes of the several stocks.

The differences between hide and bone glues are found in the protein fraction to a lesser extent, and in the proteose-peptone fraction to a greater extent than obtained in the whole glues.

[n] *Loc. cit.*

If the purified protein from the highest grade animal glues may be considered as pure gelatin, then it follows that isinglass is not a pure gelatin, or if the assumption be made that isinglass consists only of gelatin, then the purified animal glue protein contains impurities.

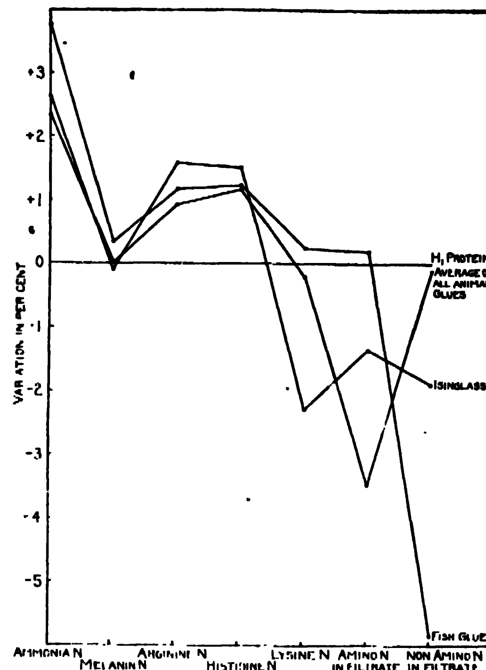


FIG. 21. THE VARIATION, FROM THE HIGHEST ANIMAL GLUE PROTEIN, OF AVERAGE ANIMAL GLUES, ISINGLASS AND FISH GLUES

The lower the grade of a glue, the further is it removed in constitution from that of the purified protein, and, if this protein be assumed to consist only of gelatin, then the gelatin content of glues diminishes with the grade, and the substance from which the hydrolytic products are obtained consists of gelatin in decreasing amounts, as the grade decreases.

Fish glue corresponds more closely in its composition to low-grade bone glue than to any other.

Fish glue and isinglass show a fundamental difference from animal glues in their low "non-amino nitrogen of the filtrate" (proline, oxyproline, and tryptoplane).

(Part V will be published in the next issue.)

Progress in Optical Glass Manufacture

Another triumph of American ingenuity is the manufacture of optical glass. Prior to the war practically all this material was produced abroad, but the cessation of imports and the great need of lenses for field glasses, telescopes, and other optical devices used in warfare, necessitated immediate investigation as to the possibility of optical glass manufacture in this country. Experiments were carried on and the process so successfully developed that not only the smaller lenses for field glasses but also the larger types which are used in telescopes were manufactured. Lenses up to 20 in. in diameter are now made and larger ones contemplated.

Great difficulty was experienced in the annealing process necessary to remove internal strains which cause the lenses to crack on cooling. To overcome this, however, a new electric furnace has been designed which gives a much closer control of temperature during the annealing, and one company soon expects to have all sizes of lenses up to 20 in. and over on the market.

The Evaporator Experiment Station at the University of Michigan*

An Account of the Institution of the Evaporator Laboratory — Description of the Vertical, Horizontal and Semi-Film Evaporators and Miscellaneous Equipment— Program of Investigations Proposed

BY W. L. BADGER AND P. W. SHEPARD

THE subject of co-operation between industrial concerns and universities has been discussed so frequently that this general question will not be taken up here. It is proposed, however, to describe what is believed to be a very noteworthy case of such co-operation.

During the summer of 1917 the Swenson Evaporator Co., of Chicago, Ill., was considering the establishment of an evaporator experiment station to study both general theoretical questions and detailed concrete problems regarding evaporator design. The possibility and desirability of co-operation in this work with some university became apparent early in the development of the idea; and the matter was taken up with the Board of Regents of the University of Michigan. After a careful and extended discussion by both parties an agreement was reached substantially as follows:

The university furnished a suitable building, light, water, steam and power, and assumed responsibility of providing equipment for making all necessary measurements involved; this consisting of such articles as weighing devices, thermometers, gages, manometers, recording instruments, volumetric measuring devices, etc. The Swenson Evaporator Co. bore the entire expense of designing, building and erecting the machinery; and as soon as erected, its title passed to the University of Michigan. The whole station, then, is the property of the university and is available for instruction, demonstration and research. In return for this investment the university granted to the Swenson Evaporator Co. the right to carry out certain detailed investigations of its own, the right to maintain in this laboratory its own employees and the right to retain as its own property the results of certain specific classes of detailed investigation. It was expressly provided, however, that in case any facts of general scientific importance were developed, they were to become public property even though they were developed by the company's employees and at the company's expense.

WORK DELAYED BY WAR

The design of the apparatus was immediately started, but its manufacture and delivery were greatly delayed due to conditions arising out of the war. Actual equipping of the laboratory did not begin till March, 1918. The principal equipment was added as rapidly as possible, but the final layout was not ready till August, 1919. Due to lack of graduate chemical engineering students during the war, the work so far has been largely carried out by the company's employees and at the company's expense. The two papers accompanying this description fall in this class. Acknowledgment is made to E. M. Baker, instructor in chemical engineering in the University of Michigan, who has taken an active part in the development of the laboratory and the prosecution of the research.

The principle adopted in planning the equipment was to make all units large enough to minimize personal errors and errors due to small-scale work. The station was to furnish data for actual engineering design—not only for evaporators but for entire plants and complete processes. Consequently all units installed were of commercial size, and results obtained in them are transferable quantitatively to full-scale commercial operation. Much thought was given to all possible problems, both general and specific, which might arise. Provisions were accordingly made for changing the set-up and connections, taking temperature and pressure measurements, and in general anticipating the requirements of the most varied and intricate work which could be expected. Attention was given to making it possible to secure ample data for every step of an experiment. Every problem, both general and specific, which the station takes up, is treated quantitatively. This is not only for the sake of collecting a general fund of information regarding the behavior of evaporators but also that all possible problems which might arise in development of the process experimented on might be forestalled.

EQUIPMENT INSTALLED

Since the primary purpose was to study evaporator design, one representative of each of the three common types of evaporators was provided. Accordingly the station has a vertical tube, a horizontal tube and a film type evaporator following the standard designs of the Swenson Evaporator Co. for each type. To handle problems where crystals are deposited there is a salt filter which may be used on either the horizontal or vertical tube evaporator. To make possible the solution of the widest variety of problems, the heating surfaces of each evaporator were made easily removable and a wide variety of methods of disposing or arranging the heating surfaces was provided. Parts forming vapor belts were made interchangeable so that the main dimensions of the machines could be altered at will. Several types of bottoms were provided and made easily removable and interchangeable.

The station also possesses a number of storage tanks, so that several materials may be on hand at one time. Capacity is provided for storing a tank car of liquid. Pumps and pipe lines make all possible combinations available. One tank is provided with an agitator for making up solutions.

Operations of interest to the chemical engineer other than evaporation have not received as much attention as evaporation, but are being added rapidly. A filter,

*Read before the American Institute of Chemical Engineers, Montreal, June 29, 1920.

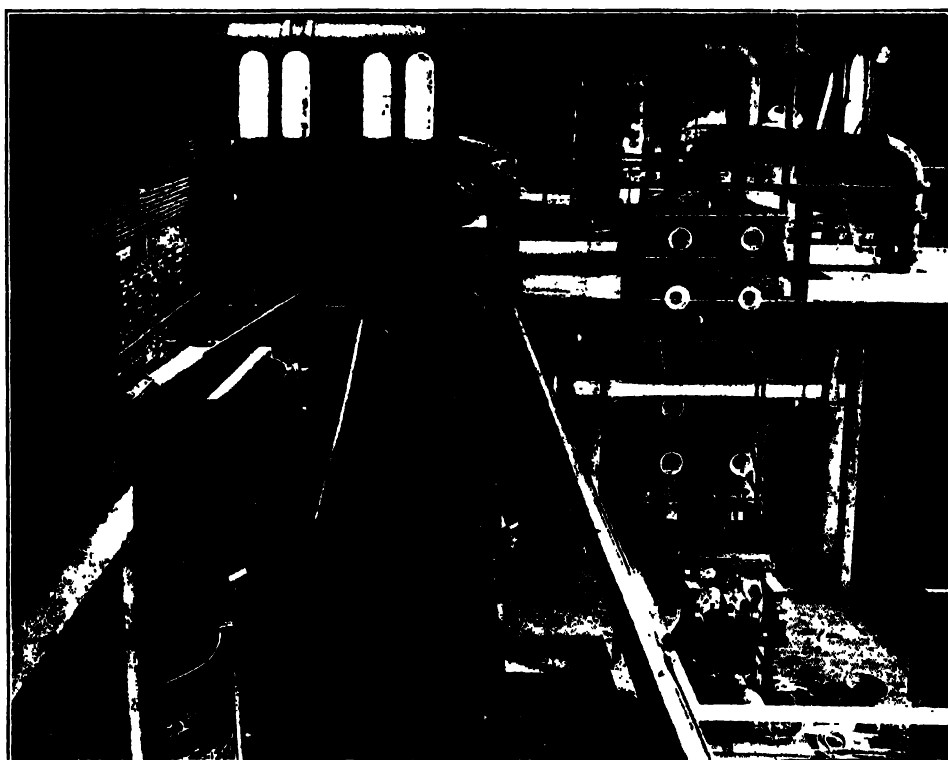


FIG. 1. GENERAL VIEW OF EVAPORATOR LABORATORY

a centrifugal, a crystallizer and a steam-jacketed kettle are now installed.

The station is housed in a building which was formerly the university power house. The old boiler room contains the laboratory proper. This is 65 x 35 ft. in plan; the floor is 15 ft. below ground level, and the roof extends in part to a height of 35 ft., giving ample head room. This room still contains the university's distribution system for steam, electricity and water, though the mains are now supplied from a new power house. A bunker 60 x 20 ft. is available for storage. The room is well adapted for the purposes of the work that will be done. In the front part of the building is an office and a drafting room for the use of the station staff. A good idea of this building is given in Fig. 1.

Vertical Tube Evaporator

The vertical tube evaporator (Fig. 2) is of the Swenson patented basket type. This choice was made not only because the Swenson Evaporator Co. was naturally most interested in this type of evaporator (as representative of vertical tube machines), but also because it made alterations of the heating surface much simpler. The body of the evaporator is of cast iron 30 in. inside diameter, and is built in 4-ft. sections. The bottom section carries connections for feed and wash water. Condensed steam from the basket is taken out through a stuffing box in this section. Intermediate sections have no pipe connections in ordinary operations. A pad is provided along one side of all sections. This carries a number of openings tapped for 2-in. and ¾-in. pipe. All ordinary connections are made through these openings, and such special piping as may become necessary is thus anticipated. The top section carries the steam connections. A 1½-in. line brings steam at about 100 lb. and a 3-in. line brings steam at about 3 lb. These unite in a "T" into a 3-in. line which passes through the top section and down the center of the evaporator to the steam basket. Some runs have been made with the top and bottom actions only, making the evaporator 8 ft. high. Most of the work has been done with one intermediate section, making the evaporator 12 ft. high. Another intermediate section is provided so that the evaporator can be carried to a height of 16 ft. if desired. The vapors are removed from the evaporator by a 10-in. cast-iron pipe to a wet parallel current condenser, which, instead of being mounted near the top of the evaporator, as is customary, is located on the operating floor so as to be available for test.

The steam baskets provided for this evaporator are all of 18-in. O.D. and carry twenty-four 2-in. charcoal iron tubes. They have a 3-in. central steam inlet and six ½-in. connections around the outside edge of the top head for manometer connections, etc. Condensed steam is removed by a 2-in. pipe flush with the bottom head. Four baskets are at present provided with

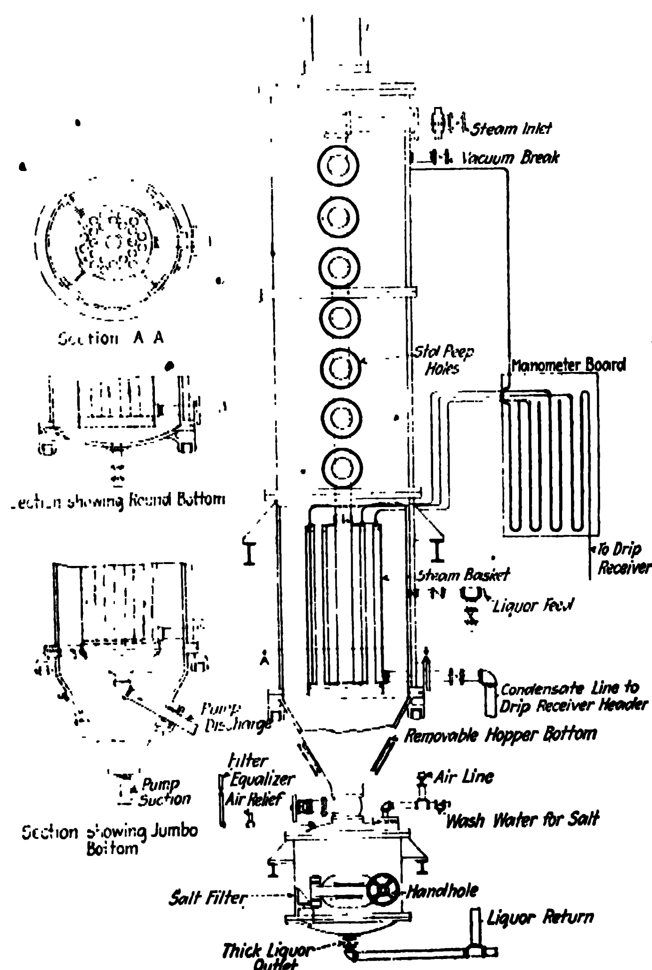


FIG. 2. DIAGRAMMATIC SKETCH OF VERTICAL TUBE EVAPORATOR

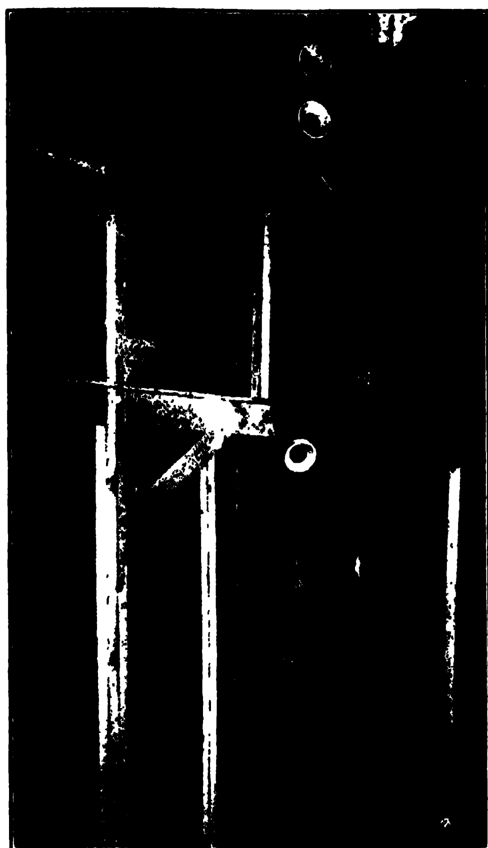


FIG. 3. VERTICAL TUBE EVAPORATOR WITH CONE BOTTOM AND SALT FILTER

tubes respectively 30 in., 48 in., 60 in. and 84 in. long. Baskets of this diameter give an annular down-take space of 6 in. This makes a very much larger ratio of downtake area to tube cross-section than is usual, but this was done purposely. The question of the proper value for this ratio is a rather important one on which no direct evidence is available. Sheet-iron filler cylinders are provided to reduce the diameter of the machine at the level of the steam basket so that the down-take ratio can be varied and the effect of changes in the ratio may be studied. This problem has not yet been taken up. The purpose of providing baskets of different tube lengths was mainly to study the question of ratio of tube length to tube diameter. Considerable work has been done on this, but the results will not be ready to report for some time.

The evaporator is provided with three bottoms—a flat bottom, a 60-deg. cone bottom, and a special cone bottom with provision for forced recirculation by an arrangement patented by the Swenson Evaporator Co. (called the "Jumbo" bottom). A salt filter, 24 in. in diameter and 18 in. high, is mounted on a truck at such a height that it may be connected by a 3-in. gate valve to the standard hopper bottom. Set screws in the brackets of this filter make its exact adjustment a simple matter. The filter is provided with monel metal screen held between two heavy perforated plates. (See Fig. 3.)

The evaporator is set so that the bottom flange of the lower section is about 8 ft. from the ground floor. An overhead trolley is provided for handling heavy parts. The various bottoms have brackets bearing rollers. Removable tracks may be quickly bolted to the columns which support the evaporator. When it is desired to change the bottoms on the evaporator, the tracks are put in place, the bottom which is in service is unbolted and lowered to the tracks (about 2 in.), rolled from under the machine and removed by the chain-falls. The new bottom is hoisted on the tracks, run under the machine and lifted into place by drawing up the bolts.

HORIZONTAL TUBE EVAPORATOR

The horizontal tube evaporator (see Fig. 4) is approximately 30 in. wide by 4 ft. long inside, made of ribbed rectangular cast-iron plates. The ends of the evaporator in ordinary commercial design are the tube sheets. In this evaporator, in order to make changes simple, the sides and bottom are assembled on a cast-iron frame called the front plate; and to this front plate is bolted the tube sheet. This makes it possible to change tube sheets, thereby permitting the study of such problems as varying the diameter of the tubes, varying their spacing, putting in circulation belts, etc. The tube sheets generally used take ⅞-in. O.D. tubes, on 1⅝-in. centers. This makes room for sixteen tubes in each horizontal row and twenty-eight in each vertical

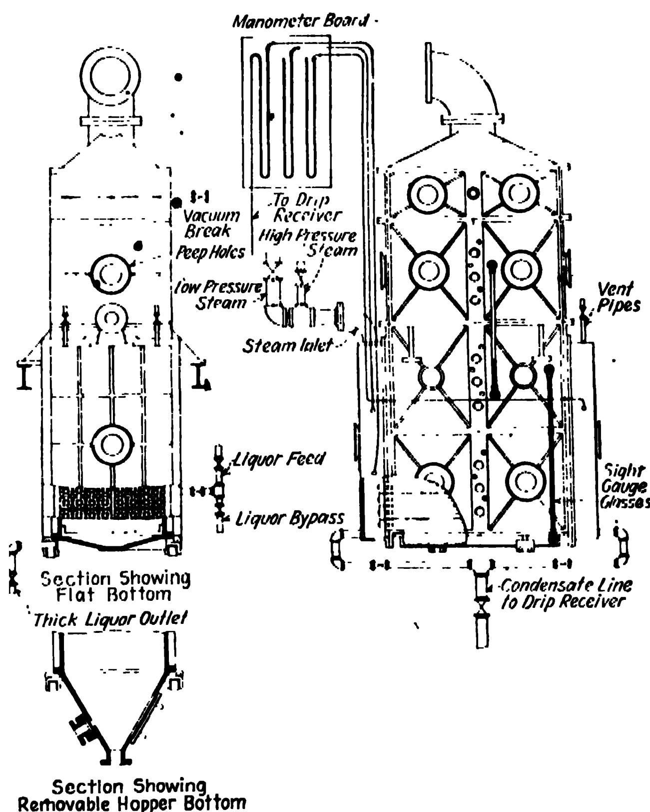


FIG. 4. DIAGRAMMATIC SKETCH OF HORIZONTAL TUBE EVAPORATOR

row. It is not intended that all these be used at once. Generally from forty to seventy-five tubes are used. They have an effective length of 3 ft. 10 in. and a heating surface of 0.75 sq.ft. per tube. The steam chests are cast box shape and have condensate drains from the bottom of each. Several vapor belts, each 27 in. wide, are provided, and the minimum height of machine is about 5 ft. This evaporator is also provided with a 10-in. vapor pipe, and its condenser is the same as the one on the vertical. Like the vertical evaporator, it is mounted on brackets so that the bottom is entirely unobstructed. It is provided with a flat bottom and also with a hopper bottom. It is set at such a height that when it is equipped with the hopper bot-

tom the salt filter which serves the vertical evaporator will fit it also. The salt filter is mounted on a truck, which makes it easy to transfer from one evaporator to the other. The hopper bottom is provided with a

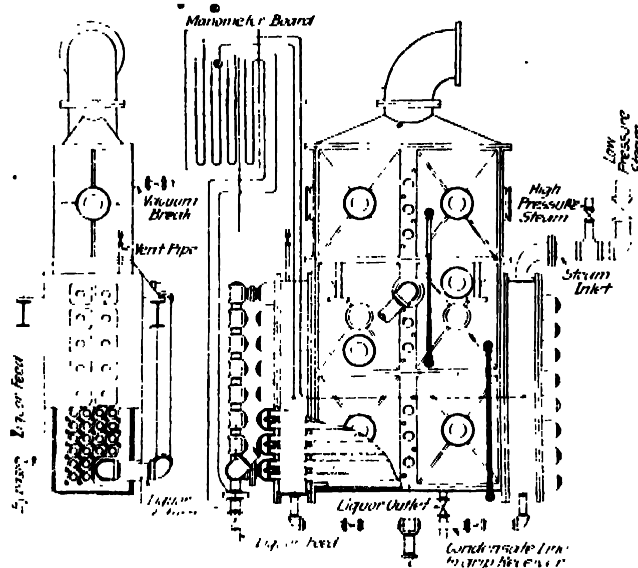


FIG. 5. DIAGRAMMATIC SKETCH OF SEMI-FILM EVAPORATOR

stuffing box so that the effect of forced circulation may be tried here also.

SEMI-FILM EVAPORATOR

This evaporator (see Fig. 5) is the third representative in the station and offers several interesting features. It is patented by the Swenson Evaporator Co. and is known as the company's "Type K" evaporator. It is primarily a horizontal tube evaporator similar to that just described except that it is only about 15 in. wide. It carries, however, 2-in. tubes. Corresponding to the steam chests of the horizontal tube evaporator are two steam belts, one on either end, and these steam belts, instead of being closed by a cover plate as in the ordinary horizontal evaporator, are closed by secondary tube sheets. These secondary tube sheets carry 1¼-in. tubes concentric with the 2-in. tubes in the primary tube sheet. These 1¼-in. tubes are connected in series on the outside of the evaporator by means of special return bends.

Steam is passed into one of the steam belts and thus enters the annular spaces between the 2-in. and the 1¼-in. tubes. The liquid to be evaporated is pumped into one of the return bends and circulated back and forth through all 1¼-in. tubes in the series. From the last return bend it is discharged into the body of the evaporator, where it is boiled by the 2-in. tubes as in an ordinary horizontal evaporator. It is possible in the operation of this machine to separate the inside tubes from the outside tubes and thus a very wide range of interesting problems is opened up.

CONDENSATE RECEIVERS

The whole subject of the basis for reporting the results of the station has been given careful consideration, and it has been decided to base all work on the actual heat transmitted rather than on amount of liquid evaporated. The latter plan obscures the results by introducing such factors as temperature of feed, loss by entrainment, radiation, etc. All these may be determined when desired; but the fundamental work is based on heat transmitted. Therefore the primary

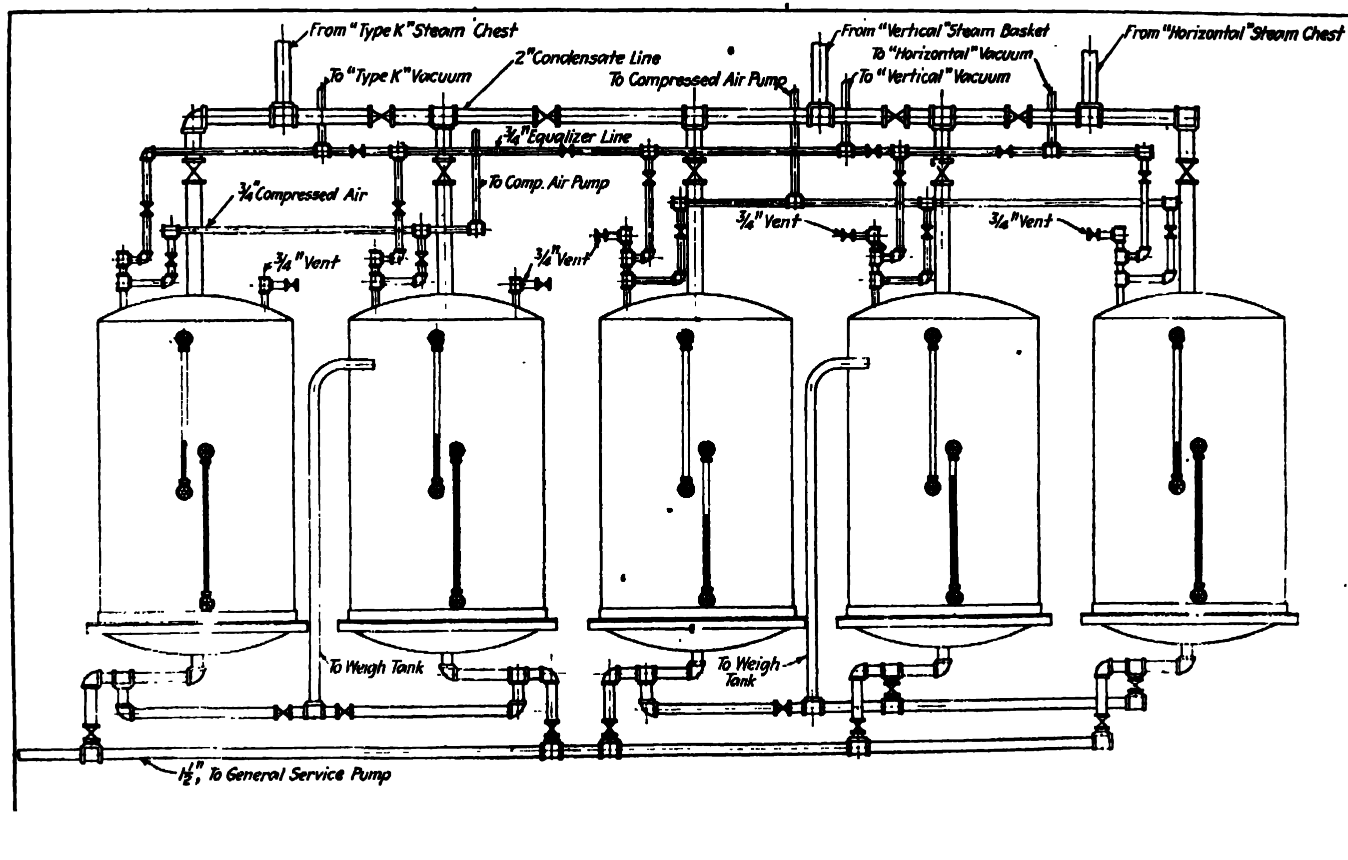


FIG. 6. ARRANGEMENT OF CONDENSED WATER RECEIVERS

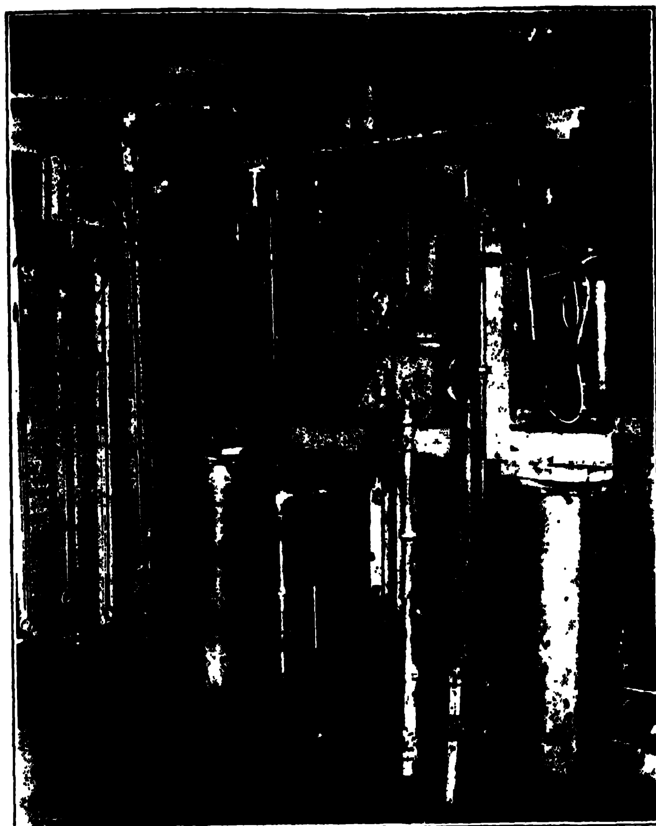


FIG. 7. WORKING PLATFORM; CONTROLS ON VERTICAL TUBE EVAPORATOR

measurement is the weight of steam condensed in a given time.

This is determined by collecting the condensate in receivers (see Fig. 6) in which it may be measured or from which it may be removed and weighed. There are five of these sheet iron tanks 30 in. in diameter, 48 in. high, with heavy cast-iron bottoms and sheet-iron heads. They are all connected into a 2-in. header. Into this header come connections bringing the condensate from the various evaporators. The headers and their valves are so arranged that all the evaporators may run at the same time or more than one receiver may be provided for runs where large amounts of steam are condensed.

In order to vent these receivers and also to remove non-condensed gases, each receiver has a ½-in. vent connected to a ½-in. header. This header in turn has three ½-in. vent lines, each with throttling and blow-off valves, running one to each evaporator. Suitable valves make it possible to vent any receiver to any evaporator. These vents, during a run, are throttled down to the point where they just serve to keep the steam space clear of non-condensed gases.

A header delivers compressed air to each receiver. The bottom outlets have two headers. One delivers to a gooseneck which discharges into a weigh tank, the other leads to the general service pump. Each receiver has carefully calibrated gage glasses and a thermometer for calculating density corrections to the calibrations. During a run the condensate level is noted at the beginning and at the end. The quantity may be calculated from the calibration; or compressed air may be turned in and the condensate blown over into the weigh tank. This latter method, of course, can be used only when the condensate is below 100 deg.

In spite of the large size of the equipment and its complexity, a highly centralized control system has been developed. From the working platform 7.5 ft. above the floor, one man can operate each evaporator and take all necessary readings. Steam, feed, condensate, vent and all other valves may be reached from one position, immediately in front of the manometer board. The condenser and vacuum pump are also controlled from this floor. Fig. 7 shows the controls on the vertical evaporator, and Fig. 8 on the horizontal.

All pressure measurements are made with mercury manometers connected by seamless copper tubing to the point where pressure is to be determined. All manometers for one evaporator are collected on a manometer board near the controls. Temperatures are measured by calibrated thermometers, protected by iron pipe guards. All measurements are taken in the metric system; partly because accurate laboratory apparatus is usually metric, partly because of simplicity of calculation, and partly because practically all of the literature on evaporator design is in German and hence comparisons with previous work are easier if results are in metric units.

Early in the work it was found that maintaining an accurately controlled vacuum was rather difficult. A vacuum regulator was devised which has been very satisfactory (see Fig. 7). A ½-in. pipe is led from the top of the vapor space to the instrument board and carries a Crane needle valve opening to the air. It also carries a special needle valve with no stuffing box around the stem. This stem is prolonged and is connected to a bar of soft iron which forms the core of a solenoid. An iron wire is immersed in the mercury in the open arm of the vacuum manometer. A brass rod ending in a platinum tipped wire passes through a stuffing box into the high side of the vacuum manometer. This rod is threaded and its position may be very accurately adjusted by a milled nut in a small bracket on the instrument board. The vacuum pump is run a little faster than necessary to maintain the desired vacuum. As the mercury in the vacuum manometer rises and reaches the desired point, it makes

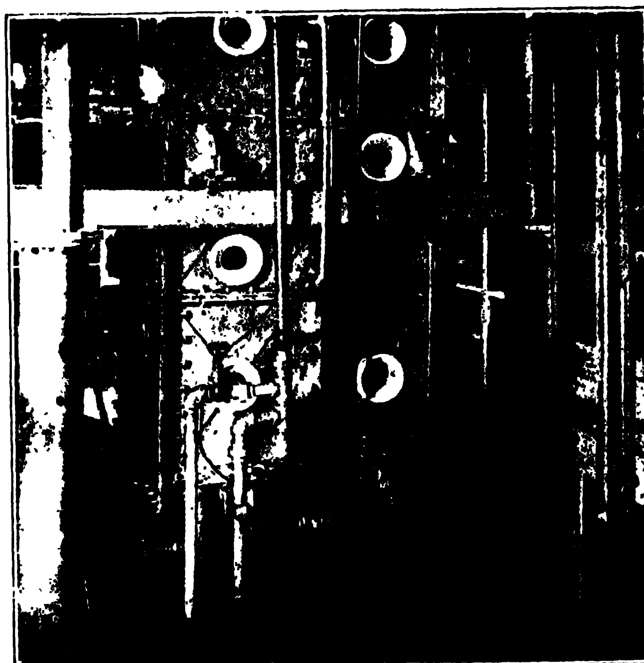


FIG. 8. WORKING PLATFORM; CONTROLS ON HORIZONTAL TUBE EVAPORATOR

contact with the platinum tipped brass rod and thereby closes a circuit through an ordinary telegraph relay. This relay closes a 220-volt circuit through the solenoid, opens the needle valve and bleeds air into the vapor space of the evaporator until the vacuum falls to the desired point. The second needle valve above mentioned is set by hand to give an approximation and the regulator is thus left to take care of only minor fluctuations. The device has worked very satisfactorily and will usually hold the vacuum to within 2 mm. for an indefinite length of time. Occasionally the strokes of the vacuum pump become synchronized with the natural period of vibration of the mercury, which produces regular surges in the manometer with a slight decrease in the accuracy of regulation.

An upper platform, 15 ft. above the floor, is provided for giving access to the upper parts of the evaporators. Weigh tanks and feed tanks, one of each for each evaporator, are located here. When desired, the feed may be weighed, but, as discussed later, this is not often necessary. This obviates maintaining an operator on the upper floor during a test. The station is surrounded by a balcony at this level connecting with these upper platforms and with the office.

General Equipment

The station is served by a 1½-in. class "C" Worthington volute pump. By means of a manifold on the suction and another manifold on the discharge this pump performs practically all the work of the station. One ring discharge main extends around the station connecting with all the storage tanks and evaporator feed tanks. The common suction line is not a complete ring, but includes all the storage tanks on one side and all the evaporators on the other side. There are a number of separate connections besides these two principal mains. A Marsh 3 x 5 x 8 magma pump is connected into the suction line and into the ring main; and valves are so placed that it may be used either as a substitute for the general service pump, or operated in parallel with, but independent of, the general service pump.

The three condensers unite in a cross and the fourth outlet of this cross is connected to an American-Marsh 8 x 10 x 12 vacuum pump. Valves are placed in the lines to the condensers so that evaporators not in use can be completely cut off. This pump and the magma pump mentioned before are a gift to the laboratory from the American Steam Pump Co. of Battle Creek. A small direct steam driven air compressor furnishes air at 25 lb.; city water at 60 lb. and 220-volt direct current are furnished from the university mains. The floor of the station is below the sewer. Waste water is consequently discharged into a sump, from which it is lifted by a Worthington Duplex 5¼ x 4¾ x 5 tank pump, the gift of the Henry R. Worthington Co. The station also has a 10-in. experimental centrifugal (see Fig. 1), loaned by the American Tool & Machine Co., and a No. 2 Sweetland filter, loaned by the United Filters Co. A crystallizer, a steam-jacketed still, and additional transfer pumps will be added in the immediate future. A Tagliabue liquor level regulator loaned by the Tagliabue Manufacturing Co. has simplified the experimental work on the vertical tube evaporator.

Program

The work of the station falls into two very distinct classes. The first, by far the most important, is the class of purely theoretical investigations into the principles of evaporator design. Two papers, the first results of this program, are being presented herewith.[1] These two deal with the vertical tube evaporator because the staff of the station has been insufficient to keep work going continuously on all three evaporators. A great deal has already been done on the horizontal tube evaporator and the "Type K" evaporator, but no results are ready for publication from these machines. The program of problems already outlined involves over sixty separate questions, illustrations of which are the problems already mentioned in connection with the vertical tube and horizontal tube evaporators. It is hoped that it will be possible to publish a continuous series of papers along these lines; and the volume of work so available depends primarily on the growth of graduate work in the chemical engineering department of the University of Michigan.

The second class of work in which the station is engaged is in the solving of concrete problems regarding the development of a particular process or the evaporation of particular solutions. As a sample of the types of problems already handled may be mentioned the following: The production of high-grade table salt from dilute brine carrying much larger amounts of calcium and magnesium chlorides than is considered practical in ordinary salt manufacture; the preparation of a high-grade potash salt from an impure Western brine carrying sulphates, chlorides and carbonates of both potassium and sodium; the evaporation of dextrine sirup to high concentration; the design of a lead evaporator for the manufacture of aluminum sulphate, etc.

The station was originally planned to study evaporators only and consequently no accessory apparatus such as filters, centrifuges, etc., was planned. The size and scope of the concrete problems which have come up have made necessary a revision of this plan, and it is intended now to extend the equipment of the station until there will be in existence a complete chemical plant with all its units on the scale of the evaporators. This will mean that complete processes can be worked through in ton lots. It takes at least 1,000 gal. of a solution to make a satisfactory test so far as the evaporators are concerned. This station is not interested in the working out of new processes on the usual chemical laboratory scale, as there are other organizations much better fitted to handle that class of research work, but we are interested in the working out, on a commercial scale, of processes already established in a chemical laboratory.

Interesting though these specific problems are, it is not intended that they shall ever displace the principal purpose for which the station was founded, which is the study of the underlying principles of evaporator design and through them the extension of our knowledge of the whole phenomenon of heat transmission from steam to liquids.

Chemical Engineering Department,
University of Michigan,
Ann Arbor, Mich.

[1] These papers will be published in subsequent issues of this journal.

Cement Factory Opened in Chosen (Korea)

The Onoda Cement Manufacturing Co., of Japan, which was formally opened at Pyongyang, Chosen, in May, is reported to have a capacity of 60,000 tons of cement a year, making it one of the biggest factories of the kind ever established in that country.

Current Events
in the Chemical and Metallurgical Industries

Important Sections Planned for Chemical Exposition

The Sixth National Exposition of Chemical Industries, which is to be held at Grand Central Palace, Sept. 20-25, plans many innovations, among which are sections on Fuel Economy, Materials Handling, Chemical Engineering and Industrial Management. Arrangements have been made for the presentation of papers by eminent men in the profession on important topics in these sections according to the following tentative program:

FUEL ECONOMY

Fluid-Heat Transmission .... H. B. McKechnie
Refractory Cement—Life Insurance for a Furnace .... F. W. Reisman
Producer Gas and Modern Mechanical Producer .... W. B. Chapman
Preventing Conduction and Radiation Heat Waste .... S. L. Barnes
Powdered Coal .... W. O. Rankin
American Dressler Tunnel Kilns.......... C. Dressler

MATERIALS HANDLING

Chain Belt Transmission .... F. G. Anderson

CHEMICAL ENGINEERING

Nitration .... H. Hough and W. Savage
New Methods of Destructive Distillation .... T. W. Pritchard
Corrosion and Galvanic Action in the Industries .... W. D. Richardson

INDUSTRIAL MANAGEMENT

Ultra Analysis of Costs.................H. E. Ernst
Research in Industrial Conservation.......H. E. Howe

There will be a wide range of exhibits this year. The fact that the Exposition has been divided into sections has caused greater interest than ever and the Materials Handling Division and the Fuel Economy Division, both of which will be new this year, have attracted many large concerns.

As in the past, moving pictures will be a part of the general program. Several new reels depicting various important chemical and mining industries have been arranged for.

The Materials Handling Section will embrace exhibits of machinery and equipment, and will be interesting to manufacturers because every industry must at some stage of its business convey its products from the place of its manufacture to the place of its consumption. Raw material must also be handled, and with the scarcity of man power, machinery promises to be a big factor in the future. It is expected that this section will enable the manufacturers to see the economy as well as the efficiency of machinery in the matter of conveying material.

The Fuel Economy Section is important in view of the high price and the increasing cost of coal. In the section will be shown machinery and apparatus, furnaces, producers, stokers and all devices that tend to the economical utilization and the more efficient combustion of fuel.

With the majority of the exhibits tending along the lines of progress and economy it is evident that a visit to the Exposition will benefit manufacturers and business men. Impressions not to be gained elsewhere which will be valuable in the future will be stowed away; for a glance into the inside of chemistry has been known to bring improved conditions in many industries and manufacturing plants.

Columbia University Offers Six-Year Course in Engineering

To meet the more exacting demands required of men in the engineering profession today, the faculty of Columbia University has arranged a 6-yr. course for would-be engineers. There is a feeling at present among some men that engineers as a whole are not as well educated as other professional men. Columbia, realizing this, is trying to solve the problem by lengthening the engineering courses to six years, three of which will be devoted to general education and three to specialized work.

The first three years are devoted to the study of mathematics through differential and integral calculus, elementary differential equations, general chemistry and qualitative analysis, general physics, drawing and the humanities. This curriculum, together with the general exchange of ideas through contact between fellow-students from all parts of the civilized world, will give the men greater opportunity to broaden out than is possible in a 4-yr. course.

After the general college course, it is expected that the student will apply all his energies seriously to perfecting himself in the line of endeavor he expects to make his life work, and all the courses are arranged with this end in view, particular emphasis being laid on the further study of subjects pertaining to mining, metallurgical, civil, electrical, mechanical and chemical engineering, and leading to degrees in these professions.

Such an arrangement will not only broaden the men, but will raise the standard of their profession, for by the law of the survival of the fittest the tendency would be for only such men as have the necessary qualifications to stick and complete their course.

Bureau of Mines Seeking Site for Experiment Station

Five cities in the South believe they are especially qualified for the site of the new non-metallic experiment station which is to be established by the Bureau of Mines. They are Chapel Hill, N. C.; Atlanta, Ga.; Birmingham, Ala.; Tuscaloosa, Ala., and Knoxville, Tenn. Dorsey A. Lyon, supervisor of stations for the Bureau of Mines, and Dr. R. B. Moore, its chief chemist, have recently been in the South, checking up the claims of each of the cities mentioned.

In effect, the new station will be a chemical station, since it is the chemical industries that have the greatest interest in non-metals.

Preliminary Program for Chicago Meeting of the American Chemical Society

The Sixtieth Convention of the American Chemical Society to be held with headquarters at the Congress Hotel, Chicago, Sept. 6 to 10, 1920, promises to be a most successful meeting as shown by the plans so far developed by the executive committee of the Chicago Section.

On Monday noon the Chicago Chemists' Club will entertain the directors and officials of the national society at luncheon. The councillors will convene about 4 p.m. on the same day and adjourn at 6:30 to be entertained by the Chicago Section at dinner. This meeting will be re-called at 8 p.m. to continue with the business of the Society.

Tuesday morning the general addresses will start downtown, and after luncheon will be reconvened at the Patten Gymnasium, Northwestern University, Evanston, about 2 p.m. About 4 p.m. the evening entertainment will start. This will be a marked departure from the time-worn smoker, permitting the attendance of the ladies, and consisting of a beach party, picnic supper, athletic contest, college reunions, musical program outdoors, and a special program in the gymnasium after 8 p.m.

Under the towering elms of the campus, on the shores of Lake Michigan, the band concert will continue until 7:30 p.m. Refreshments will be served, and baseball games held between teams to be later announced. The beach of Lake Michigan is a beauty spot which will attract many from the other entertainments during this period. Rowboats will be furnished. The swimming tank in the gymnasium will be open for men. An organ concert will be given in Fisk Hall, from 4:30 to 6 p.m.

A special feature of the outing will be the decoration of the campus with the colors of the American Chemical Society, college banners, chemical fraternity pennants and the colors of other chemical organizations to serve as nuclei and stimulate many reunions. The entertainment committee will provide a booth at which reservations can be made by such groups as desire to sit together at supper. This picnic supper will be served at tables in another portion of the large campus.

The entertainment program, given indoors at 8 p.m., is veiled in mystery as to details. In case of inclement weather all events will be carried out in the mammoth gymnasium, which has several halls large enough to accommodate many times more than will be present.

Other social features provided during the week are entertainments for the ladies and the banquet on Wednesday night. This banquet will be at the Congress Hotel and the program embraces a songfest, timely speeches and numbers by noted opera singers. For the ladies Miss Ethel M. Terry, chairman of the committee, promises an automobile trip, a specially guided tour of the Chicago Art Institute, dinner for the professional women and many alternative excursions. These plans are in addition to the general entertainments which the ladies will attend. There will be a hostess lady for every visiting lady.

Divisional Meetings

While the headquarters of the convention are to be at the Congress Hotel, arrangements have been made to hold all divisional meetings at the University of Chicago. Facilities are there available for lanterns, blackboards and auditoriums with fine acoustic properties such as will make this work a real pleasure. Luncheons are to be provided at the Edelweiss Gardens, a five-minute walk from the buildings. Thursday and Friday will find the visitors then in an atmosphere appropriate to the true purpose of the convention.

Visits to Industrial Plants

On Wednesday afternoon the members will assemble at the Van Buren St. station of the Illinois Central for a visit to the plants of the Sherwin-Williams Paint Co., the Carter White Lead Co., Libby, McNeil & Libby canning plant, the Pullman Car Co. and the Doehler Die Casting Co. Friday morning the works of the Grasselli Chemical Co., the U. S. Lead Refining Co. and the American Maize Products Co. will be inspected, while the afternoon trip will include the Crane Co.'s gray-iron foundry, the Fansteel Co., tungsten products, the Lindsay Light Co. and the Carnotite Reduction Co. plants.

The executive committee of the Chicago Section in charge of the work is composed of the following members: W. Lee Lewis, chairman; F. M. DeBeers, Convention treasurer; R. J. Quinn, Convention secretary; Julius Stieglitz, honorary chairman; W. A. Converse, finance; Chester H. Jones, publicity; H. McCormack, excursions; G. H. Pichard, registration and information; S. L. Redman, hotels; A. E. Schaar, transportation; J. A. Hynes, program; D. K. French, banquet; Herbert N. McCoy, men's entertainment; Ethel M. Terry, ladies' entertainment; William Hoskins, relation to other scientific societies.

Chemical Industries Protest Coal-Tar Priority

While the chemical industries were not represented among those who appeared before the Interstate Commerce Commission to protest against allowing coal mines to have prior claim on open-top cars, the Commission has received many informal complaints from chemical industries, as much of their raw material is moved in that class of equipment. The Commission recognizes that much hardship and great losses are being occasioned by its various orders giving priority to the movement of coal, but feels that it is absolutely necessary to concentrate on coal transportation to the exclusion of most other commodities. This is due largely to the fact that coal can be moved with so much greater facility in the summertime as to constitute a great saving of cars. It is believed that if coal is moved in maximum quantity, up to Sept. 1, the worst of the situation will have been surmounted. After that time, it seems probable, other industries will be able to have their normal proportion of cars.

The decision of the Railroad Labor Board is expected to have a very immediate effect on efficiency in transportation. It is apparent that the Commission is fully determined to stand by its priority orders, despite the great pressure which has been exerted to secure their modification. It was evident that the Commission was most impressed by the complaint that the so-called non-essential industries are being allowed the use of a large portion of the supply of open-top cars which are used in transporting their coal supply, while the chemical industry, the building industries and the maintenance of highways are practically denied any use of this class of railroad cars. The difficulty is that the Commission does not feel that it has the authority to discriminate between essential and non-essential industries.

Industrial Relations Association Elects Officers

J. M. Larkin, assistant to President E. G. Grace of the Bethlehem Steel Co., Bethlehem, Pa., will direct the destinies of the Industrial Relations Association of America for the coming year. He was the unanimous choice of the members of the board of directors at the annual reorganization meeting at Atlantic City. Mr. Larkin is ably qualified for the place, being one of the few industrial relations men of the country who have been given recognition as such by a seat on the board of directors of his company. His handling of the representation plan in effect at the plants of both the Bethlehem Steel Co. and the Bethlehem Shipbuilding Corporation has won him the highest esteem, of both the company and the workers.

Mark M. Jones, director of personnel of the Thomas A. Edison Industries, whose resignation as executive secretary was received and accepted to be effective Sept. 15 at the latest, was elected vice-president. A change in the constitution of the organization is being planned to allow the election of six other vice-presidents, each one of whom will be assigned to a specific territory.

F. C. Parker, executive officer of the Central Y.M.C.A., Chicago, and secretary of Chicago Council, Industrial Relations Association of America, was elected secretary for the second time.

W. H. Winans, of the Union Carbide & Carbon Co., New York City, was elected treasurer. For the present the administrative offices will remain at Orange, with E. A. Shay, the assistant secretary of the association, in charge. A meeting of the board of directors will be held in Buffalo on July 30 to formulate a program for the coming year and to elect a successor to Mr. Jones.

The administrative offices are now engaged in preparing for publication the proceedings of the Chicago convention in May, at which between 2,000 and 3,000 industrial relations workers and executives of all classes were in attendance.

Program of Fall Meeting of T.A.P.P.I.

On Sept. 1 to 3, 1920, the fall meeting of the Technical Association of the Pulp and Paper Industry will take place at Saratoga Springs, N. Y., with headquarters at the Grand Union Hotel. The program gives assurance of a most interesting and instructive meeting.

The business session will open on Wednesday morning, Sept. 1, at 9:30 o'clock, in the Casino. Officers' and committee reports will be presented, followed by papers on special subjects, an especially important one being on the Washing of Felts. In the evening members and guests will be entertained at dinner by the paper manufacturers of the Hudson River Valley and vicinity. The speakers thus far selected include C. R. McMillen, of the Union Bag & Paper Corporation, who will act as toastmaster; Philip T. Dodge, of the International Paper Co., and Colonel C. H. L. Jones, of the Spanish River Pulp & Paper Mills, Ltd.

Thursday, Sept. 2, will be given up to mill visitations, followed by a steamboat excursion on Lake George in the evening. It has been arranged to pay visits of inspection during the day to the plants of the International Paper Co., Finch, Pruyn & Co., Union Bag & Paper Corporation, Standard Wall Paper Co. and Sandy Hill Iron & Brass Works. Automobiles will be provided to convey the members to and from the places visited.

On Friday the members of T.A.P.P.I. and their guests will be taken to the works of the General Electric Co., at Schenectady, where the machinery and electrical apparatus used in pulp and paper mills will be shown in the making. The visitors will subsequently be the guests of the General Electric Co. at luncheon. In the afternoon it is planned to visit the felt mills of F. C. Huyck & Sons and the Albany Felt Co.

T.A.P.P.I. asks the pulp and paper manufacturers who are represented by membership in the association to take a broad and generous view of this gathering of the technical men of the industry and arrange for a good attendance on the part of members connected with their mills, or of prospective members. The stated meetings of T.A.P.P.I. afford valuable opportunities for the discussion of common problems, new developments, methods and processes, and it is hoped that mill executives will appreciate the advantages to be derived from their technical advisers coming in personal contact with the engineers and chemists of other mills in this way.

Chemical Warfare Service and Charcoal

Due to the fact that private concerns at Columbus, Ohio; Elizabeth, N. J., and Cleveland, Ohio, are conducting important researches in connection with the utilization of charcoal for chemical purposes, the Chemical Warfare Service has suspended temporarily that portion of its research work. This is done to avoid possible duplication of effort. Later, the Chemical Warfare Service expects to take up experiments with the synthetic charcoals made from coal and coke.

General A. A. Fries, chief of the Chemical Warfare Service, is gathering many important data regarding special uses of charcoal. Since the efficiency of the gas mask depends upon certain classes of charcoal, the Chemical Warfare Service expects to keep in very close touch with all developments in that connection. Just at present, General Fries is greatly interested in the development of an excellent charcoal from rice husks. The rice husk contains a great deal of silica and as a result, when properly burned, does not powder into a lampblack. During the war it was found that the charcoal made from coconut shell was best suited for use in gas masks. Cohune nut charcoal and peach pit charcoal came next in respective desirability. As yet no better substitutes have been found, but experiments are planned which will take up the matter of impregnating charcoals with chemicals which will add to their efficiency in neutralizing gases.

General Fries will request an appropriation at the next session of Congress which will enable him to add several civilian chemists of ability to his staff. At present the chemists needed in the service must be drawn from the Army. It is the desire of General Fries to supplement his staff of military chemists with several civilian chemists who have specialized in the subjects of greatest interest to the Chemical Warfare Service. This need will be met in the meantime by the appointment of consulting chemists who will be willing to give a limited amount of time to the problems of the Service, in connection with their regular work. They will be paid a nominal salary. The first consulting chemist to be appointed is Dr. E. E. Reed, of Johns Hopkins. Other appointments will be made soon.

Quebec Pulpwood Embargo to Stay

It is announced officially that the Quebec Government has no intention of raising the embargo on the export of pulpwood as has been demanded by American interests.

Bakelite Used for Airplane Propellers

A series of tests with Bakelite propellers has recently been completed by the Army Air Service. The results are reported to have been satisfactory. Several designs of propellers were used, but the micarta construction was more serviceable. These propellers were made by coating sheets of duck with Bakelite, then pressing five or six of these sheets tightly together to form a board that is sawed out in the shape of a propeller lamination just as wood laminations are cut. The Bakelite is then molded to an exact angle in a special mold under pressure at 350 deg. F.

The advantages discovered in the Army tests are: Uniformity of texture; strength; absence of warping; elasticity; absence of metal hub; uniformity of all propellers made from the same mold; proof against abrasion; proof against moisture, including oil; freedom from checking and splitting; adjustable pitch feature, resulting partly from elasticity; ease and rapidity of manufacture, once the molds are completed.

Shortage of Chlorine Affects Purification of Water Supply

Complaints of short supplies of chlorine and other chemicals used in water purification have reached the Interstate Commerce Commission from several sources. It is the opinion of Dr. R. B. Moore, chief chemist of the Bureau of Mines, that these shortages are chargeable mainly to the transportation situation, but he calls attention to a general tendency on the part of chemical manufacturers to overestimate the length of time that stocks accumulated during the war will last. The fact that stocks frequently are overestimated and that consumption is greater than is realized has resulted in great scarcity in several chemicals. Stocks become low before the manufacturing of new supplies starts, with the result that shortages become acute before production catches up with demand.

Retirement of Government Scientists

The only member of the scientific staff of the U. S. Geological Survey who will retire at an early date under the recent act for retirement of Government employees is T. Nelson Dale, geologist. Mr. Dale has been for a long period on the geological staff of the Survey, engaged particularly in economic geology studies of slate, granite, marble, etc.

Dr. F. W. Clarke, chief chemist, and William H. Dall, geologist and paleontologist, are of retirement age, but under the provisions of the act will be retained in active service for an additional period.

None of the members of the scientific staff of the Bureau of Mines is affected by the provisions of this act for retirement. Similiarly none of the scientific men at the Bureau of Standards will be retired.

Shortage of Motor Fuel Serious

The gasoline shortage in the Pacific Northwest is rapidly becoming acute. For the past month it has been with difficulty that the three large oil companies operating in that territory have been able to provide sufficient gasoline for the most necessary of occupations. The rationing system has been in effect for a month and in general has limited trucks to purchases of ten gallons and pleasure cars to tankfuls of three gallons. Only vehicles operated by fire and police departments and doctors have been able to secure unlimited supplies. The Standard Oil Co., Shell Co. and Union Oil Co. do not offer any hope for permanent relief from the shortage until in the middle of the summer at the very earliest with possibilities that strict economy will be necessary until next fall. The reasons ascribed to the shortage, are insufficiency of supply of the oil obtainable in California oil fields. Besides affecting hundreds by shortage of the gasoline supply, the lack of fuel oil is also embarrassing a great many manufacturers in that since they are equipped to burn fuel oil, it is with difficulty that they are able to rapidly make changes that will provide for coal burning. It is possible that the ultimate solution for this latter situation may be the substitution of powdered coal or producer gas.

Chemical Exports and Imports During May

Exports of chemicals during May, 1920, were valued at $18,357,237. This is nearly double the value of the chemicals exported in May, 1919. Some of the items making up the total, as well as revised figures for May, 1919, are as follows:

	May, 1919	May, 1920
	Lb.	Lb.
Acids:		
Carbolic	130,457	420,274
Nitric	17,890	99,359
Picric	88	53
Sulphuric	1,627,860	2,655,432
Benzol	70,482	1,484,630
Calcium carbide	2,883,309	1,452,955
Copper sulphate	861,168	461,916
Lime:		
Acetate of	97,017	4,425,267
Chloride of (bleaching powder)	1,752,352	5,560,938
Chlorate of potash	57,380	235,130
	Value	Value
Total sodas	$927,600	$2,702,473
Total chemicals	9,733,513	18,357,237
Total dyes and dyestuffs	954,943	3,377,885
Medicinal and pharmaceutical preparations	1,523,784	2,305,718

Some of the import figures, as compiled by the Bureau of Foreign and Domestic Commerce, are as follows:

		Lb.	Lb.
Acids (except coal tar acids)			
Oxalic	(duty)	none	6,406
All others:			
Duty		266,791	490,926
Free		4,260,288	1,096,921
Chemical and medicinal compounds:			
Alkalis, alkaloids and preparations, mixtures of	(duty)	418,731	777,661
Medicinal preparations,	(duty)	84,473	150,293
		Value	Value
Total coal-tar products		$737,909	$634,840
Total gums		2,520,845	5,714,192
Total chemicals, drugs, dyes, etc.:			
Free		4,534,508	15,734,604
Duty		6,229,522	3,286,458

Re-exported chemicals, as compiled by the Bureau of Foreign and Domestic Commerce, are:

	1919	1920
	Lb.	Lb.
Acids:		
Carbolic	none	none
Oxalic	none	11,540
All other	7,204	74,415
Extracts and decoctions for tanning:		
Quebracho	21,442	366,419
All other	none	971,196
Gums:		
Camphor, crude, natural	264	13,431
Camphor, refined and synthetic	2,625	19,448
Copal, dammar and kauri	98,677	160,719
Gambrier, or terra japonica	none	16,503
Indigo, natural or synthetic	14,014	74,455
Iodine, crude or resublimed	none	none
Licorice root	372	none
Opium, containing 9 per cent and over of morphia	789	41,538
Carbonate of potash	none	none
Nitrate of soda	none	none
	Value	Value
Total chemicals, re-exported	$222,443	$1,052,878

Movement to Form Chemical Warfare Service Association

A movement is under way to establish a Chemical Warfare Service Association. Qualifications for membership will not be restrictive and anyone who is particularly interested in the work being performed by the Service will be eligible.

More Swiss Dyes Here

Another large consignment of Swiss dyes, consisting of 13 casks, 4 barrels, 115 packages, 90 cylinders and 5 cases, arrived the first week in July from Havre. It is understood that these assorted colors will be disposed of in the same way as former consignments, without disturbance to the local market. Further shipments from the same source are expected and arrangements have already been made for allotments to the consuming trade.

It is not expected that these foreign products will interfere in the slightest degree with the market for American colors; in fact there is a tendency to welcome the relief thus afforded from the pressure brought to bear on the manufacturers.

Railroad conditions are still retarding business, but the most serious handicap thus far experienced has been the shortage of coal at plants. This has already resulted in the shutting down of one New Jersey plant and curtailment of operations at others.

Additions to Columbia University Metallurgical Laboratory

In addition to the equipment of the Columbia University metallurgical department, in the ore-dressing laboratory, which was installed by Prof. H. S. Munroe, now retired, there is being added, under the direction of Prof. Arthur F. Taggert, a Hardinge conical mill, a Dorr classifier, a Dorr thickener, a Deister-Overstrom concentrating table with interchangeable decks, flotation equipment to demonstrate different successful flotation processes, and considerable accessory equipment such as microscopes, polariscopes, refractometers and viscosimeters. Additional motors are also being provided to drive this machinery. These changes and additions have been made possible by the generosity of machinery manufacturers and of individuals and mining companies who have contributed money.

Executive Committee Meeting of the Manufacturing Chemists Association

The regular monthly meeting of the executive committee of the Manufacturing Chemists Association was held at the India House, New York City, Wednesday, July 21. The session was called to order by Chairman Henry Howard of the Grasselli Chemical Co. The committee voted favorably on the mechant marine bill and expressed hope that it would help the export business. The Chamber of Commerce referendum No. 31 was also favorably received.

In co-operation with the Bureau of Explosives the test committee is working out standard tests for carboys to reduce the percentage of breakage in transportation. This work is being carried on at the Grasselli Chemical Co.'s plant in New Jersey.

Rubber From Candleweed

The plant of the Ocotillo Products Co. at Salome, Ariz., has started operations and is producing a ton of crude rubber per day from the ocotillo, or candleweed, which grows wild in great abundance in that section. The product is said to vulcanize satisfactorily and to act in every way like rubber. One ton of ocotillo yields 200 lb. of gum and 90 lb. of a tarry product which is marketable.

The company was organized in Indianapolis, Ind., but will establish permanent offices in Los Angeles.

Bureau of Mines to Assist in Power Survey

O. P. Hood, chief mechanical engineer of the Bureau of Mines, will be a member of the principal engineering staff in connection with the superpower investigations of the U. S. Geological Survey. Mr. Hood presumably will be directly in charge of those aspects of this power development work which relate to coking of coal and efficiency in fuel utilization. He will be responsible for tieing up the Survey superpower study with the related investigations of the Bureau of Mines, most of which are under his direction. This development is directly in line with the editorial comment made in this journal recently, referring to the possibility of coking coal and augmenting the supply of byproduct gas in lieu of developing electric power and building transmission lines. It indicates that the problems emphasized as important from an industrial-chemical point of view will receive that attention which they deserve, as Mr. Hood is intimately acquainted with these.

Book Reviews

ELECTRIC FURNACES IN THE IRON AND STEEL INDUSTRY. By *W. Rodenhauser*, *J. Schoenwa* and *C. H. Vom Baur*. Third edition, 1920. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Electric Furnaces in the Iron and Steel Industry contains considerably more information descriptive of electric iron and steel furnaces and more electrometallurgy of iron and steel than any other book which has been published on the subject. The book is written in a somewhat German style, and contains considerable descriptive matter which the average technical reader might not consider necessary. The arrangement of the book would be improved if the information in the two chapters of Part II—materials used in furnace construction, and the electrometallurgy of iron and steel—was placed where the subjects are first discussed in Part I. This is especially true of the electrometallurgy of iron and steel, as a reader familiar with the subject finds considerable data lacking when he reads the discussion on electric furnace pig iron in Part I. Too much space has been allotted to the induction furnace. The induction steel furnace may have considerable standing in Germany, but it has none in the United States, where interest in it is largely of a historical nature. An excellent feature is the inclusion of basic electrical information on which the design and operation of electric furnaces is dependent. Considering the fact that Heroult electric steel furnaces have been installed in considerably greater number than any other type of electric steel furnace, not enough space is devoted to this furnace. The value of the book would be increased by discussion of processes to a greater length, including manufacture of steel castings, alloy steel, acid steel and basic steel, and giving more actual operating detail for use of the furnace operator. A new development covered briefly is the production of synthetic pig iron from steel turnings in Canada. It is to be regretted that the book went to press a little too early to include the results of Keller on production of synthetic foundry iron. An important subject not mentioned is the heat treatment of steel in the electric resistance furnace, a phase of electrometallurgy which has had a great development during the past three years.

Except for the following additions there are few changes in the text from that of the 3rd edition, 1917: Seede electrode regulator, Greene furnace, Moore furnace, Booth-Hall furnace, Vom Baur furnace, Ludlum furnace, pig iron from steel turnings, and duplexing with the cupola. Although the arrangement of the book is not the best, and there are several important omissions, the book contains a large quantity of information and is the most up-to-date publication on the subject.

ROBERT M. KEENEY.

Personal

Dr. CHARLES FREDERICK CHANDLER received the honorary degree of Doctor of Science at the recent commencement exercises at Union College. In conferring the degree, Dr. Charles Alexander Richmond, chancellor of the university, spoke briefly as follows: "Charles Frederick Chandler, educated at Lawrence Scientific School, Harvard University, and at the Universities of Berlin and Göttingen; professor of chemistry at Union College, 1857-1864; one of the organizers and for many years dean of the School of Mines of Columbia University; author of many chemical papers; member of many scientific and learned societies both here and abroad; the recipient of distinguished academic honors from universities in America and England; esteemed by your profession, beloved by generations of grateful students to whom you have imparted both knowledge and wisdom, we delight also to do you honor. *Honoris causa*, I admit you to the degree of Doctor of Science and direct that your name be enrolled among the honorary sons of Union College."

M. J. GAVIN, refinery engineer for the U. S. Bureau of Mines, with headquarters at Salt Lake City, visited the San Francisco office of the Bureau during June, in connection with oil-shale development.

DAVID JONES, who holds an 1851 exhibition scholarship (from London University) at Johns Hopkins University, is now connected with the chemical division of the Eastman Kodak Co.'s research laboratory.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, and DORSEY A. LYON, its supervisor of experiment stations, have returned from an inspection visit to the various points in the South which are under consideration as sites for the new non-metallic mineral station. It is expected that the selection will be announced within a week.

JAMES T. NEWTON, Commissioner of Patents, has tendered his resignation to the President, which was effective July 19. No official report that the President had accepted has been received, but it is understood that he will. Commissioner Newton expressed great reluctance at leaving the office after thirty years' Government service, and mentioned the inadequate salary of $5,000 a year among his reasons for resigning.

Dr. HARRISON E. PATTEN has recently resigned as research chemist of the Bureau of Chemistry, Department of Agriculture, to accept an appointment as chief chemist of the phosphate plant of the Provident Chemical Works, St. Louis, Mo.

A. B. PORTMAN has recently been appointed assistant sales manager of acids and heavy chemicals for the Monsanto Chemical Works at St. Louis, Mo., vice John W. Carroll, who has been transferred to higher duties.

F. L. RIGHTER, a Leland Stanford University graduate, who during the past year has been doing graduate work in the chemistry department at Cornell University, has joined the staff of the research laboratory of the Eastman Kodak Co., Rochester, N. Y.

L. D. VORCE has severed his connection with the Canadian Salt Co. to take an active part in the business of the Precision Instrument Co., Newark, N. J.

Obituary

FRED S. BRADLEY, son of Peter B. Bradley, president of the American Agricultural Chemical Co., died on July 5. Mr. Bradley was manager of the Jacksonville, Fla., branch of the company. His death was the result of the collapse of the wheel of the automobile he was driving on the beach at Jacksonville.

Current Market Reports

The Iron and Steel Market

Pittsburgh, July 23, 1920.

The iron and steel market has become still more inactive, conditions bordering almost on stagnation. There is some buying, but it is only of material that the buyer is assured he will need in the very near future, or is in the nature of covering requirements in the distant future with the Steel Corporation. In other words, buying of steel products is for very late delivery, the first or second quarter of next year in the case of the Steel Corporation, and is only for very early delivery in the case of the independents. The difference in policy is of course due to the difference in prices quoted. In the matter of pig iron, there are occasional instances reported in other districts of small purchases for late delivery, but in general the buying of pig iron is only for very early shipment, and usually by consumers who are already covered by contract but are not getting deliveries.

TRANSPORTATION CONDITIONS

The common testimony is that transportation conditions, as regards the supply of cars for loading at blast furnaces and steel mills, have grown worse in the past week. An exception is the Chicago district, where, it is said, a little of the accumulated steel has been moved. In the steel industry as a whole the stocks of steel at mill are not only increasing, but are increasing at a more rapid rate than a month ago.

The further curtailment in car supplies is attributed to service order No. 7 of the Interstate Commerce Commission, giving preference in car supplies to coal mines. The original order was dated June 21, and it has since been renewed for an additional thirty days, or to Aug. 19. Last week there was some expectation of relief to the furnaces and mills by an interpretation issued, that the order is not to include, as coal cars, flat bottom gondola cars under 30 in. high, inside measurement. Previously most of the roads had been considering as coal cars any such cars over 30 in. in height. As an offset to the results of the new interpretation, however, has come strict enforcement of the point that coal cars may be loaded only in the direction of the coal. It seems there had been considerable evasion, or loose interpretation, of this point, but with the strict interpretation very few cars indeed will come under the permission.

The chief hope of the iron and steel trade in the matter of car supplies now is that the coal mines will soon be well enough supplied with cars that there will be a surplus for other uses. It is recognized that it will not be necessary to furnish the coal mines with 100 per cent of their theoretical requirements, for it is reasonably clear that with a considerably smaller supply than that one of these so-called "labor shortages" will develop, whereby additional cars could not be used. The shortage would not be in the number of men, but in the time put in, the experience of the river mines showing that the men are not willing to work day after day the full eight hours.

CURTAILMENTS

Thus far there has been practically no curtailment of steel production by reason of inability to ship, although of course there has been curtailment on account of fuel, chiefly coke, not being in abundance. Since the first of the month there has been more or less curtailment of finishing operations, by mills leaving more steel in semi-finished form. If, however, definite relief from present shipping conditions does not come within thirty days, or possibly sixty days at the very outside, it will be necessary for steel production itself to be curtailed. Possibly it would have been prudent to begin curtailing steel production before this. The finishing departments can stand only a

moderate overload, and to accumulate large quantities of unfinished or semi-finished steel would mean that the finishing departments would require a very long time to work off the surplus, providing of course they had to take care of current steel production at the same time.

The further difficulty is now becoming rather pressing, that finished steel rolled to customers' specifications may prove quite unacceptable months hence, it being clear that with the greatest improvement in transportation that can be hoped for it will be a long time before the last of the mill accumulations disappears. Accordingly many of the mills are now following a new policy in shipping, and are using such cars as are available for moving material that is particularly special in character, as for instance from being cut to length, and the mills are taking such material either from stock or from current rolling, as occasion presents itself. The object is to leave the mill, to such an extent as is possible, only with stock sizes on hand.

Construction Work Light

For several weeks past the mills have reported demand for plates and structural shapes as particularly light, this being quite in contrast with demand for merchant bars of the smaller sizes, this demand being quite heavy.

Prices for steel products for prompt shipment show further weakening in spots, although for sheets there seems to be a somewhat stiffer market. Prices of the large independents, for moderately early but rather uncertain delivery, are at the level that has ruled for several months, while the Steel Corporation prices are of course unchanged. Independent prices may all recede to the Steel Corporation level, though this is far from certain, but no one seems to think that the Steel Corporation level can possibly be endangered even should there be a continuance of this dull market for several months.

The Chemical and Allied Industrial Markets Today and a Year Ago

New York, July 23, 1920.

Inasmuch as the quiet that has become almost customary in the chemical market still persists, this week's article will compare prices with those of a year ago, instead of repeating the commonplace "news" of the last few months. Among the heavy chemicals there are only two items of current interest: (1) sulphate of aluminum, and (2) citric and tartaric acids. Ordinarily, *sulphate of aluminum* (iron free) sells for 3@4c. per lb. in car lots; but small stocks and the almost impossibility of obtaining bauxite has boosted the price to 6c. The commercial sulphate has advanced to 4½c., as against a former price of 1½@3c. As for *citric* and *tartaric acids*, the sharp drops are the outcome of too many speculators in sugar. Tartaric has declined from 80@85c. to 70@72c.; citric from 80@100c. to 78c.

In the *coal tars* it is interesting to note that one concern sold 19,000 lb. of *paranitraniline* in a single day last week, whereas there had not been a sale made in the two weeks preceding. *Beta naphthol* (technical) sells for 80@95c., against 45@55c. a year ago, owing to increased demand and smaller production because of shortage of raw materials. Improved methods of manufacture have lowered the price of *phthalicanhydride* from $1.75@$2.15 to 60@70c. per lb. Coal-tar products that are active at the present time are shown in the following table in comparison with prices a week ago and a year ago.

	Current	Week Ago	Year Ago
Aniline oils, drums extra	$0.33 @ $0.34	$0.34½ @ $0.36	$0.25 $0.30
Aniline salts........ ...	0.40 @ 0.42	0.41 @ 0.45	0.28 0.33
Beta naphthol, tech	0.80 @ 0.95	0.80 @ 0.88	0.45 0.55
Metaphenylenediamine...	1.25 @ 1.30	1.23 @ 1.30	1.20 1.80
Paranitraniline.......	1.30 @ 1.40	1.40 @ 1.50	1.00 1.2[illegible]
Paraphenylenediamine...	2.50 @ 2.65	2.50 @ 2.75	2.75 4.00
Phthalicanhydride.......	0.60 @ 0.70	0.65 @ 0.75	1.75 2.15

In the ensuing tabulations for waxes, rosins, rubber and fish oil, it will be found that prices are generally lower than a year ago.

WAXES

Original quantities in large packages, per lb.

	Current	Week Ago	Year Ago
Carnauba, No. 3, North Country..............	$0.35 @ $0.36	$0.36 @ $0.37	$0.60 @ $0.75
Stearic acid, single pressed	0.24 @ 0.25	0.25 @ 0.26	0.25 @ 0.27
Stearic acid, double pressed	0.25 @ 0.26	0.26 @ 0.27	0.28 @ 0.29

NAVAL STORES

Carload Lots

	Current	Week Ago	Year Ago
Rosin E-I, 280 lb.	$16.60 @ $16.75	$16.10 @ $16.25	$17.50 @ $18.75
Rosin K-N, 280 lb.	17.00 @ 17.20	16.25 @ 16.35	21.00 @ 22.25
Rosin W-G @ W-W, 280 lb.	17.25 @ 17.50	16.50 @ 16.70	22.50 @ 22.75
Rosin oil, first run.	0.70	0.67	0.81 @ 0.91
Rosin oil, second run, gal	0.73	0.70	0.83 @ 0.93
Rosin oil, third run, gal	0.92	0.87	0.88 @ 1.10

CRUDE RUBBER

Per Pound

	Current	Week Ago	Year Ago
Para Upriver fine	$0.32 @ $0.33	$0.34½ @ $0.35	$0.54 @ $0.55
Upriver coarse	0.23 @ 0.24	0.24 @ 0.24½	0.31 @ 0.33
Upriver caucho ball	0.23 @ 0.24	0.26 @ 0.26½	0.31 @ 0.34
Plantation			
First latex crepe	0.32½	0.32½ @ 0.33	0.39½ @ 0.40½
Ribbed smoked sheets	0.31½	0.33 @ 0.33½	0.38½ @ 0.39½
Brown crepe, thin, clean	0.30	0.32 @ 0.32½	0.34½ @ 0.35½
Amber crepe, No. 1	0.30	@ 0.25	0.36½ @ 0.37

MENHADEN OILS

Per Gallon

	Current	Week Ago	Year Ago
Winter pressed	$0.90 @ $1.05	$1.17 @ $1.18	$1.25 @ $1.35
Yellow bleached	0.95 @ 1.05	1.20 @ 1.22	1.27 @ 1.37
White bleached	1.00 @ 1.25	1.23 @ 1.24	1.29 @ 1.38
Blown	1.00 @ 1.20	1.30 @ 1.32	1.35 @ 1.40

The Chicago Market

Chicago, Ill., July 21, 1920.

With apathetic demand, scarcity of spot stocks and producers sold up for some time to come in the general chemical line, with the vegetable oil market absolutely dead and with transactions in naval stores still hampered by lack of shipping facilities, there is little of interest to report from the Chicago district. The exhaustion of spot stocks of general chemical lines has tended to eliminate the second-hand dealer and the speculator, and the fact that factories have their entire output under contract for some time to come will prevent the re-entry of that element into the market in the near future.

Heavy Chemicals

In the face of reports of a weaker market in the East the *alkalis* have held their own locally, as supply is extremely limited. *Caustic soda*, both solid and granulated, is firm at 6@6½c. per lb., with handlers of spots turning away more business than they are accepting. Contracts are quoted around 5½c. *Soda ash*, as scarce as ever, is nominally quoted at $3.50 per cwt. and at least one transaction involving fifty drums was carried through last week at $3.75 per cwt. *Sal soda*, when obtainable, commands $1.90 per cwt. for delivery from stock and no futures are offered lower than $1.70. Demand is materially in excess of available supply. Nominal quotations on bleaching powder range from 6c. to 7c. per lb. with but few actual transactions reported.

Stiff prices rule on *arsenic*, oxide lumps (white) being held firmly at 16½@17½c. per lb., depending on quantity. The powdered sulphide (red) is quoted at around 20c., with no undue pressure of demand. *Barium chloride* continues to advance, nominal quotation on imported being $185 to $190 per ton. But few transactions are recorded and they probably passed at figures slightly lower than quotations. *Carbon tetrachloride* shows little change, spots going for 11½@12c. per lb. Producers maintain this price is too low and offer contracts no lower than 13c. *Sodium sulphate crystals* (Glauber's salts) are at a premium for spots, $2.75 per cwt. being the prevailing price. Futures are offered at about a dollar lower.

Nothing can be added to the last report in regard to *alcohol*. Both *ethyl* and *methyl* are available in quantities much less than normal demand and are finding a ready sale at the prevailing high prices. *Denatured*, under extraordinary demand, is up to $1.10 a gal. Buying of *formaldehyde* seems restricted by high prices, and a reduction of 2c. in the prevailing price, to 53c. a lb., has failed to arouse any great interest. *Glycerine*, c.p., at 29c., remains in slack demand.

Acid business remains quiet, consumers being content to proceed on a hand-to-mouth basis. Offers of spot stocks at seemingly attractive prices find no active demand. Producers are rapidly catching up in deliveries on contract and spot supplies are ample. *Acetic*, 28 per cent commercial, is quoted at $3.87½ per cwt. on contract. Holders of stocks of *carbolic* are finding but small demand at the offered price of 12c. per lb. *Muriatic* (hydrochloric) is not available in as great quantity as the others and but little is changing hands at $3@$3.15 per cwt. A wide range in offerings and slight demand are noted in *nitric*, 42 deg. being quoted at 7½@8c. per lb. *Sulphuric acid* is available for prompt delivery at $23 per ton for 66 deg. in tanks.

Vegetable Oils

Development of the fact that practically unlimited supplies of flaxseed are in sight has brought *linseed oil* down to the lowest point for some time, with but little interest shown by either buyer or seller. Quotations for immediate delivery, f.o.b. Chicago, are: for tank car lots, $1.52 per gal.; for car lots in cooperage, $1.59, and for barrels in less than car lots, $1.62. Contracts for future delivery are offered at 11c. less than above figures, but with the expectation of still lower figures, business is light. For *cottonseed oil* the demand is so slight as to be negligible. Prime summer yellow is offered at 12¾c. and refined, deodorized, at 19c., f.o.b. Chicago. *Coconut oil* is likewise dull at 12½c. per lb. in sellers' tanks, f.o.b. Coast. Spots from local stock go at 15½@16c. Current shipments of *soya bean oil*, in sellers' tanks, f.o.b. Coast, are offered at 10¾c., with next month's delivery quoted at ½c. less. Little interest is shown in any of these offerings.

Naval Stores

Supplies are being received much more freely now, several cars of *turpentine* having arrived during the last few days. Demand is sufficient to absorb receipts and to maintain a price of $1.75 per gal. on barrels in carload lots, 5c. less in drums. Requirements of *pine oil* are still in excess of supply and the price is firm at $1.90 per gal. on both pure and destructively distilled. The shortage in the items was so great during the spring that it will take considerable time to get supply back to normal. Receipts of *rosin* are approaching normal, $15.80@$15.90 being today's ruling quotation on E, F and G grades.

The St. Louis Market

St. Louis, Mo., July 19, 1920.

The St. Louis chemical market continues quiet and prices for the most part are firm. Many of the larger buyers are contracting for their present needs only and manufacturers are loath to take on large contracts for future delivery on account of the present labor conditions and the raw material situation. The transportation situation continues to show improvement, although car movements continue to be slow. The supply of most chemicals is now ample to meet present demands and little change in prices is to be expected in the near future.

The demand for *sulphuric acid* continues good and prices show a small increase. The 60 deg. grade is quoted at $15 per ton, an advance of $1 per ton over two weeks ago. The 66 deg. is quoted at $24 per ton, as against $22 per ton two weeks ago. *Oleum* remains unchanged at $27.50 per ton. Prices are based on carload lots.

The market for *muriatic acid* is quiet and prices are unchanged at $25 per ton in carload lots and 2@2.25c. per lb. in carboys for the 18 deg. grade. The recent shortage of *sodium bisulphate* has been relieved. Price remains unchanged at $6 per ton in carload lots.

Nitric acid is unchanged and quoted in carload lots at $7 per cwt. for 36 deg., $8 for 38 deg., $9 for the 40 deg. and $10 for the 42 deg. Standard *mixed acid* consisting of 36 deg. nitric and 61 deg. sulphuric acid is quoted at 11.5c. per lb. per degree of nitric and 1.5c. per lb. per degree of sulphuric acid. *Zinc chloride*, of 50 per cent solution, is unchanged at $3.50 to $3.75 per cwt. The supply of *phenol* is plentiful and prices are unchanged at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....-.....	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent. carboy	cwt.	16.20 -	16.25 - ....
Boric, crystals	lb.	.15 - .15½	.16 - .19
Boric, powder	lb.	.15 - .15½	.16 - .20
Citric	lb.	.78 -	.82 - ....
Hydrochloric (nominal)	cwt.	2.00 - 3.00	3.10 - 4.00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		.....-.....	.....-.....
Nitric, 40 deg.	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg.	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.60 - .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.25 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 16.00	.....-.....
Sulphuric, 60 deg., drums	ton	.....-.....	.....-.....
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	.....-.....
Sulphuric, 66 deg., carboys	ton	.....-.....	.....-.....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - .....
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.60
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.	.....-.....	.70 - .72
Tungstic, per lb. of WO	lb.	.....-.....	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.	.....-.....	3.25 - 3.30
Alcohol, Methyl, pure	gal.	.....-.....	3.50 - 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	.....-.....	1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	.....-.....	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05	.05½ - .06
Alum, potash lump	lb.	.07¾ - .08½	.09 - .09½
Alum, chrome lump	lb.	.15½ - .18	.19 - .20
Aluminum sulphate, commercial	lb.	.04¾ - .	.....-.....
Aluminum sulphate, iron free	lb.	.06 - ...	.....-.....
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09¼ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ - .13½	.13½ - .14½
Ammonium nitrate	lb.	.09 - .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ - .....
Amylacetate	gal	.....-.....	5.00 - .....
Amylacetate tech.	gal.	.....-.....	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .23
Barium chloride	ton	150.00 - 160.00	.....-.....
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.09½ - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		.....-.....	.....-.....
Blue vitriol (see copper sulphate)		.....-.....	.....-.....
Borax (see sodium borate)		.....-.....	.....-.....
Brimstone (see sulphur, roll)		.....-.....	.....-.....
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt	3.50 - 3.55	.....-.....
Calcium carbide	lb.	.04½ .04½	.04¾ - .05½
Calcium chloride, fused, lump	ton	25.00 - 30.00	35.00 - 45.00
Calcium chloride, granulated	lb.	.01½ - .01¾	.02 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	.....-.....	4.50 - 6.50
Calcium peroxide	lb.	.....-.....	1.50 - 1.70
Calcium phosphate, monobasic	lb.	.....-.....	.75 - .80
Calcium sulphate, pure	lb.	.....-.....	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.14 - .15	.16 - .17
Carbonyl chloride (phosgene)	lb.	.....-.....	.80 - 1.05
Caustic potash (see potassium hydroxide)		.....-.....	.....-.....
Caustic soda (see sodium hydroxide)		.....-.....	.....-.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.	.....-.....	2.00 - 2.05
Copperas (see iron sulphate)		.....-.....	.....-.....
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	.....-.....	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		.....-.....	.....-.....
Epsom salt (see magnesium sulphate)		.....-.....	.....-.....
Ethyl Acetate Com. 85%	gal.	1.35 -	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		.....-.....	1.75 - .....
Formaldehyde, 40 per cent (nominal)	lb.	.....-.....	.57 - .65
Fusel oil, ref	gal.	.....-.....	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	.....-.....	.....-.....
Glauber's salt (see sodium sulphate)		.....-.....	.....-.....
Glycerine	lb.	.....-.....	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	.....-.....	.03 - .20
Iron sulphate (copperas)	cwt.	.....-.....	2.75 - 3.50
Lead acetate, normal	lb.	.....-.....	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	.....-.....	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	.....-.....	1.50 - .....
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	.....-.....	3.25 - 3.60
Nickel salt, double	lb.	.....-.....	.14 - .16
Nickel salt, single	lb.	.....-.....	.13 - .14
Phosgene (see carbonyl chloride)		.....-.....	.....-.....
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	.....-.....	.35 - .37
Potassium bichromate	lb.	.50 - .55	.57 - .60

	Unit	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 - $0.56	$0.57 - $0.58
Potassium bromide, granular	lb.	..... -	.90 - .95
Potassium carbonate, U. S. P.	lb.	..... -	.47 - .50
Potassium carbonate, crude	lb.	.20 - .25	.26 - 28
Potassium chlorate, crystals	lb.	.15 - .17	.18 - .20
Potassium hydroxide (caustic potash)	lb.	.30 - .33	.35 - .38
Potassium iodide	lb.	..... -	3.35 - 3.(0
Potassium nitrate	lb.	.15 - .17	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 - ...
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$225.00 - 240.00	..... - .....
Rochelle salts (see sodium potas. tartrate)		..... -	..... - .....
Salammoniac (see ammonium chloride)		..... -	..... - .....
Sal soda (see sodium carbonate)		..... -	..... - .....
Salt cake	ton	..... -	40.00 - 50 00
Silver cyanide (nominal)	oz.	..... -	1.25 - .....
Silver nitrate (nominal)	oz.	..... -	.(3 - 70
Soda ash, light	100 lb.	..... -	3.50 - 3 (0
Soda ash, dense	100 lb.	..... -	3.55 - 3.(5
Sodium acetate	lb.	.08½ - .09	.09½ - .12
Sodium bicarbonate	100 lb.	2.60 - 2 75	3.00 - 3.50
Sodium bichromate	lb.	.24 - .27½	.28 - .29
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 10.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½ - ..	.09 -
Sodium borate (borax)	lb.	.09 - .10	.11 - 12
Sodium carbonate (sal soda)	100 lb.	1.50 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	11 - .12	.12½ - .13
Sodium cyanide, 96-98 per cent	lb.	.25 - .30	.32 - .35
Sodium fluoride	lb.	.18 -	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	. -	6.50 7 50
Sodium hyposulphite	lb.	..... -	.03 .04
Sodium molybdate	lb.	2.50 -	3.25½ - .....
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	16 - .18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	.. - ..	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 - 1.70	1.75 - 2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½ - 10	.10½ - .11
Sodium sulphite, crystals	lb.	.04 -	.05 - .07
Strontium nitrate, powdered	lb.	17½ - .18½	.19 - .20
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	25.00 - 30 00	..... - .....
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	..... -	3.80 - 4 35
Sulphur, roll (brimstone)	100 lb.	..... -	3.40 - 3 90
Tin bichloride (stannous)	lb.	.42½ - .44	.45 - .46
Tin oxide	lb.	..... -	..... - .....
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.13 - 13½	.13½ - .17
Zinc cyanide	lb.	.45 - .49	.50 - .(0
Zinc dust	lb.	.11 - .12	.12 - .13
Zinc oxide, U. S. P.	lb.	.17 - .25	..... -
Zinc sulphate	lb.	.03½ - .03½	.04 - 06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

	Unit	Price
Alpha naphthol, crude	lb.	$1.40 — $1.50
Alpha naphthol, refined	lb.	1 (0 — 1 70
Alpha naphthylamine	lb.	.53 — .55
Aniline oil, drums extra	lb.	.33 — .34
Aniline salts	lb.	.40 — .42
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.35 . 1.40
Benzidine, sulphate	lb.	1.15 . 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.00
Benzoate of soda, U.S.P.	lb.	.80 — .90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35 — .40½
Benzol, 90%, in drums (100 lb.)	gal.	.33 — .38½
Benzyl chloride, 95-97%, refined	lb.	.35 — .41
Benzyl chloride, tech.	lb.	.25 — .35
Beta naphthol benzoate (nominal)	lb.	3 50 — 4.00
Beta naphthol, sublimed (nominal)	lb.	... — ...
Beta naphthol, tech (nominal)	lb.	.85 — .95
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 - .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1 (5 - 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1 (0 - 1.05
Cresylic acid, 50%, first quality, drums	gal.	.(5 — .75
Dichlorbenzol	lb.	.(1 — .10
Diethylaniline	lb.	1 50 — 1 (0
Dimethylaniline	lb.	1 35 — 1.45
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.32 — .35
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	40 — .45
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 - 40
Diphenylamine (nominal)	lb.	80 - .85
H-acid (nominal)	lb.	2.25 — 2 50
Metaphenylenediamine	lb.	1.25 — 1 30
Monochlorbenzol	lb.	.18 — 20
Monoethylaniline	lb.	2.00 — 2 40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.... — .
Naphthaline, flake	lb.	.... — 19
Naphthaline, balls	lb.	.... — .19
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.18 — .25
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.35 — .45
Para-amidophenol, base	lb.	2.50 — 3.00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.30 — 1.40
Para-nitro-toluol	lb.	$01.35 — $01.50
Paraphenylenediamine	lb.	2.50 — 2.65
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .20
Pyridin	gal.	2.00 — 3.50
Resorcin, technical	lb.	4.25 - 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.50 — .60
Salol	lb.	.90 — 1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½ — .35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23 — .26
Sulphanilic acid, crude	lb.	.32 — .35
Toluidine	lb.	1.70 — 2.50
Toluidine, mixed	lb.	.45 — .55
Toluol, in tank cars	gal.	.35 — .....
Toluol, in drums	gal.	.38½ — .40½
Xylidine, drums, 100 gal.	lb.	.50 — .65
Xylol, pure, in drums	gal.	.37 — .45
Xylol, pure, in tank cars	gal.	.35 — .....
Xylol, commercial, in drums, 100 gal.	gal.	.37 — .45
Xylol, commercial, in tank cars	gal.	.23 — .27

Waxes

Prices based on original packages in large quantities.

	Unit	Price
Beeswax, refined, dark	lb.	$0.36 — $0.39
Beeswax, refined, light	lb.	.39 — .40
Beeswax, white pure	lb.	.63 — .68
Carnauba, No. 1 (nominal)	lb.	1.00 — 1.05
Carnauba, No. 2, regular (nominal)	lb.	.85 — .88
Carnauba, No. 3, North Country	lb.	.35 — .36
Japan	lb.	.19 — 19½
Montan, crude	lb.	.23 — 25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09 — .09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.10 — .10½
Paraffine waxes, refined, 118-120 m.p.	lb.	.11 - .12
Paraffine waxes, refined, 125 m.p.	lb.	12½ — ..
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½ — .15½
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½ — .17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½ — .18½
Stearic acid, single pressed	lb.	.24 — .25
Stearic acid, double pressed	lb.	.25 — .26
Stearic acid, triple pressed	lb.	.27 — 28

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

	Unit	Price
Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2 30
Pine oil, pure, dest. dist.	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	2.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

	Unit	Price	
Rosin B-D, bbl.	280 lb.	$12.25	- $16 25
Rosin E-I	280 lb.	16 (0	16.75
Rosin K-N	280 lb.	17 00	17 20
Rosin W. G.-W. W.	280 lb.	17 25	17.50
Wood rosin, bbl	280 lb.	15.00	-
Spirits of turpentine	gal.	1.58	— .
Wood turpentine, steam dist.	gal.	.	— ....
Wood turpentine, dest. dist.	gal.	.	— ...
Pine tar pitch, bbl.	200 lb.	.	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	15 00
Retort tar, bbl.	500 lb.	15 00	- 15.50
Rosin oil, first run	gal.	70	— ...
Rosin oil, second run	gal.	.73	— . .
Rosin oil, third run	gal.	92	— .....

Solvents

	Unit	Price
73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

	Unit	Price
Para—Upriver fine	lb.	$0.32 $0.33
Upriver coarse	lb.	23 — .24
Upriver caucho ball	lb.	.23 — .24
Plantation—First latex crepe	lb.	.32½ — ...
Ribbed smoked sheets	lb.	.31½ — .....
Brown crepe, thin, clean	lb.	.30 — ..
Amber crepe No. 1	lb.	.30 — ...

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

	Unit	Price
Castor oil, No. 3, in bbls.	lb.	$0.17 — $0.18
Castor oil, AA, in bbls.	lb.	.19 — ..
China wood oil, in bbls.	lb.	.18½ — .19
Cocoanut oil, Ceylon grade, in bbls.	lb.	.16 — . .
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17½ — .17½
Corn oil, crude, in bbls.	lb.	.16 — .16½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10 — .11
Cottonseed oil, summer yellow	lb.	.13½ — .13½
Cottonseed oil, winter yellow	lb.	.19 — ..
Linseed oil, raw, car lots (domestic)	gal.	1.20 — ..
Linseed oil, raw, tank cars (domestic)	gal.	1.30 — . . .
Linseed oil, boiled, car lots (domestic)	gal.	1.35 — .....

Olive oil, commercial	gal.	3.00 —	3.10
Palm, Lagos	lb.	.10½ —	.
Palm, bright red	lb.	.10½ —	.
Palm, Niger	lb	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb	.12½ —	.12½
Peanut oil, refined, in bbls	lb	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1 65 —	..
Rapeseed oil, blown, in bbls	gal.	1 70 —	..
Soya bean oil (Manchurian), in bbls N. Y.	lb.	14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	.11

FISH

Winter pressed Menhaden	gal.	$0.90 —	$1.05
Yellow bleached Menhaden	gal.	0 95 —	1 05
White bleached Menhaden	gal.	1.00 —	1 25
Blown Menhaden	gal.	1.00 —	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	—$25 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00	20 00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8 00	10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00	25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16 00	19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12 00	
Barytes, floated, f.o.b. St. Louis	net ton	25 50	— 28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11 00	11 25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60 00 —	80 00½
Casein	lb.	.15 —	.18
Chalk, domestic, extra light	lb.	.05 —	06
Chalk, domestic, light	lb	.04½ —	05½
Chalk, domestic, heavy	lb	.04 —	05
Chalk, English, extra light	lb	.05 —	.07
Chalk, English, light	lb	.05	.06
Chalk, English, dense	lb	.04½	05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00	40 00
China clay (Kaolin), imported, lump	net ton	[illegible] 00	— 35 00
China clay (Kaolin), imported, powdered	net ton	[illegible] 00	— 60 00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50	8 00
Feldspar, crude, f.o.b. Maine	net ton	7 [illegible]	10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00	20 00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00	20 00
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00	
Fuller's earth, powdered, f.o.b. Fla.	net ton	18 00	
Fuller's earth, imported, powdered	net ton	3[illegible] 00	40 00
Graphite (dust polish grade 30%) Ashland, Ala	lb	.	01
Graphite (dust facing grade 50%) Ashland, Ala	lb		02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	..... —	05
Graphite, crucible, 90% carbon Ashland, Ala	lb.	—	10
Graphite, crucible, 85% carbon	lb	—	08
Graphite, crucible, 88% carbon	lb		09½
Graphite, crucible, 90% carbon	lb.	.	10½
Pumice stone, imported, lump	lb	04	.50
Pumice stone, domestic, lump	lb	05	
Pumice stone, ground	lb	04	07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		— 14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		17 00
Quartz, lump, f.o.b. North Carolina	net ton	5 00	— 7 50
Shellac, orange fine	lb	1 35	
Shellac, orange superfine	lb	1 45	
Shellac, A. C. garnet	lb.	1 05	— 1 15
Shellac, T. N.	lb.	1.20 —	1.30
Soapstone	ton	1 00 —	25 00
Talc, paper-making grades, f.o.b. Vermont	ton	9 50	14 00
Talc, roofing grades, f.o.b. Vermont	ton	8 00	9 00
Talc, rubber grades, f.o.b. Vermont	ton	9 00	— 15 00
Talc, powdered, Southern, f.o.b. cars	ton	12 00	— 15 00
Talc, imported	ton	60 00	— 70 00
Talc, California Talcum Powder grade	ton	20 00	35 00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	80—	90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45	53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75	
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40	
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90	
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90	100
Silica brick, 9-in. and 9 in. sizes, Chicago district	1,000	55	
Silica brick, f.o.b. Birmingham	1,000	51	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50—	55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17 —	.18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.19 —	20
Ferro-manganese, 76-80% Mn	gross ton	190.00 —	225.00
Spiegeleisen, 18-22% Mn	gross ton	75.00 —	.....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.50 —	3.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77 —	.85
*Coke, foundry, f.o.b. ovens	net ton	18.00 —	19.00
*Coke, furnace, f.o.b. ovens	net ton	17.50 —	18.50
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	..
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	—	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02 —	.....
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	72½ —	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.60 —	.65
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 —	.
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ —	....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	...
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.50	7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2 75 —	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2 75 —	3.00
Vanadium pentoxide, 99%	lb.	12 00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	.
Zircon, washed, iron free	lb.	.10 —	.....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	8.00
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	49.50
Lead, New York, spot	9.25
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8.25@8.75
Zinc, spot, E. St. Louis	7.90@8 40

OTHER METALS

Silver	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@85
Iridium	oz.	350.00
Palladium	oz.	80.00
Mercury	75 lb.	90 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	14.75@15.25
Copper, light and bottoms	13.75@14.25
Copper, heavy cut and crucible	15.50@16.00
Brass, heavy	9.50@10.00
Brass, light	7.25@ 7.75
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@ 5.00
Lead, heavy	7.25@ 7.50
Zinc, scrap	5.00@ 5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3 97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4 62	4 12	3.37	4.50	3 27	3 87	3.37
Soft steel bar shapes	4.62	4.12	3.37	...	3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25	....	....	..
Plates, ¼ to 1 in. thick	4.68	4.17	3.67	4 50	3 57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

CLAREMONT—Pomona College is having plans prepared for the construction of a 2-story, 60x200-ft. chemical laboratory. Estimated cost, $200,000. James P. Jameson, Security Bldg., St. Louis, Mo., archt. and engr.

Connecticut

BRIDGEPORT — The Amer. Tube & Stamping Co., 471 Hancock Ave., will build a 1-story, 55x60-ft. manufacturing plant on Stratford Ave. Estimated cost, $14,000. Work will be done by day labor.

BRISTOL—The City School Comn. will receive bids until Aug. 3 for the construction of a 3-story high school at Dunbar Meadows. A chemical laboratory will be installed in same. Estimated cost, from $750,000 to $800,000. Wilson Potter, 22 East 17th St., New York City, archt.

NEW HAVEN—The Fritzell Brass Fdry. Co., 33 Chestnut St., will soon award the contract for the construction of a 1-story, 60x150-ft. factory. Estimated cost, $40,000. Fletcher Thompson Inc., 1089 Broad St., archt. and engr. Noted May 19.

NEW HAVEN—The Natl. Folding Box & Paper Co., James St., plans to build additions to plant.

NEW HAVEN—The New Haven Pulp & Board Co. has awarded the contract for altering a factory to Levering & Garriques, 552 West 23d St., New York City. Estimated cost, $30,000.

ROCKVILLE—The J. J. Regan Mfg. Co., 74 West Main St., has awarded the contract for the construction of a 1-story, 21x70-ft. addition to finishing plant and a 1-story, 40x80-ft. dye house to J. H. Grozier Co., 721 Main St., Hartford. Estimated cost, $16,000.

STAMFORD—The Petroleum Heat & Power Co., Selleck St., has awarded the contract for the construction of a 1-story foundry to H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $15,000.

WATERBURY—The Waterbury Farrel Fdry. & Machine Co., 425 Bank St., will build a 1-story, 45x180-ft. factory addition. Estimated cost, $45,000. Work will be done by day labor.

District of Columbia

WASHINGTON—The General Purchasing Officer of the Panama Canal will receive bids until Aug. 2 for furnishing 3,200 lb. of bone black, hydrocarbonated, in barrels of approximately 400 lb. each, to be manufactured from selected hard white bone, charred, ground to a uniform mesh and then charged with additional carbon extracted from a hydrocarbon oil; 100,000 lb. of calcium carbide, 1¼x¾ in., commercially pure; and 5,000 lb. of asbestos magnesia furnace cement.

Illinois

CHICAGO—The Abbott Laboratories, 4753 Ravenswood Ave., will build a chemical manufacturing plant, including ten 1-story buildings, at 4800 Ravenswood Ave. Estimated cost, $225,000. Work will be done by day labor.

CHICAGO—The Amer. Car & Foundry Co., 2417 Paulina St., has purchased a site along Paulina St., near Blue Island Ave., and plans to build a plant on same. Estimated cost, $2,000,000.

CHICAGO—A. Finkel & Sons Co., 1326 Cortland St., had plans prepared for the construction of a 1-story, 32x98-ft heat treating plant. Estimated cost, $20,000. E. M. Newman, 80 West Washington St., archt.

Indiana

CROWN POINT — The Bd. of County Comrs. had plans prepared for the construction of a 2-story, 100x200-ft. hospital here. Chemical laboratory equipment will be installed in same. Estimated cost, $400,000. J. N. Coleman, Chicago, Ill., archt.

EAST CHICAGO — The Carroll Castings Co. has purchased a site on the Indiana Harbor Belt R.R., Gibson St., and plans to construct a plant for the manufacture of small gray iron castings on same. Equipment will be installed in same.

INDIANAPOLIS—The General Amer. Tank Car Corp., Euclid Ave. and 145th St., East Chicago, plans to build a large addition to its brass foundry and is in the market for equipment for same.

INDIANAPOLIS — The Pioneer Brass Wks., 424 South Pennsylvania St., has awarded the contract for the construction of a 1-story, 200x300-ft. factory on 23rd St. and the Lake Erie Western R.R. to John G. Karstedt Constr. Co., 129 Lemcke Bldg. Estimated cost, $200,000.

INDIANAPOLIS — The Pioneer Brass Wks., 424 South Pennsylvania St., plans to install new foundries and equipment in the proposed plant here.

INDIANAPOLIS—The United States Fiber Box Co., Martindale and Roosevelt Aves., is having preliminary plans prepared for the construction of a 4-story, 100x160-ft. factory on Martindale Ave. Estimated cost, $125,000. Charles E. Bacon, 617 Merchants Bank Bldg., archt.

INDIANAPOLIS—The Universal Slag Brick & Tile Co., Gary, Ind., is in the market for $50,000 worth of machinery for use in plant including all machinery used in making tile and brick.

WEST HAMMOND—The La Salle Iron Works, 2305 South Halsted St., Chicago, has awarded the contract for the construction of a steel plant including seven 1-story buildings, to the Broline Nolan Co., 8 South Dearborn St., at $650,000.

Iowa

CUSHING—A. H. Bullock, Secy. of the Bd. of Educ., has awarded the contract for the construction of a 3-story, 59x111-ft. school, to W. F. Kucharo & Co., 622 Hubbell Bldg., Des Moines, at $111,414. Chemical laboratories will be installed in same.

LARABEE—H. Montgomery, Secy. has awarded the contract for the construction of a 3-story, 82x139-ft school, to W. F. Kucharo & Co., 622 Hubbell Bldg., Des Moines, at $124,500. A chemical laboratory will be installed in same.

MORNING SUN—The Bd. Educ. has awarded the contract for the construction of a 2-story, 56x130-ft. school, to the Western Constr. Co., Earlham, La., at $142,400. Chemical laboratories will be installed in same. Noted May 12.

MUSCATINE — The Muscatine Packing Co. has awarded the contract for the construction of a 4-story, 54x64-ft. fertilizer building in connection with the proposed packing plant, to the Federation Constr. Co., 532 Davidson Bldg., Sioux City. Estimated cost, $1,000,000.

PACKWOOD—N. E. Olliver, Secy. of the Bd. Educ., has awarded the contract for the construction of a 2-story, 58x99-ft. school, to W. F. Kucharo & Co., 622 Hubbell Bldg., Des Moines, at $92,980. Chemical laboratories will be installed in same. Noted May 12.

POCAHONTAS—W. J. Gilchrist, Pres. of the School Bd., has awarded the contract for the construction of a 2-story, 56x110-ft. school, to C. E. Larson, Fort Dodge, at $118,000. Chemical laboratories will be installed in same. Noted June 16.

Louisiana

NEW ORLEANS—The Prest-O-Lite Co., 30 East 42nd St., New York City, has purchased a site on Anthony and St. Louis Sts., for the construction of a 2-story acetylene plant.

Massachusetts

CHELSEA — The Walker Bros. Dyeing & Bleaching Co., Clinton St., plans to rebuild bleachery recently destroyed by fire. Estimated cost, $50,000.

FALL RIVER—The New England Oil Co. will build a 1-story, 17x25-ft. oil receiver house, 32x74-ft. oil condensers and 45x181-ft. oil stills, etc., along the Taunton River here. Estimated cost, $100,000. Work will be done by day labor.

HOLYOKE—The New England Tire & Rubber Co., 285 High St., has awarded the contract for the construction of a 3-story, 110x210-ft. factory on Main St., to the Casper Ranger Constr. Co., 20 Bond St. Estimated cost, $350,000.

SPRINGFIELD—The Buckley Fdry Co., 13½ Cypress St., has awarded the contract for the construction of a 1-story, 85x100-ft. foundry on Roseland St., to J. G. Roy & Sons Co., 21 Silver St., at $8,600.

Michigan

BAY CITY—The city is having preliminary plans prepared for the construction of a filtration plant, etc., in connection with the proposed waterworks improvements. Estimated cost, $2,000,000. Frazier-Elms-Shael Co., 1223 Illuminating Bldg., Cleveland, O., engrs.

DETROIT — The Michigan Grey Iron Casting Co., Harbaugh Ave., plans to build a 1-story foundry addition on Harbaugh Ave. and the Wabash Ry. Estimated cost, $40,000. F. J. Winter, 2331 Dime Bank Bldg., archt.

Minnesota

COLERAINE—The Indian School Dist. 2, Itasca Co., has awarded the contract for the construction of a 2-story, 176x208-ft. high school, to Evenson & Utterberg, 552 Builders' Exch., Minneapolis, at $455,000. A chemical laboratory will be installed in same. Noted June 9.

MINNEAPOLIS—The State Bd. of Control, Capitol, St. Paul, will soon award the contract for the construction of a 3-story, 80x110-ft. chemistry building on the State University campus here. Estimated cost, $200,000. C. H. Johnston, 716 Capital Bank Bldg., St. Paul, archt.

Missouri

ST. LOUIS—The St. Louis Surfacer Paint Co., 5132 Hazel Ave., has awarded the contract for a 2-story, 40x64-ft. manufacturing building on Hazel Ave., to George I. Cousins & Co., Chemical Bldg. Estimated cost, $30,000.

New York

MARCY—The State Hospital Comn., Capitol, Albany, will receive bids until Aug. 25 for the construction of a mechanical gravity filtration plant, etc., for the Utica State Hospital here. Noted July 7.

TONAWANDA—The city has awarded the contract for the construction of a filtration plant, to the Roberts Filtration Co., Philadelphia, Pa., at $200,000. Noted April 14.

North Dakota

GRAND FORKS—The Industrial Comn. of North Dakota has awarded the contract for the construction of a reservoir and filter plant, etc., to the Fegles Constr. Co., Minneapolis. Noted May 19.

Ohio

CANTON—The Canton Drop Forge Co., 300-400 Odd Row Pl., S.E., plans to build a 1-story, 95x100-ft. factory on Willet Ave., S.E. Estimated cost, $45,000. C. E. Firestone, Renkert Bldg., archt.

GLENMONT—The Bd. Educ. has awarded the contract for the construction of a grade and high school here, to the State Constr. Co., 11 State St., Columbus. A chemical laboratory will be installed in same. Estimated cost, $80,000.

IRONTON—The Bd. Educ. is having plans prepared for the construction of a high school here. A chemical laboratory will be installed in same. Estimated cost, $600,000. F. L. Packard, Hayden Bldg., 16 East Broad St., Columbus, archt.

KENTON—The Bd. Educ. plans to construct a high school here. A chemical laboratory will probably be installed in same. Richards, McCarty & Bulford, 1504 East Broad St., Columbus, archts.

MIAMISBURG—The Bd. Educ. is having plans prepared for the construction of a 2-story, 120x140-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $200,000. F. L. Packard, New Hayden Bldg., archt.

MIDDLETOWN—The Advance Bag Co., 155 North B'way, has awarded the contract for the construction of a 3-story, 65x300-ft. paper factory, to J. R. Stevens, Odd Fellows Temple, Cincinnati, at $150,000.

SOUTH EUCLID — The Bd. Educ. will soon award the contract for the installation of septic and filter tanks in the streets adjoining the Victory Park School. Estimated cost, $25,000. W. H. Nichlas, 1900 Euclid Ave., Cleveland, engr.

WARREN—The Bd. Educ., c/o J. Buckwalter, received bids for the construction of a 2-story, 110x182-ft. school addition to the West Technical High School, from the Shustrump Co., Youngstown, $329,869; for a 2-story, 125x150-ft. school addition to the East Technical High School, $322,212. Laboratory equipment will be installed.

Pennsylvania

CEDAR GROVE (Philadelphia P. O.)—J. F. Stokes, 17th and Cambria Sts., has awarded the contract for the construction of a 1-story plant for the manufacture of chemical machinery, to John N. Gill, Otis Bldg., Philadelphia.

DERRY — The Pittsburgh High Voltage Insulator Co. plans to improve and enlarge its plant here. Plans include a 101x244-ft. building which will be equipped with new clay mixing machinery. Estimated cost, $150,000.

SCRANTON—The Bour Refractories Co., Laurel Line and Front St., plans to build a 3-story, 90x200 ft. refractory addition on Stafford Ave. Estimated cost, $300,000.

Rhode Island

PROVIDENCE — The Franklin Process Co, 29 Promenade St, will soon award the contract for the construction of a 2-story, 110x175-ft, dye house. Estimated cost, $150,000. Lockwood, Greene & Co., 60 Federal St., Boston, archts. and engrs.

Tennessee

MEMPHIS—The Fly Shot Co., Nashville, Ga., has purchased a site on Dowa Ave. and 4th St., and plans to construct a 2-story, 50x150-ft. insecticide factory on same. Estimated cost, about $100,000.

Virginia

AUSTINVILLE — The Bertha Mineral Co. will build a mining, milling and smelting plant. Work will be done by day labor.

NORFOLK — The city is having plans prepared for the construction of a water plant. A filtration system will be installed in same. Estimated cost, $4,000,000. W. H. Taylor, Dir. of Pub. Wks.

ROANOKE — The Greenstone Products Co. Inc. plans to build a slate granite plant to have a daily capacity of 1,000 tons. L. P. Costy, secy. and treas.

West Virginia

SHINNSTON CITY — The city plans to build a 100,000-gal. filtration plant. Estimated cost, $75,000.

Wisconsin

MERTON—The Merton Dairy Products Co. is having plans prepared for the construction of a 1-story, 45x70-ft. addition. Estimated cost, $35,000. Laboratory equipment will be installed in same. M. Tullgren & Sons, 425 E. Water St., Milwaukee, archt.

MILWAUKEE — The Badger Brass Co., 243 Lake St., is in the market for brass foundry equipment.

MILWAUKEE—Milwaukee County plans to build an 8- and 6-story hospital on Grand Ave. Chemical laboratories will be installed in same. Estimated cost, $2,000,000. Van Ryn & DeGelleke, Caswell Blk., archts.

MILWAUKEE—St. Mary's Hospital, 448 Lake Drive, plans to build an addition to a hospital. A chemical laboratory will be installed in same. Estimated cost, $200,000.

NEENAH — The Theda Clark Hospital has awarded the contract for the construction of a 2-story, 40x100-ft. hospital addition, to C. R. Meyer & Son, 50 State St., Oshkosh. A chemical laboratory will be installed in same. Estimated cost, $75,000.

WAUKESHA — The Waukesha Casting Co. has awarded the steel contract for a 120x130-ft. foundry, to the Federal Bridge Co., at $50,000. Noted July 14.

Ontario

FORT WILLIAM—The Fort William Pulp & Paper Co. has awarded the contract for the construction of a 2-story, 400x600-ft. pulp and paper mill at the mouth of the Mission River, to the Barnett McQueen Co., at $1,800,000. Noted July 21.

TORONTO — The Grinnell Co. Ltd. has awarded the contract for the construction of a 1-story, 100x150-ft. foundry building to the Anglin Norcross Co. Ltd.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will holds its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

Industrial Notes

DEWEY, STRONG & TOWNSEND, patent attorneys, announce the entry of Capt. W. A. Loftus and Thomas Castberg, J. A. Abbett and J. H. Herring into the firm, which will be known as Dewey, Strong, Townsend & Loftus. Mr. Abbett will specialize in chemical and electrical patent matters and Mr. Castberg will devote his attention to engineering and industrial patent cases. The offices will remain in the Crocker Bldg., San Francisco.

THE MOLYBDENUM CORP. OF AMERICA, Empire Bldg., Pittsburgh, Pa., having the same executive and operative personnel as that of the Electric Reduction Co., announces that it has acquired as of July 1, 1920, the plant, equipment and operations of the Electric Reduction Co. at Washington, Pa., together with extensive molybdenum mines in New Mexico. This company will continue to furnish ferrotungsten, ferromolybdenum and other high grade ferro-alloys, metals and chemical products as heretofore furnished by the Electric Reduction Co., with no change in policy whatever. Having now direct control from the crude ore to the finished material the Molybdenum Corp. of America is in position to render exceptional service in supplying molybdenum products.

THE GLIDDEN CO., Cleveland, O., uses in its sixteen paint and varnish plants a tremendous quantity of lithopone. With a view to insuring a uniform supply of this important commodity it has acquired the St. Helena lithopone plant of the Chemical Pigments Corp. The capacity of the plant will be increased to meet the needs of the Glidden Co. The present staff will be maintained and augmented. The business will be operated under the name of the Glidden Co. Lithopone Department.

THE AMERICAN METALLURGICAL CORP., Philadelphia, which was the controlling factor of the Philadelphia Electric Steel Corp., announces the reorganization of that company's affairs along the following lines: E. C. Hummel, who has been the electric steel foundry superintendent at the United Alloy Steel Corp., Canton, Ohio, has purchased a controlling interest and has reincorporated the company, which will be known as the Philadelphia Electric Steel Castings Co. The new directors and officers of the corporation will be: E. C. Hummel, president and general manager; F. J. Ryan, vice-president and treasurer (Mr. Ryan is also president of the American Metallurgical Corp.); F. H. Schrenk, secretary (Mr. Schrenk is also the attorney for the American Metallurgical Corp.) C. T. Hess, director (Mr. Hess is vice-president of the E. P. Wilbur Trust Co., Bethlehem, Pa.); R. V. Mitchell, director (Mr. Mitchell is the manager and secretary of the United Securities Co., Canton, Ohio). The American Metallurgical Corp. retains a 40 per cent interest in the new corporation. Operation under the new management commenced on July 9 and it is the intention of the new controlling factors to enlarge the plant considerably as soon as production has been reached through the present equipment. The furnace capacity has already been doubled. The plant will manufacture high-grade steel castings in addition to special alloy heats, especially catering to instrument and automobile concerns. At the beginning the product will be entirely castings, but later the plant will be enlarged in order to take care of production of small blooms for forgings. This work will all be taken care of through high-speed tool steel.

THE INDIANA INDESTRUCTIBLE PAINT CO. has moved to a new location at 1247 Belmont Ave., Chicago. The new quarters consist of a four-story factory 50 x 125 ft.

Manufacturers' Catalogs

C. F. PEASE CO., 813 North Franklin St., Chicago, Ill., has issued its new catalog No. F-20, called "Drafting Room Practice."

BRIGGS & TURIVAS, INC., 1309 Westminster Bldg., Chicago, Ill., has issued a new publication entitled "Classified Scrap Iron." It is a very valuable little handbook for those who are interested in either the sale or purchase of scrap metal.

NORTON CO., Worcester, Mass., has issued three little booklets, entitled: "The Balancing of Grinding Wheels for Norton Precision Grinding Machines," "Norton Grinding Wheels on the Blanchard Surface Grinding Machines," and "Commercial Diamonds for Truing Grinding Wheels."

LEA-COURTENAY CO., Newark, N. J., has issued a little booklet on "Typical Examples of Lea-Courtenay Centrifugal Pumping Machinery" known as Bulletin S-5, which illustrates and describes a few of its different types of centrifugal pumping machinery.

THE GRISCOM-RUSSELL CO., 90 West St., New York, has just received from the press Bull. No. 1910, on G-R Expansion Joint, Low Pressure.

THE ESTERLINE CO., Indianapolis, Ind., desires to announce Bull. No. 395, covering power factor recording instruments. In this bulletin are pointed out the evils of low power factor to the central station, the isolated plant and the power customer, as well as how to locate and eliminate the causes of low power factor. Copies can be secured upon request.

THE FULLER ENGINEERING CO., Allentown, Pa., is distributing Bull. No. 800, on Metallurgical Furnaces, Annealing and Heat-Treating. The furnaces illustrated and described are representative of the types this company build, including the use of pulverized coal, oil or gas as fuel.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y., calls attention to a new bulletin on Metallographic Equipment.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Reconstruction the Theme For A. C. S. Chicago Meeting

INCREASED production through chemistry, and the part which the science can play in the reconstruction of our industries, is to be the theme of the Chicago meeting of the American Chemical Society in September. The topic is timely and should develop some valuable suggestions for those whose chemical control of manufacture has not yet reached the highest development. There is scarcely an industry of any magnitude in which chemistry does not play a part of greater or less importance. And those are few, no matter how highly developed, that cannot profit by looking ahead and giving thought to the improvements that will follow the adoption of better technology. In fact, a casual survey of the largest and most prosperous of our industries will reveal a lively appreciation of the value of chemistry and allied sciences.

If there is one lesson we can learn from our late enemy—who technically still occupies that unhappy position—it is the wisdom of co-ordinating the science of chemistry with the operations of industry. Notwithstanding popular impressions to the contrary, Germany is not noted for fundamental contributions to chemistry. Read the history of the science, and you will search almost in vain for the names of Germans who lifted chemistry out of the realm of crude speculation and placed it on a sound theoretical basis. English, French, Scandinavians were the pioneer thinkers. But none has been quite so industrious as the German in applying to manufacture the fundamental facts developed by others. This is one of the outstanding features in Germany's industrial growth; and if the noblest use has not always been made of it, other national traits must be called to account. Anyhow the lesson is there and may well be learned.

The forward-looking and progressive slogan adopted for the chemists at Chicago is in curious contrast to the reactionary tendencies evident in our political life. There is much talk in conventions and by candidates for high office of a return to pre-war conditions in methods of government and party control. Faith is expressed in the doctrines of the fathers; reliance is placed in tried methods; and confidence reposes not in a new day but in the old. Chemistry, on the other hand, has its face to the rising sun and places its hope in the new things it can do for sound reconstruction.

Incidentally, it is worth while noting the plans which the local committees of the American Chemical Society are making for the Chicago meeting. Profiting by past experience in other cities, they are showing commendable initiative in arranging for technical sessions and social functions under the most favorable conditions. The tentative plans published in our last issue are an earnest of what may be expected in September.

An Organization Of Potential Influence

ENGINEERS often tell themselves, or are often told by non-technical admirers, that as a profession they are not exerting an influence upon human activity as wide as they deserve. Without wishing to set themselves up as persons who could do almost anything better than the fellow who is doing it, engineers can therefore be pardoned for hoping that the newly formed Federated American Engineering Societies can quickly bring the best trained talent to focus on a subject of economic importance and then present the decision with all the prestige and ability inherent in a united body of men of recognized intelligence. The public in general is impressed by the ability underlying the many engineering triumphs daily serving its comfort and convenience; it now remains to capitalize this prestige in a nation-wide organization.

However, these ideas are almost always nebulous, and the words which usually express them clothe glittering generalities. "What can a Federation of Engineering Societies do? Give me something specific" will be insisted by many of the more practical among us. Even when definite tasks are proposed many of them seem of very narrow gage.

ARTHUR P. DAVIS, the President of the American Society of Civil Engineers and Director of the U. S. Reclamation Service, has mentioned one instance drawn from recent history which may appeal to some as indicating the way in which a national engineering organization may really be most useful. That is to say, since the problems before that body are at present somewhat indefinite it would be well worth the effort of its creation and maintenance as a being of potentiality, capable of exerting large influence on short call.

Older engineers can remember the agitation in favor of the Nicaragua Canal—a diligent agitation carried on for many years by men of national prominence. Even after this Government was bound by treaty to construct the Panama Canal, bills favoring Nicaragua were year after year introduced into Congress, and pressed with all the devices of skilled lobbyists.

The matter finally came to a point where it was referred to three engineers for a technical opinion, Messrs. LUDLOW, NOBLE and ENDICOTT. The work they did in that connection will ever be known as a most honorable achievement. With an appropriation so insufficient that these men had to forego their compensation and still have but a fraction of the funds necessary for thorough investigation, they devoted themselves with sufficient energy and persistence to show that the Nicaraguan scheme was full of glaring blunders, that many proposals were clearly unworkable and that the plan had received millions for promotion to thousands for investigation.

These three men were strong and brave enough to set these facts before the American people. Their work was directly responsible for a second commission backed by an appropriation fifteen or twenty times as large as the original, which even yet was supplemented as entirely inedequate. Finally the Panama route was investigated in detail, and after all the influence that malice and malignity or honest and well-meaning opposition could bring to bear the American Government was saved from a blunder and failure at Nicaragua beside which the best French attempt at Panama would have been a pigmy.

LUDLOW, NOBLE and ENDICOTT did their work almost unassisted. Naturally, there were many supporters in the technical and daily press, and among the more responsible Congressmen and Government officials—without which, of course, they could not have gone very far. But how much better would it have been if the entire engineering profession had been behind them, with every resource of a complete organization! Under such circumstances they unquestionably could have accomplished the task which was finally done, although often perilously near failure, with half the effort, risk and self-denial.

Other tasks, more important and more insistent for correct performance, will arise from time to time before the American Engineer. He will do well to note how successful HERBERT HOOVER was when as food controller and relief administrator he was backed by a closely knit organization. What could have been done by even Mr. HOOVER without such support?

Science, Population And Means of Subsistence

WHEN at the close of the eighteenth century the English economist THOMAS ROBERT MALTHUS wrote his Essay on Population he might have been justified in lamenting the misfortunes consequent on the tendency of population to increase faster than the means of subsistence, though at the present time it would seem preposterous to admit that population increases in a geometrical ratio while means of subsistence increases only in an arithmetical ratio. In his time little was known of the powers of chemistry, and the natural wealth of the populated areas, small as they were, was scarcely realized. The toilers of the soil prayed for rain and good crops instead of working out their own salvation by the application of scientific methods. Since that time necessity has been a great incentive toward balancing the increase of population with the food supply and other needed accessories, and has resulted in great strides in scientifically reclaiming waste areas, chemically stimulating returns from the soil, methodically working the natural raw products, and especially using the hitherto practically useless raw material supplies from different parts of the world. Relatively little progress has been made up to this time, but the little already accomplished has given excellent results, so that food production stoutly keeps pace with the increase of population.

How much more might be expected can be surmised from an analysis of the contribution of all branches of science and engineering to the welfare of humanity, and from a better knowledge of economic geography as typified by the phenomenally rapid progress of the United States since MALTHUS' time; nor is our country a unique exception. Following closely in the steps of the guardian nation comes the community of the Philippine Islands, which up to a few decades ago was a territory practically unknown to the rest of the world. First-hand information about the current economic status of this region contributed by Dr. ALVIN J. COX, in our last issue, may be taken as typical of similar descriptions which might be made of the resources of other parts of the Australasian and African continents. It shows that the natural heritage of the human race, when used in accordance with scientific and engineering principles, is and will be amply sufficient at all times to meet the necessities and luxuries of life.

MALTHUS was right in his time, but he lacked light and vision.

Utilization of Oxygen in Non-Ferrous Metallurgy

AMONG the more important developments in non-ferrous metallurgy have been new methods or improvements in old methods of ore concentration. These have resulted in changes as to both type and design of metallurgical furnaces. Of importance also is the recovery of byproducts, hastened perhaps by the necessity of removing deleterious impurities from smelter gases as a result of smoke-damage suits but receiving additional impetus as the value of these byproducts has increased or as methods have been devised for their economical utilization. Many of the larger plants are now producing sulphuric acid, the Tacoma smelter is producing liquid sulphur dioxide, and there are several plants at which arsenic is recovered. A further step in advance may result from the use of oxygen to enrich the gases supplied to metallurgical furnaces—in other words, from the concentration of the gases as well as the ores.

The utilization of oxygen in this manner has been the dream of chemists and metallurgists. The late J. E. JOHNSON, JR., pointed out the advantages of oxygen-enriched gases in iron blast-furnace operation, predicting the necessity of its use as the grade of available ores decreased; and F. G. COTTRELL has frequently and forcibly called attention to the desirability and practicability of enriching gases with oxygen in the non-ferrous metallurgical furnaces. Some inconclusive experiments were carried out in Belgium before the war, which, with JOHNSON'S, are probably the only tests that have been conducted up to the present.

That the use of oxygen in metallurgical operations is receiving serious attention, on the part of some metallurgists at least, is evidenced by the patent recently granted to FREDERICK LAIST and FREDERICK F. FRICK of the Anaconda Copper Company's staff. At Anaconda a large quantity of sulphur dioxide is produced, all of which cannot be converted into sulphuric acid, as it is improbable that a market could be found for the product. On the other hand, there is a market for liquid sulphur dioxide and for sulphur. The dilute sulphur dioxide gases from ordinary furnace operations cannot easily be liquefied or converted into sulphur. If, however, the concentration of the sulphur dioxide of these gases can be increased, both of these operations are simplified and become economically possible. In order to obtain a gas containing a larger proportion of sulphur dioxide it is proposed to replace the air supplied to the furnaces by a mixture of oxygen and sulphur dioxide. The exit gases from a furnace would

consist principally of sulphur dioxide. A portion of this gas would be returned to the furnace and enriched with a regulated amount of oxygen in order to avoid the intense action of pure oxygen on the sulphide materials. The remainder of the exit gases can either be compressed for the production of liquid sulphur dioxide or be treated with carbonaceous material in a suitable apparatus for the production of sulphur.

It is true in this instance that oxygen is to be used to accomplish a particular result and that the advantages to be gained by its use in the operation of the furnace are in the nature of secondary consideration. Yet it is to be hoped that the experiment will be tried, as it would be conducted under favorable circumstances and if successful would hasten an important metallurgical development.

Utilizing Lower Grade Iron Ores

AS HAS been well known for a long time, the total quantity of iron-bearing material in the earth's crust is very large, the iron content of material that is moderately well known being probably dozens of times the amount of iron that has actually been produced in the world to date. About fifteen years and more ago much interest was exhibited in certain quarters over "the world's supplies of iron ores" and studies were made indicating that the supplies of "iron ore" were relatively limited, usually involving a life measured only by decades. Most of these studies were made from an objectionable viewpoint—that of regarding the iron ore of the future as definable by existing standards. In many cases what is the waste material of one time becomes the mineral of another. In the case of iron-bearing material this is particularly true. Indeed, on account of the low value and great weight involved, there have been contemporary cases of this sort. At no time in the past would the iron ore of Alabama be iron ore if found in Sweden. The Swedish industry, using first charcoal only and later charcoal and electricity, required a rich material, which it had or produced by concentration. The blast furnaces that used the early pickings from the Lake Superior region would not have regarded as ore the material that has since been utilized in hundreds of millions of tons from the Minette district of Europe.

What the studies referred to really indicated was that as time passed lower and lower grade material would have to be used as iron ore. Even though in iron ore explorations little attention has been paid to the iron-bearing material that was not classifiable at the time as iron ore, it has always been the case that the known material below the ore limit was many times greater than the known material then classed as ore.

The Lake Superior region now stands in the delicate position of having its future depend upon the processes men develop and apply for beneficiating iron ore. The present known reserves in the region meeting the present standard are sufficient for only from fifteen to thirty years, according to various estimates made, but iron and steel are likely to be made for an indefinite time in the future. The various districts will be in competition. If the Lake Superior region develops sufficiently cheap means for beneficiating its low-grade material, it will survive the competition with the ore of the South and other districts in the United States as well as the competition of the rich ores of various foreign countries. Utilization of one material or another by blast furnaces, or whatever appliances are employed to make the merchantable product, will depend upon costs. The absolute cost will have nothing to do with the matter. Particularly on account of experiences of the past few years, it is plain that a difference of a few dollars a ton in the cost of steel means nothing as to regulating the quantity consumed, but even a very few dollars a ton is a great deal with iron ore.

Each district will have its own problems. There will be no solution open to all districts, to be utilized by each according to its degree of enterprise. In the case of Chilean and other far off but rich deposits, the chief matter will be one of cheap transport. With Lake Superior it will be a matter of cheap concentration, on the ground, since the ore must travel long distances and the methods of transportation cannot be very greatly improved upon. With Alabama it will be a matter of more economical methods of mining iron ore and producing coke, and so with all districts in the competition that is to come. Not so much the present geological conditions, but rather what men do, will determine the relative importance of the various iron ore districts a quarter century from now.

The Factors Influencing the Adhesive Properties of Glues

EVER since the time of PETER COOPER the question of grading glues has been an open one and free to individual opinion. The "Cooper Standards" have been used in commerce so long that they may be regarded as venerable and valuable antiques to be continued in use as long as the trade will stand for them, or until it is known just what glue is and what it isn't—a time which appears a long way off even today.

Undoubtedly the reader who has been interested in and following the articles on the Properties and Constitution of Glues and Gelatines in the first five issues of the present volume has come to the conclusion that the author has not spent three years of his time in a vain research. Dr. BOGUE has studied the factors influencing viscosity and jell strength, which in turn have long been established as functions of the adhesive properties of glues. He finds that vigorous agitation and prolonged heating tend to break up the physical structure and give a glue of less viscosity and strength. Dehydration if carried far enough produces a reversion of gelatine to an insoluble form called collagen. The effect of electrolytes is largely dielectric. The most probable structure of the colloid glue aggregate is streptococcal. The action of low-grade bone glues in crazing upon drying out thoroughly is due to the non-glue protein content, which does not reduce the vapor pressure of the required water solvent of solid solution to that of the atmosphere.

In commercial interest the outstanding feature is the recommendation that glues be evaluated by a melting-point test. The author demonstrates in the present issue that many errors now prevalent in the viscosity and jell-strength tests can be entirely avoided by a simple melting-point determination. In the final analysis the tensile and shear-strength tests are what the user wants to know, but he cannot take the time such tests require. In a measure, if his product sticks together he can feel assured that the glue he used was at least good enough, but apparently the melting-point test offers considerably more certainty and should therefore be widely adopted.

Readers' Views and Comments

Science the Desecrator

To the Editor of Chemical & Metallurgical Engineering

SIR:--You may have noted that the ubiquitous tinkers have again resurrected the vacuous proposal to mend the Liberty Bell. This time it is aired at length in the *Public Ledger*, and sent broadcast in a pearl of newspaper English by that estimable journal the *Literary Digest*, whose perspicacity in things relating to Science and Invention is attested by its occasional use of my own contributions to your estimable columns.

Passing over an evident play for publicity on the part of some men engaged in welding, the proposal is to mend the crack by arc-welding. In the words of the newspaper:

> They would proceed in this fashion: Take first a grain of metal from the crevice of the bell. Have it analyzed by a board of expert metallurgists. Reproduce in the laboratories of the alchemist the identical metal of which the Liberty Bell is composed. When you have the proper alloy you are ready to bring on the electric needle.

Was it Berzelius or was it Stas who was able to obtain the chemical formula for a minute fragment of an unknown mineral? But they are dead. Hence the use of the "board"—ouija board probably is meant. For these expert "metallurgists" would undoubtedly need advice as to how to perform the analysis, being unused to the routine of such work themselves, and unhappily not being able to rely upon Ramsay, that most genial experimenter. But before getting started it would doubtless occur to some of the experts (other than welding experts) who might have sampled a goldmine somewhere that the bell was cast some years before the advent of large melting furnaces, and is the product of at least two dozen crucibles, and each portion had been remelted twice by amateurs, with attendant doctoring! You will agree with me, Mr. Editor, that the alchemist would indeed be needed to reproduce the "identical metal."

> Now for the process of welding. Fashion the new metal to be applied into a wire or needle of the welding apparatus. Measure the resistance of the bell and the resistance of the wire after having estimated the amount of steel to fill up the crack. Now to fill in the crack . . . The Liberty Bell is mended just as the surgeon takes a piece of bone from the shin and grafts t on the face to make a new nose—bone for bone and, in this case, metal for metal.

"Steel," did he say? Indeed a strange bell must be this Liberty Bell, well worthy of mending! But he writes prettily, so why be meticulous?

> It is asserted by the welders that electricity will also cure the famous bell of its chronic disease. The bell's doctor . . . has held that the bell suffers from a form of distemper. It is to be guarded carefully lest it go all to pieces.
>
> The electrical engineers now prescribe baths for the bell—electrical baths. Heat it electrically and then allow it to cool slowly. This will eliminate the fatigue of the metal. The heat treatment is recommended regardless of the proposed transfusion. The heat, it is reasoned, would preserve the bell by relieving the stress between the metal particles caused by vibration. Constant vibration wears against the relic particularly when it is opened to visitors, as in the recent case when the Spanish novelist, Vicente Blasco Ibañez, clasped and kissed it.

Enough to make even a bell tired!

And so on and so on. Fortunately others than progressive welders are to be consulted before "the invalid bell, with its supposedly fatal wound, shall be summoned into the electric clinic—or left to its fate"! Would not any fate, Mr. Editor, be as good as the electric chair?

I will not impose on your good nature by pointing out in detail what is probably well known to all interested persons except newspaper writers—who evidently do not need to know: that no attempt is made to get an electrode of the same chemical composition as the metal to be welded; that the deposit is changed considerably from its original analysis by the intense temperature; that sound fusion welds cannot be made in bronzes such as bell metal, because the low-melting beta or gamma constituent boils out of the pasty alpha matrix, leaving a veritable honeycomb, and that closed structures of any sort are particularly hard to weld, because upon cooling shrinkage strains are almost sure to reopen the defect.

But for the information of any American who wishes the Old Bell to be preserved against the ravages of time and electrical experimenters it may be confidently stated that the old crack which destroyed the bell's somewhat raucous voice, but thereby canonized it, as well as the new crack discovered about ten years ago, is probably due to the relief of casting or cooling strains, existing in all such pieces, and mitigated ordinarily by careful annealing. Further extension of these defects has been prevented by the late J. Sellers Bancroft, who constructed a concealed spider whose fingers clasp the rim of the bell and are drawn to a central rod by turnbuckles, the whole contrivance being so arranged as to throw compression into that portion of the casting which had split under tensile stresses.

Rest in peace! MARTIN SEYT.

Cleaning Up Mexico—With Soap

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was much interested in reading your editorial in the issue of June 16 respecting the large importation of soap into Mexico. I have wondered if you thought there might have been ulterior motives in securing such a large quantity of material not usually associated with our ideas of the Mexicans (although I can assure you that there are Mexicans thoroughly familiar with the use of soap and its intended functions).

Only yesterday, however, I was informed by a man recently returned from Mexico that soap was being used for the secret shipment of ammunition in various sections of Mexico; the practice being to slip cartridges into cakes of soap which were then returned to their original boxes and shipped as "soap" to various sections of the country where ammunition was deemed most useful; the boxes with the empty cakes of soap being "returned" to the original point of shipment for fresh loading with cartridges. I cannot vouch for the accuracy of this statement, but it seemed to fit very well with your statement respecting the unusual amount of soap imported by Mexico. MURRAY C. BOYER.

Philadelphia, Pa.

British Chemical Industry

(From our London Correspondent)

London, July 9, 1920.

SIGNS are not wanting that in common with many other industries in this country, the chemical industry is passing through a transition period in an atmosphere charged with considerable anxiety. Labor unrest is, of course, still with us and is again causing nervousness, but the crucial question of the moment is undoubtedly that of transport. Increases in freight rates and more particularly demurrage charges and inordinate delays and uncertainties in regular deliveries of fuel and raw materials have greatly hampered production and regular output, especially in the case of the larger works. It is hoped that increasing use of road motor transport will ease the situation, and in the meanwhile the proposals of the Transport Ministry for the unification and co-ordination of railway traffic are viewed with scepticism. As regards labor unrest, a typical case is that of Van den Berghs, Ltd., margarine manufacturer, where a strike of the workers for an additional $4 a week has been firmly refused and the works closed for the time being. The present wages paid are already higher than those at any other factory in the district, while in addition the firm is noted for the excellence of its welfare work. This will perhaps be a test case and there can be little doubt that this example will be followed by many of the large employers of labor. The next few months should show whether the result will be a series of disastrous strikes and lockouts or the alternative—renewed confidence in the future of the country's trade.

Commercial Developments

The annual reports of Explosives Trades, Ltd., and Brunner Mond & Co., Ltd., are of great interest, over 60 per cent of the former company's activities being now devoted to interests other than those suggested by its title and including various chemicals, candles, gas mantles, electric lamps, varnishes, metal goods, motor accessories, metal powder, welding and artificial leather. In addition, the company has acquired an interest in General Motors, Ltd., of America, British Dyestuffs Corporation and the British Cellulose Co. and has purchased the British Pluvinsine Co., of Manchester, manufacturing artificial leather. The Chemical & Dyestuffs Traders Association referred to in my last report (see CHEM. & MET. ENG., July 7) has taken offices at 22, Buckingham Gate, London, S. W. 1, and has already taken action with the government authorities in regard to excess profits duty and the status of the association under the Board of Trade. It is interesting to note that its rival, the British Chemical Trade Association, is now furnishing the market reports to the *Chemical Trade Journal*.

The possibilities of oxygen in connection with the carbonization of coal for gas production are attracting considerable attention and it is anticipated that, given a reasonably cheap source of supply as foreshadowed in the report of the Nitrogen Products Committee, considerable saving in fuel is possible together with increased efficiency in the utilization of the available supplies of coal. This problem should be of particular interest in America and other countries possessing adequate water-power resources which are being utilized for the manufacture of nitrogen from the air.

The supply of fertilizers is still inadequate, nearly all countries having recourse to export prohibitions or restrictions. The bearing of the projected developments in the Haber ammonia process has already been discussed, and in the meanwhile the supplies of foreign basic slag are increasing. Much attention is being paid to increased crop production based on scientific methods and the use of mechanical appliances. The electrical treatment of seeds by processes such as the "Wolfryn" process is coming into increasing use and with satisfactory results. The seeds are immersed in a weak solution of salt and a weak electric current is passed for a few hours. After carefully drying the seeds, it is found that on sowing, germination is more rapid and the increase in the crop varies from 20 to 30 per cent, while at the same time the yield of straw and immunity from disease are greatly increased. Arrangements are now being made for the exploitation of the process in all parts of the world and further experiments are to be undertaken in connection with its application to special classes of seeds used in tropical climates.

Uses for Surplus Ammunition

In nearly all European countries hundreds of thousands of tons of surplus artillery ammunition are either awaiting disposal or are being broken up into their component parts. In this country the work is proceeding at the national filling factories, hot water being used to wash out the ammonium nitrate and to melt the TNT content in the amatol charge. Many ingenious devices and methods are being applied to the economical recovery of the brass, aluminum and other components. The ammonium nitrate has been largely used as a fertilizer, but so far no use has been made officially of the cordite or other propellant powders and the recovered TNT, these materials being at present merely burned. It is hoped in the near future to find a use for cordite, while it is reported that the TNT can be used as a fertilizer if applied in a sufficiently dilute form. The surplus ammunition in France, amounting to about half a million tons, has been sold to F. N. Pickett & Son, of Wimereux, while the corresponding arrangements in this country with George Cohen & Sons, of London, appear to be hanging fire. The problem of dealing with ammonal charges is probably more difficult than recovery from amatol and attempts are also being made to recover and utilize the saltpeter from the black powder charge of shrapnel shells. The chief problem in these factories is efficient organization and proper handling appliances together with careful physical control of the ammonium nitrate recovery process.

Dinner to Lord Moulton

A complimentary dinner is to be given this month to Lord Moulton in appreciation of the valuable services which he has rendered during the war as director general of explosives supplies at the Ministry of Munitions and in other capacities. It is possible that an announcement may be made at this dinner in regard to the scheme of the Federal Council of Learned and Scientific Societies for establishing a chemical headquarters in London and the details should have matured sufficiently by the end of the year to enable the plan to be launched at about the same time as the annual dinner of the Chemical Industry Club in November.

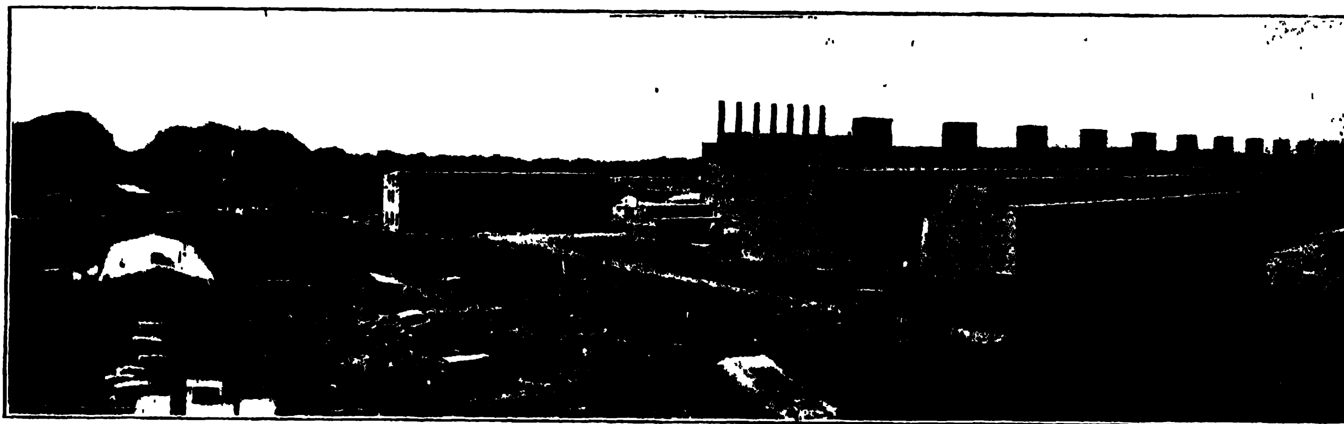


FIG. 1. LOOKING EAST AT DRY-END BUILDINGS

Cyanamide Process Plant at Muscle Shoals

Condensed Sketch of U. S. Nitrate Plant No. 2 Shown by Photographs and Flow Sheets—An Accomplishment Reflecting Credit Upon American Engineers and Builders—Now Stands Idle Awaiting Congressional Action on Government Operation Bill

BY CHESTER H. JONES

LOOKING backward through the facts and fiction about the nitrate situation in general and the cyanamide process as known in the United States through the Muscle Shoals plant in particular, it is noted that the fiction has obscured the truth as presented in the popular press, in the records of the Graham House committee, the report of the proceedings of the Senate Committee on Agriculture and Forestry, the politically colored report No. 998 by Mr. Graham of Illinois, and the subsequent discussions during the second session of the Sixty-sixth Congress. Even a careful perusal of these records by one unfamiliar with the character of the personnel of the conflicting interests would leave him in doubt as to whether the large property in Alabama is valuable or a mere heap of war-time waste. It is not the purpose of this article to enter into the political aspects but rather to show by the pictured fact that U. S. Nitrate Plant No. 2 is one of the largest chemical plants in the world, that it is for all practical purposes completed and that it is constructed in accordance with the best engineering practice. Laying aside the question of expenditures and motives attributed to its builders it is a marvelous achievement constructed in record time.

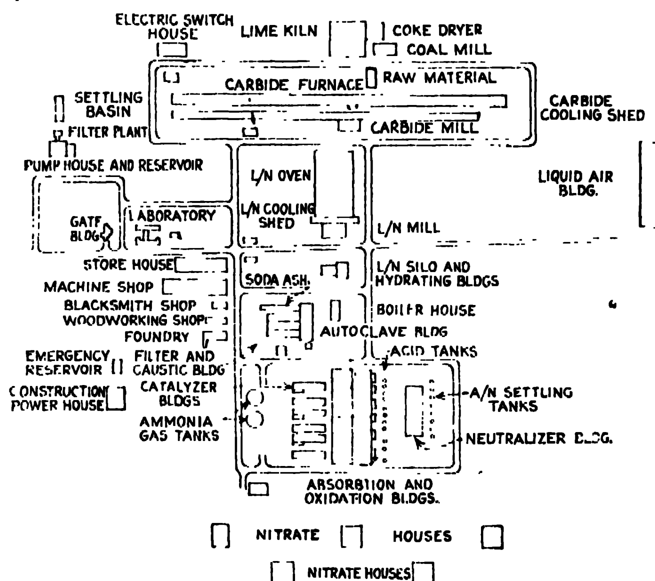


FIG. 2. PLAN OF PROCESS BUILDINGS



FIG. 3. TURBINE ROOM STEAM POWER PLANT

CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, No. 1, dated Jan. 1, 1919, contains a most excellent article by Andrew M. Fairlie on the details of construction and operation written during the construction period, and the actual record of Government operating tests may be found in the July 15, 1919, issue.

Examination of the plan (Fig. 2) gives an idea of the extent of the process buildings, with the exception of the power plant, which lies about three-quarters of

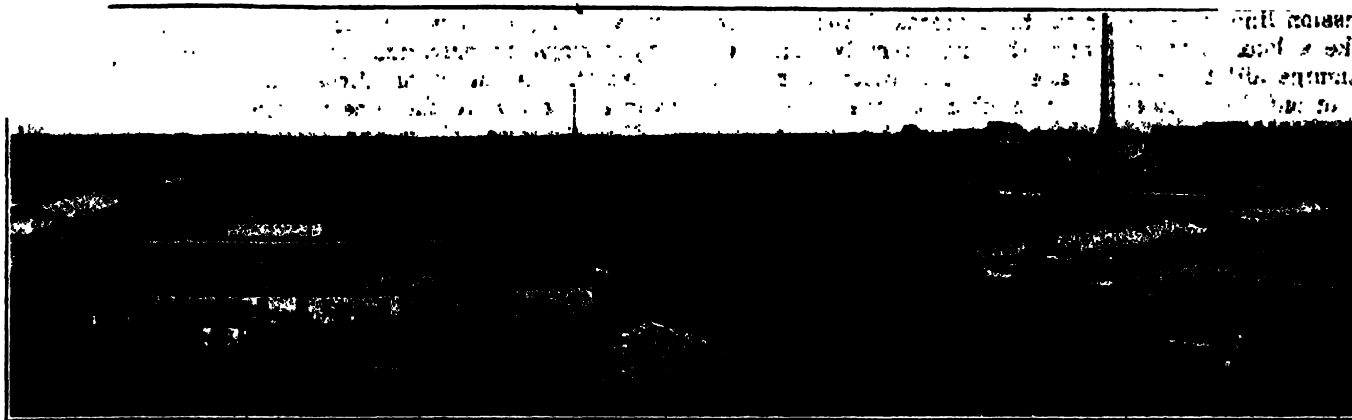


FIG. 1 (CONTINUED). LOOKING EAST AT DRY-END BUILDINGS

a mile to the north of the electric switch house. The section which lies north of the hydrating building is known as the "dry end," while that on the south half is the "wet end" of the process. The flow of material is southward through the plant.

Reading from left to right in Fig. 1, the main power house stacks are visible through the trees. The next low building is the electric switch house, or main substation for the distribution of current to the various process substations. The seven steel stacks locate the limekilns and the twelve steel rectangular stacks are extensions of the hoods over the carbide furnaces. The next long building paralleling the furnaces is the cooling shed. Then comes the carbide mill, the lime nitrogen or cyanamide oven building, attached to the lower of which is seen the cooling shed and lime nitrogen mill. The storage silos and hydrating building are just beyond, but the wet-end buildings are better shown in Fig. 8.

The low buildings in the foreground at the left of this view are the shops, and the building with three monitors to the right is the filter plant. Attached to the rear of this building and directly in front of the brick stack is the autoclave building. These two buildings house the ammonia process machinery. The stack is all that is seen of the process power house which furnishes steam for the autoclaves and the evaporating pans in the ammonium nitrate houses. The long low building in the background and to the right of this stack is the liquid air building, where nitrogen is made for the lime nitrogen ovens.

In the foreground of the right half of the view are the two ammonia gas holders, and directly behind these the six catalyzer buildings. Beyond these the low shed covering the nitric oxide cooling apparatus is scarcely discernible as connecting them with the twelve sets of nitric acid towers standing in the high building beyond. On the extreme right is seen one of the five ammonium nitrate houses with five stacks showing, and a second one in the immediate rear. Three small substations for distributing current to the catalyzers lie between the catalyzer buildings, and the power substation for wet end appears to the right of the autoclave building.

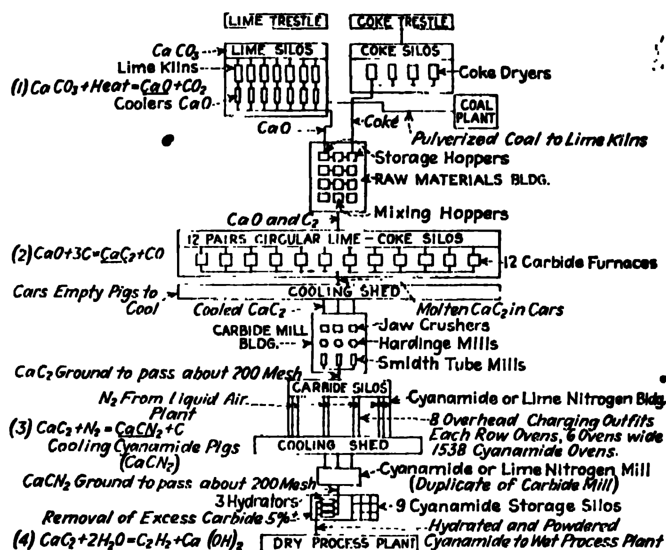


FIG. 5. FLOW SHEET OF DRY PROCESS

THE PROCESS

Now it must be quite apparent that this mile of houses contains operations of some importance, and it is therefore well worth while to take a look within a few of the more important ones. Let us first take a walk down through the woods to the main power house on the river and see the largest steam turbine in the world, 60,000 kw., made by the Westinghouse Electric Co. It stands in the rear of Fig. 3 with two smaller turbo-exciters in front. If we were to take a walk about the place we could see where the 80-mile trans-

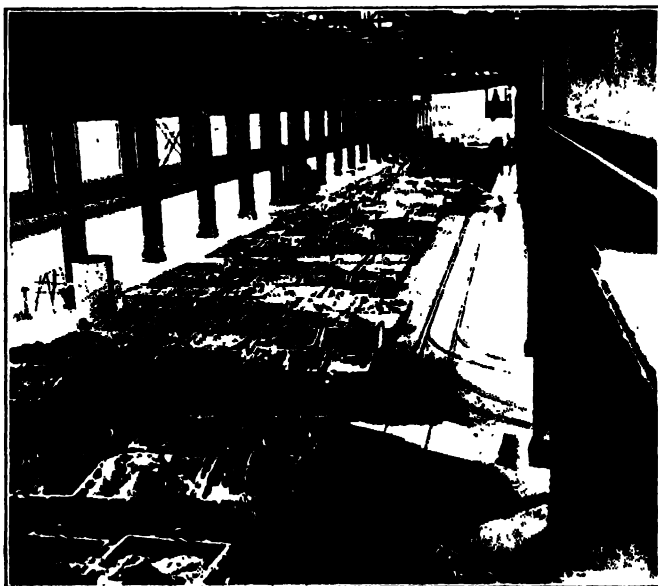


FIG. 4. CARBIDE COOLING SHED, LOOKING WEST

mission line comes in from the Alabama Power Co. and take a look up-river where the new dam is building; examine all the control panels in the switch room and point out the foundation for another turbine, 30,000 kw. As it is we return to the process plant through the bus tunnel, coming outdoors at the electric switchhouse.

Before entering the buildings again, examine the flow sheets (Figs. 5 and 6) and the subsequent views

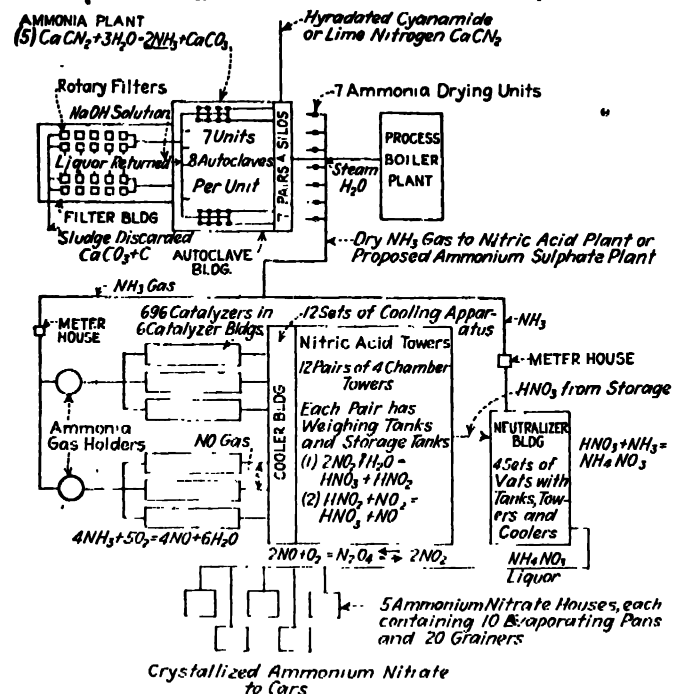


FIG. 6. FLOW SHEET OF WET PROCESS

will be the more easily oriented. Fig. 6 is just a continuation of Fig. 5, and the north to south flow is noted in comparing with the plan in Fig. 2. A sectional flow sheet shown in Fig. 9 gives a more detailed idea of some of the equipment.

Entering the carbide cooling shed (Fig. 4), we see the chill cars in which the molten carbide is taken from the electric furnaces on the right by electric locomotives and the chills subsequently distributed along the floor by the overhead crane seen in the rear. When these have cooled, the crane transports them singly to the concrete tipple pier at the entrance to the mill and shown directly beneath the crane on the left where the contents fall to the jaw crushers within.

Fig. 7 is a view of the mill looking northwest. The screw conveyor shown at the discharge end of the tube mill conveys the pulverized product to a common system where the output of all three mill units is carried in overhead screws to the lime nitrogen oven room.

Fig. 10 shows only a small portion of the oven room. The rail alongside the ovens carries the charging and discharging machines which straddle each double row. One of these is just visible in the rear of the left-hand row. The ovens are charged at the top by removing the sheet steel covers from the sand-seal on which they rest. The nitrogen is brought over from the liquid air plant in sheet steel conduits.

Fig. 11 is an interior view of the liquid air building, showing the largest installation of high-pressure air compressors in one plant. There are twenty-three in all, Sullivans, Norwalks and Ingersoll-Rands, of which five furnish service air for the shops and the acid lifts in the wet end, and eighteen operate on the liquid air production. The air columns are seen on the right and with a closer view in Fig. 12. There are thirty-six of

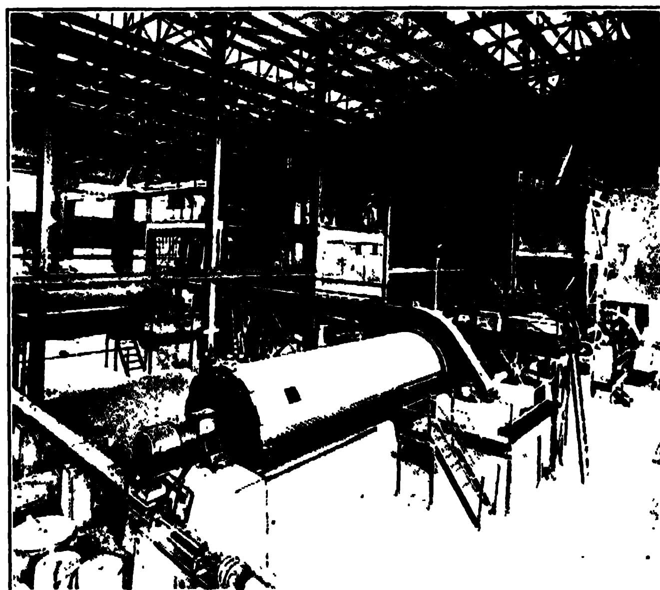


FIG. 7 CARBIDE MILL

these operating independently but with each compressor serving two units. The higher tanks shown at the end of the row are caustic towers employed for washing the air before it enters the compressors. Service cranes operate in both bays of this building.

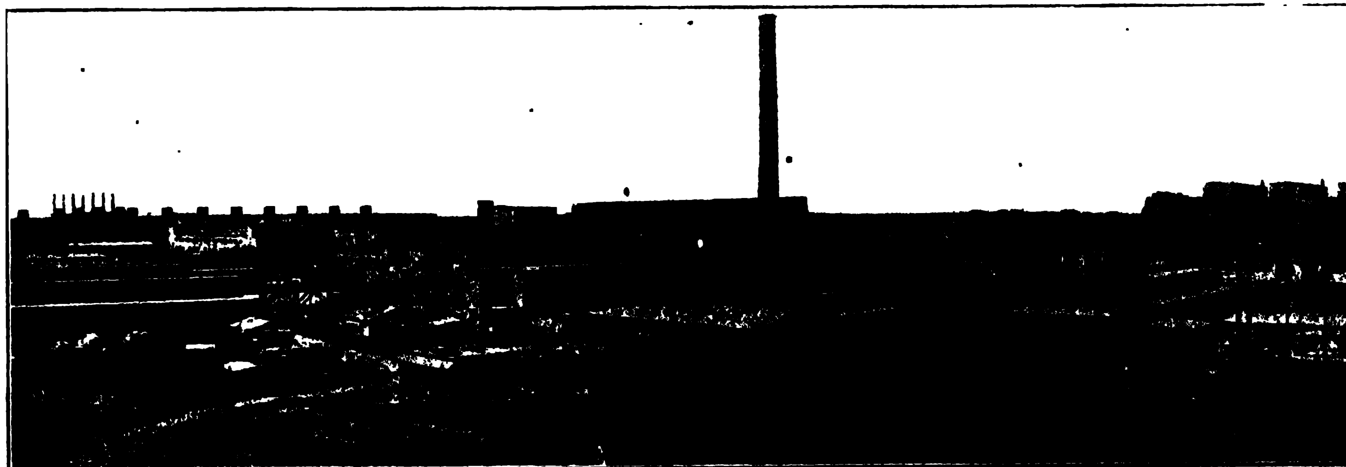


FIG. 8. LOOKING EAST AT WET-END BUILDINGS

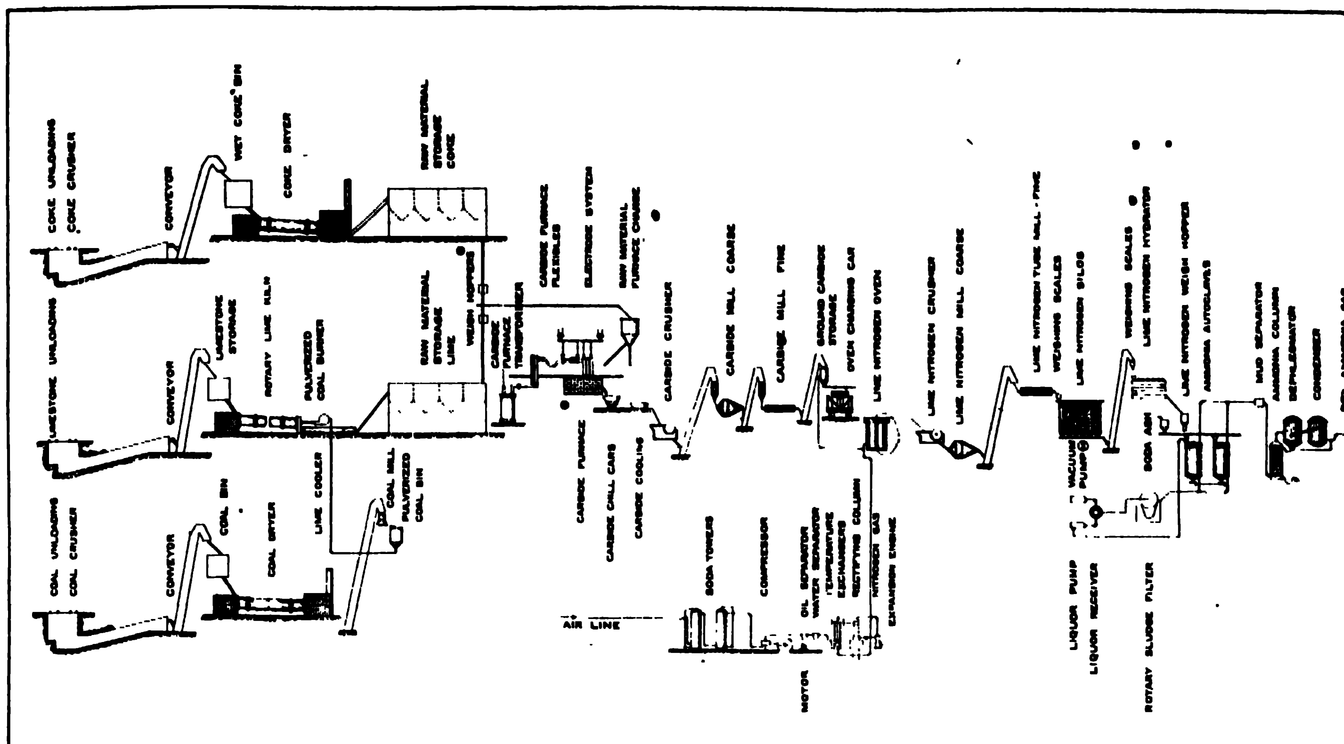


FIG. 9. SECTIONAL FLOW SHEET OF PLANT

Passing over the ammonia process, which is one of the secret operations, we come to the ammonia oxidation plant and see in Fig. 13 the interior of one of the six catalyzer buildings. The ammonia enters at the top of the aluminum boxes and passes downward into the brick flue as nitric oxide gas, when it is carried to the cooling, oxidation and absorption systems to produce nitric acid.

Fig. 14 is interior of one of the five ammonium nitrate houses. There are five rectangular evaporating pans on each side bay whence the concentrated liquor is drawn to the twenty grainers for crystallation. When the sirupy liquid is changed to sugar-size granules in these grainers the handwheel gates are opened, permitting the charge to flow onto the floor down the center, whence it is shoveled through the grizzly openings to a belt conveyor which carries it to storage or into the cars.

Rated capacities of apparatus in the plant are:

Coke Driers. There are four coke driers, three for operation, one for spare; capacity, 111 tons each for 16 hr.

Coal Driers. There are two coal driers, one for operation, one spare; capacity, 170 tons each for 16 hr., or at rate of about 10 tons per hr. per drier.

Coal Mills. There are four coal mills, three for operation, one spare; 3½ tons each per hr. for 16 hr.

Limekilns. There are seven limekilns, five for operation, two spare; 100 tons per day each.

Furnaces. There are twelve furnaces, ten for operation, two spare, producing 48 tons of 80 per cent carbides each in 24 hr. There is 50 lb. of electrode consumed per ton of carbide. There is 12 lb. of CaC_2 produced per horsepower-day; 124 kilowatt-days required per ton of 80 per cent CaC_2, or 29.76 kilowatt-hours operating at an 84 to 87 per cent power factor.

Mill Units. There are three mill units, two per actual operation; 16 hr. per day; 240 tons each per day or 15 tons per hr. per unit.

Lime Nitrogen Ovens. There are 1,538 lime nitrogen ovens, 1,500 for actual operation and 38 spares. Each oven takes a charge of 1,600 lb. of carbide (1,570 actual) through a 60-hr. cycle or 1,200 tons of CaC_2 in

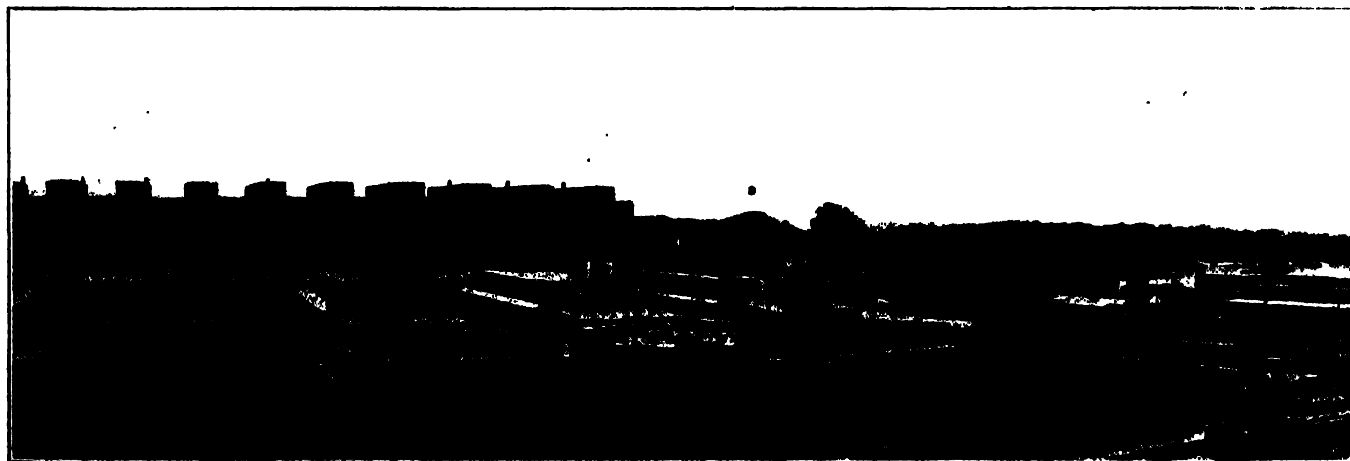
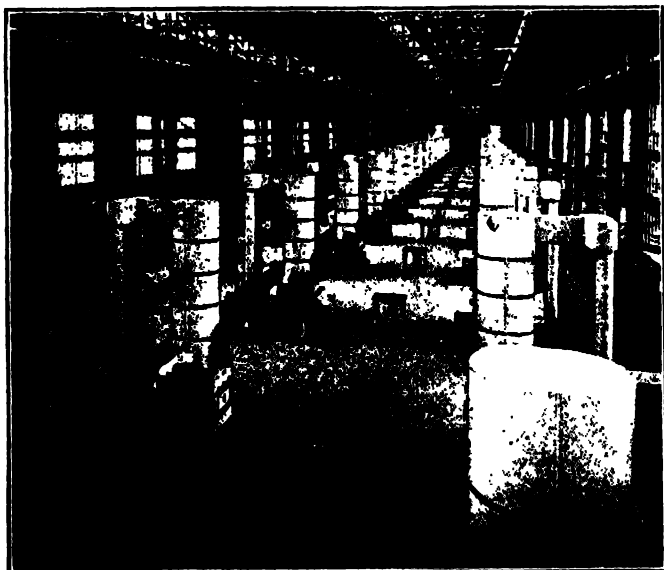
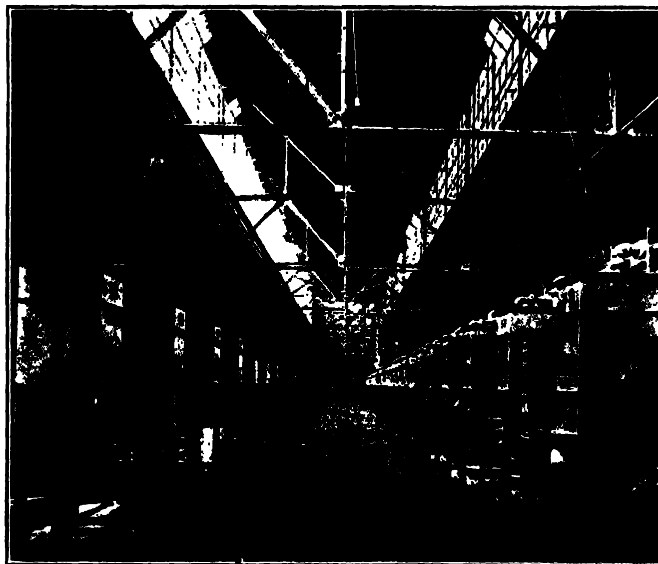


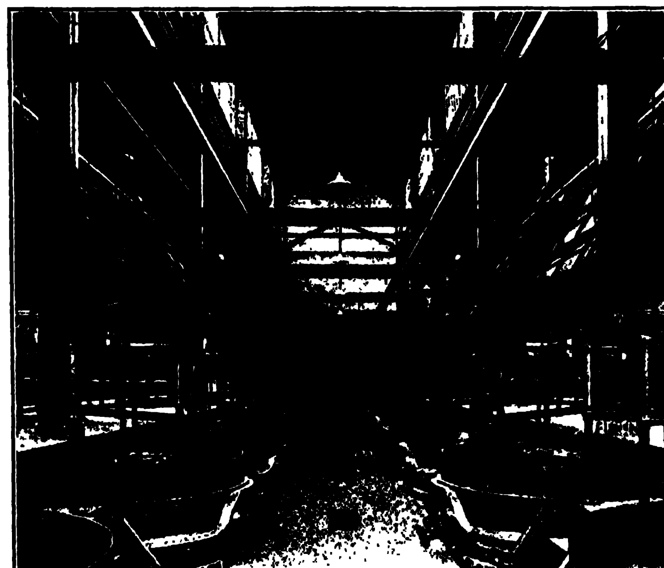
FIG. 8 (CONTINUED). LOOKING EAST AT WET-END BUILDINGS













FIGS. 10 TO 15

Top left, Fig. 10. Section of cyanamide oven building. Top right, Fig. 11. Air compressors, liquid air building. Middle left, Fig. 12. Liquid air columns. Middle right, Fig. 13. Catalyzer building, interior. Bottom left, Fig. 14. Ammonium nitrate house. Bottom right, Fig. 15. Section of construction camp.

60 hr., or 1,500 ovens every 2½ days, equals 510 ovens per day. This produces 600 tons of lime nitrogen daily.

Lime Nitrogen Mill. There are three mill units, two for operation, one spare; 16 hr. operation, 300 tons each.

Hydrating Building. There are three hydrators, two for operation, one spare; rated capacity 30 tons per hr. each.

Autoclave Building. There are seven autoclave units, six for operation, one spare; rated 100 tons per unit per day.

Filter Building. There are twenty filter wheels, fifteen for operation, five spare; rated capacity, 15 tons of sludge per filter in 24 hr. Total estimated tons of sludge, 720.

Nitric Acid Group. There are 696 catalyzers, one catalyzer producing 900 lb. 100 per cent HNO_3 for 24 hr.



FIG. 16. STREET IN PERMANENT VILLAGE

One nitric acid unit produces 22.5 tons of 100 per cent HNO_3 with 100 catalyzers in operation per 24 hr.

Neutralizer. There are four neutralizer units, each producing 100 tons of 100 per cent NH_4NO_3, three for operation, one spare.

Ammonium Nitrate Houses. Three hundred tons of ammonium nitrate total grained. Each house rates 60 tons per day. Each evaporating pan produces 8 tons per day. Forty pans for operation, ten spares. There are 100 grainers, eighty for operation, twenty spares. Each grainer handles four tons per day.

CONCLUSION

Neither space nor readers' patience will permit the penning of a eulogy on this work of our own engineers and craftsmen. It was made in the United States; the machinery, instruments and apparatus were turned out in our own factories; the special tile and chemical fittings testify to the achievements of our clay-working industries; the raw materials, the electrical equipment —but why continue, the story tells itself in pictures. Noble minds of many men have fabricated their souls' spirit into a being of metals and silicates which now lies sleeping in the Alabama sunshine while Government executives fiddle and politicians whittle. May the day soon come when it will be awakened to again sing a part in tune with the nation's industry and bring thereby all honor to these American engineers and workmen.

Prices Fixed on Sicilian Sulphur

By a decree of the Italian Ministry of Industry, Commerce and Labor, maximum selling prices on different grades of crude and refined Sicilian sulphur are established, to take effect retroactively from May 1. The decree is dated May 24 and appeared in the *Gazzetta Ufficiale* of May 29. The prices fixed by the decree for sulphur, refined or worked, apply to certain ports in Sicily which are taken as basing points. For instance, Catania, Licata, Porto Empedocle and Termini Imerese are named as the four Sicilian seaports for which the following base prices are given as the maximum per 100 kilos:

	Lire per 100 kilos.
Sulphur, advanced beyond crude state:	
Refined, in cakes	84.26
Refined, in rolls	87.26
Pure sublimed	108.62
Crude ground	77.46
Refined and ground:	
Content—	
From 60 to 65 per cent	96.90
From 65 to 70 per cent	98.35
From 70 to 75 per cent	99.98
Refined and fanned:	[illegible]
Content—	
From 75 to 80 per cent	101.55
From 80 to 85 per cent	103.67
From 85 to 90 per cent	106.66

To each of these prices as tabulated is to be added the charge of 5 centimes per 100 kilos, or 0.5 lira per metric ton, as a contribution toward the support of the Sicilian Sulphur Consortium, of which all producers are obliged to be members. The given prices are f.o.b. vessels or loaded in cars at the station of any one of the four ports selected as basing points. To determine the maximum allowable prices for other points in Sicily, actual transportation charges from one of the basing points to the destinations in question may be added. Furthermore, in the case of refined sulphur in cakes, allowance may be made for loss in transit not exceeding 1 per cent.

The prices of crude grades of sulphur shipped to Italian destinations outside Sicily are to have added to them 120 per cent of transportation costs, the extra 20 per cent to cover cost of handling, with a permitted allowance for loss of weight in transit not to exceed 2 per cent. The prices of worked sulphur at points outside Sicily are to be calculated in the same way, that is, by adding 120 per cent of the freight charges to the base prices, but the maximum allowance for loss of weight in transit cannot be greater than 1 per cent.

On crushed sulphur ore the maximum prices per 100 kilos, f.o.b. cars at shipping point and exclusive of cost of bags, have been set by the same decree as follows:

	Lire per 100 Kilos
Sulphur content of ore:	
From 25 to 30 per cent	21.85
From 30 to 35 per cent	25.15
From 35 to 40 per cent	28.45
From 40 to 45 per cent	31.75
From 45 to 50 per cent	35.05

For the resale of worked sulphur and crushed ore an addition of 2 per cent is allowed on the fixed purchase price as it is prescribed by the decree or calculated on the basis of transportation charges in lots of 1 metric ton or more. On the resale of lots amounting to less than 1 metric ton an addition of 4 per cent is permitted in order to yield the dealer's profit.

The ministerial decree which establishes the prices set forth above does not set them for sulphur of fineness exceeding 90 per cent, washed sulphur for medicinal purposes, and flowers of sulphur, all of which are specifically exempted from the purview of this particular price-fixing measure.

Small-Scale Manufacture of Barium Chlorate

By Treadway B. Munroe

THERE has recently been published by the Ordnance Department, U.S.A., in three volumes, an excellent work entitled "Military Pyrotechnics," by Henry B. Faber, dean of the Pyrotechnic Schools of the Department, the third volume of which is devoted to "A study of the chemicals used in the manufacture of military pyrotechnics." In this volume there is given for each substance its history, occurrence in nature, method of manufacture, availability of supply, uses other than in pyrotechnics, physical properties, chemical properties, function in pyrotechnic pieces, qualitative analysis, quantitative analysis, specifications and discussion of specifications. Among these chemicals barium chlorate occupies an important place, and since examination shows that the only methods given in this treatise for the preparation of barium chlorate are through (1) the metathesis of barium chlorate with sodium chlorate, (2) the chlorination of barium carbonate, and, especially (3) "the electrolysis of barium chloride," which is said to be the method by which "the barium chlorate of commerce is invariably prepared," it seems proper to place on record an account of a recent emergency use of Wheeler's method[1] in the preparation of this substance.

During the early summer of 1917 the Navy Department laboratory at Indian Head, Md., was unable to obtain any bids for supplying barium chlorate for use in its green signal rockets and flares. Up to this time this material had been imported from Germany at a very reasonable price. Attempts were made to substitute compositions made from various copper salts and potassium chlorate, with sugar, flour and other combustible substances, but the brilliancy of the green light obtained with barium chlorate mixtures apparently could not be duplicated.

Aid to Navy Department

This condition was brought to our attention by the Government contractor who ordinarily supplied the requirements, with the statement that the shortage was acute, that he had been unable to obtain this material or enlist the interest of others in its manufacture, and that if we could arrange to make up to 500 lb. in the laboratory it would allow the department time to arrange for the development of a permanent source of supply. Under these conditions we promised to make it.

A survey of the materials immediately available having shown a sufficient supply of sodium chlorate, hydrofluosilicic acid and barium carbonate at hand, it was determined to proceed by Wheeler's method as shown in the following expressions:



$$2NaClO_3 + H_2SiF_6 \rightarrow 2HClO_3 + Na_2SiF_6$$



$$2HClO_3 + BaCO_3 \rightarrow Ba(ClO_3)_2 + H_2O + CO_2$$

All the substances employed were commercial. The determined amount of sodium chlorate was dissolved in the least quantity of hot water possible, this was then added to a known quantity of the hydrofluosilicic acid in a stoneware jar and allowed to stand until the sodium fluosilicate formed had settled; the chloric acid was then decanted to another stoneware jar, the sodium fluosilicate stirred up with hot water, allowed to settle and the weak acid decanted and added to that in the other jar. The chloric acid was then neutralized with barium carbonate, concentrated in galvanized washtubs and allowed to crystallize; the mother liquid was saved and then several portions batched together would be evaporated to dryness and this impure chlorate used in place of part of the sodium chlorate to prepare the chloric acid. The barium chlorate was crystallized a second time, dried on a fruit evaporator, ground to better than 80 mesh in a coffee burr mill and sacked. Something over 400 lb. was made and proved to be satisfactory. The work was discontinued when the Navy Department was able to interest other parties in manufacturing this material electrolytically.

Theoretically 1 part of sodium chlorate yields about 1½ parts of barium chlorate; by this method we obtained a yield of but 1 to 1, the chief loss being due to the difficulty in separating the chloric acid from the sodium fluosilicate.

[1] "On the Fluosilicic and Chloric Acids," by J. L. Wheeler. *Quart. J. Sci.*, vol. 4, pp. 287-289; 1818.

Difficulties Encountered—Interesting Sidelights

Attempts were made to use various stone and artificial filtering mediums with suction, but owing to the slimy character of the precipitate they invariably clogged. A centrifuge would probably have solved this difficulty, but time would not permit us to secure one. Another difficulty was that the chloric acid fumes given off from the hot solution killed the trees and other vegetation adjacent to the laboratory and attacked the eyes, throat and nose of the operator to such an extent that he was finally compelled to wear a British army gas mask nearly continuously during his work.

It is of interest to note that when this material was crystallizing from solution if the crystal formation was disturbed then both sound and green flashes of light were observed. This occurred in glass, galvanized iron and wooden containers. Reference was found in the literature to the fact that sound is given off through agitation of the crystals, but we have at no place noted it recorded that light is given off also.

It is also of interest that the production of barium salts in this country, other than the natural barium compounds, was so new at that time that this small production was taken into account by the Geological Survey in its 1917 report.

Some of the crystal groups obtained in the course of this work were quite attractive. One of them, in fact, was presented to the National Museum and deemed by its curator worthy of a place in its exhibits.

Proposed Law to Permit Exportation of Pulpwood From Burned-Over Lands in Canada

A bill was introduced in the Provincial Legislature of Ontario on May 20, 1920, by the Minister of Lands and Forests, in which authority is provided for the exportation of pulpwood from areas which have been burned over by forest fires.

The object of the bill, as explained by the Minister, is to get the pulpwood cleaned off in these districts quickly in order to prevent a recurrence of forest fires. The districts to be cleaned up in this manner are not large, though the bill provides that the government shall decide what areas are included in the measure.

Early Commercial Electrolytic Cells*

Reminiscences of the Pioneer Chlorine Cell Work Done at Rumford Falls, Maine, and Berlin, New Hampshire—Graphite Electrodes Introduced—Porous Diaphragm Cell Developed

By CHARLES B. BARTON

THE paths of the early workers on electrolytic cells were not strewn with roses. They were very rocky. I speak from experience, for I think I have been continuously in the business longer than any other man in this country. In September, 1894, I went to work for the old Electro-Chemical Co. of Rumford Falls, Me., as a laborer; twenty months later I was made superintendent of the plant, and have held that position there, and subsequently in Berlin for the Brown Co. This makes twenty-six years of experience.

The original cells in Rumford Falls were the old belljars, with an asbestos diaphragm, approximately horizontal. The anodes were of retort carbon and were cast in lead, a projecting portion coming through the top of the belljar, to which was connected the positive wire. The cells were supposed to take about 100 amp. each and were run in parallel in the iron cathode tanks, the tanks being connected in series. The diaphragms of these cells had to be changed very often, the units were too small, and when I entered the employ of the company in 1894 it had discarded this type and was changing the type of cell.

These second cells were square boxes about 24 x 24 x 24 in., the top and upper third of the outside being made of slate with a slate cover, a wooden leg on each corner and a wooden bottom. Around the open part asbestos paper was wound for a diaphragm and outside of this wire netting, the netting being turned on the bottom of the cell so as to give electrical contact with the bottom of the iron tank, which held the cathode bath. The anodes were of gas carbon, with the ends cast in lead and space between the central anode proper, and the asbestos diaphragm was filled with lumps of broken retort carbon, the object being two-fold: To hold the diaphragm against the cathode and to bring the active anode surface closer to the cathode surface. About 500 of this type cells were discarded and another type later installed.

The third type of cell was a slate box with gas retort carbon anodes and no packing between the anode and the diaphragms. They were of various sizes, a large number about 36 in. in length x 6 in. wide and about 18 in. deep. These cells are very similar in construction to cells in commercial operation today. They were, however, soon discarded in favor of another type installed.

The fourth type was a distinct departure from the previous types. It was a large unit and was contained in a cathode tank, 9 ft. long, 5 ft. wide and 18 in. deep. A wooden frame of 4 x 6 in. lumber was laid in the bottom of the tank, on this frame a grid of iron made of $\frac{3}{8}$ x $1\frac{1}{2}$ in. iron stock was laid and part of the irons were extended and bolted to the tank to make contact with it. These irons were inclined to the horizontal so there was a pitch of 2 in. to the foot. On top of these irons a wire netting was placed to act as the cathode proper, and on top of this cathode a diaphragm of asbestos paper was laid. The side walls of the cells were made of red brick and the diaphragm was cemented in with quick-hardening cement. The covers were slate and the anodes were platinum wire. About fifty of these were operated during the spring and summer of 1898. The design was good and with the substitution of perforated metal plate for the iron grid and concrete side walls for the brick and wood the same cells are running today and are running efficiently.

Transfer of the Electro-Chemical Co.

The plant of the Electro-Chemical Co. of Rumford Falls closed in the fall of 1898 and part of the plant and operating personnel were transferred to Berlin, N. H., to make chlorine for bleaching the pulp of the Burgess Sulphite Fibre Co. T. P. Burgess, the manager of this plant, believed in the future of electrolytic chlorine and he believed that experience was the most valuable asset he could buy. He bought the experience of the Rumford Falls plant and he paid a very low price for it. The stockholders of the Electro-Chemical Co. shouldered their loss. The stockholders of American electrolytic chlorine and caustic soda corporations owe to stockholders of the old Electro-Chemical Co. at least a debt of gratitude. Let us analyze the reasons why the different cells developed at the Rumford Falls plant were not a success commercially. The first cells of the old belljar type failed because they were too small a unit, the diaphragm broke too often, and they were connected in parallel in the cathode tanks. The second cells failed because of the wooden construction of the body, the fact that the anode compartment was filled with broken pieces of carbon so as to give very poor circulation, and because of the method of making electrical contact to the anodes, which, you will recall, was by casting the upper ends in lead. The lead soon became oxidized at the points of contact, and this caused a rising voltage and uneven distribution of current in the tanks, for these cells had the fault of the previous ones, that they were connected in parallel.

The third type of cells failed because the same method of making electrical contact with the anode, casting in lead, was used, because the cells were connected in parallel, because too small a chlorine chamber was left in the cell and because the material of which they were composed, slate, was not the proper material of which to make cell bodies.

The final type of cell developed at Rumford Falls was a commercial failure there because the stockholders did not care to sink any more money in the plant. It was a success in Berlin.

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920

I think it is proper at this time to state that E. A. LeSueur had no active part in the management of the Rumford Falls Electro-Chemical Co. until the original development funds were about all spent. After the original management had demonstrated it could not run the plant at a profit he was made manager, but there was so little money available for experiments and development that the plant could not be developed to a commercial success. The offer from the Burgess Sulphite Fibre Co. to take over the plant came while the plant in Rumford was still in operation and was accepted as an easy way out of an exceedingly uncomfortable financial condition.

Trouble With Carbon Dioxide

It is now time to mention a few of the difficulties of operation encountered in the infant industry. The draft for moving the chlorine was originally obtained by introducing a pipe into the draft tube of the water wheels. It was later produced by steam siphon. The gas pipes to all the first cells were of lead and of small diameter, so that they were always clogging up. The brine was fed to the cells by means of a dipper and a funnel through a hole in the top of the cells, and when acidulated brine was introduced to a cell whose anode compartment was full of sodium hypochlorite the foam immediately clogged the gas pipes and imparted a green tint to the atmosphere. In fact, the atmosphere of the cell houses was usually slightly green and all men who entered the cell houses wore muzzles. A cell whose anode compartment is contaminated with alkali always runs at a low current efficiency. The oxygen liberated at the anode immediately attacked the amorphous carbon and formed CO_2 with which the chlorine was contaminated. The lime spread in the bleach chambers absorbed the CO_2 and this lowered the test of the bleach so that it was not always salable, in competition with English bleach. It was observed, however, that the CO_2 always combined with the top lime and formed a hard crust. It was necessary to skim off this top crust in order to produce merchantable bleach.

This difficulty finally led to experiments with platinum anodes, which seemed to promise elimination of our troubles. It was necessary because of financial reasons to use the smallest amount of platinum possible. Mr. LeSueur produced a platinum anode which was based on the idea of the electric light bulb. Sixteen pieces of platinum wire about 4 in. long were sealed in a glass tube in the same manner as was formerly usual in making light bulbs. About ½ in. of wire was left inside the tubes, and the outside wires, which were flattened, were spread like the spokes of a wheel at right angles to the tube. Electrical contact to the inside wires was made by a drop of mercury. It was necessary to have a horizontal diaphragm to use this anode, and they were used in the last type of cell installed in Rumford Falls.

The money for this last installation was very meager. The directors wanted a profit or they wanted to close down the plant, and not enough platinum anodes were allotted to each cell to carry the load. The result was that many of them cracked. This threw the load on the remainder, with the result that the cells ran at very high voltages, from 5.5 to 7.5 or 8 per cell, at 1,200 amp., with about 30 sq.ft. of diaphragm per cell. This produced a very peculiar and puzzling result. The temperature rise was so great that sodium chlorate was formed in large amounts; the caustic liquor going to the kettles contained only about 2 per cent NaCl, but the finished product would contain about 10 per cent. When the reason was discovered all caustic liquor was treated with potassium chloride, and we were obliged to go into the manufacture of chlorate of potash. It was at the time of the Spanish-American war and chlorate of potash, being contraband, shot up in price, so that it really was a blessing in disguise, and allowed us to weather the gale for a little longer. However, after the offer from the Burgess Sulphite Fibre Co., we soon shut down and thus closed the first commercial American plant of porous diaphragm cells for the production of chlorine and caustic soda.

McDonald and Mercer were foremen of the cell houses in Rumford Falls. H. K. Moore had his first experience with cells in the employ of the Rumford Falls plant. The Nelson cell was born of experience with the McDonald cell, which was a copy of the third type of LeSueur cell. I should like to read some claims of the LeSueur cell patents granted in 1891, now lapsed.

> 2. An electrolytic cell comprising a bell of earthenware, a positive electrode therein, a diaphragm covering the mouth of said bell, a negative electrode, and a tank in which said bell is placed, the level of the liquid within the bell being higher than that of the liquid outside the bell, whereby the diaphragm is prevented from bulging, substantially as set forth.
>
> 3. An electrolytic cell comprising a combination, with a tank to contain liquid, of a bell in said tank, positive and negative electrode, and a flexible diaphragm between said electrodes and covering the bottom of said bell, said diaphragm being adapted to maintain the liquid of the positive electrode side of the said diaphragm on a higher level than that of the liquid of the negative side of the diaphragm, whereby the diaphragm is kept from approaching the positive electrode, substantially as set forth.

In the LeSueur electrolytic patents the principle of having on the anode side of the diaphragm a greater hydrostatic head than is carried on the cathode side is first mentioned. Unless I am greatly mistaken, these patents were the foundation of all electrolytic porous diaphragm cells, and credit should be given E. A. LeSueur as being the real founder of the industry.

Early Work at Berlin

When we moved to Berlin, N. H., in October, 1898, it was with the purpose of making bleach liquor for bleaching the pulp, and letting the caustic run to waste. The plant was a success from the start, though handicapped in various ways. Seventy-two cells were installed to run at about 1,000 amp. The writer should have known better from past experience, for he made a mistake in starting the original plant in using the exhaust steam from the engine that furnished the auxiliary power to heat the water that was run in the cathode compartment to flush out the cathode liquor. This made the cathode liquor so active that it diffused into the anode compartment to such an extent that it seriously affected the efficiency of the plant. This mistake, was, however, soon rectified.

The power for the operation of the cells in Berlin was bought under a peculiar arrangement. The power from four water wheels, a maximum of about 1,000 hp., was contracted for at a low figure, when there was water enough in the river to run these wheels, the six other wheels in the same power house having prior right to the water and running the sawmill. The result was that the power was very uneven and in the winter of 1899-1900 it was necessary to shut down.

The writer moved to the sulphite mill and set up some

experimental cells in the digester building. There we ran experiments for several months, mostly on cells of the Moore type, and with the new Acheson graphite, which had just then come on the market. In plotting the variables, and trying to find why some cells ran better than others, I found that by manipulating the flow through the diaphragm in proportion to the amperes going through the cells, using saturated brine, I could get any results I desired within certain limits. If we wanted to get 97 or 98 per cent current efficiency we simply increased the flow to the point necessary. This would decompose about 50 per cent of the salt in the brine fed to the cell. If we wanted to decompose about 60 per cent of the salt we reduced the flow to the point on the curves that would give this figure, and would get about 90-91 per cent current efficiency.

Acheson Graphite Electrodes

We immediately designed a cell and installed 160 of them, the original Moore cells, the first cells run commercially with unsubmerged cathodes. There were mistakes made in the construction. The frames were made of slate put together with wood screws. They were installed in a single row, on about 8 in. centers. The graphite was not impregnated, the brine was not purified. The gas outlets were 1 in. glass tubes. The gas space in the cells was too small and they vomited chlorine continuously. We lived, I don't know how, with them nine months, and then threw them all out the back windows, and called it good riddance. The principle was all right, but we did not work it out to its logical conclusion. I had been steeped in chlorine for nine months and cared nothing about principles or conclusions. Now, however, we had Acheson graphite. The graphite from the Moore cells was used in the LeSueur cells and we soon began to get wonderful results for that time. The voltage drop on individual cells was 4 to 5 volts, instead of 5.5 to 6.5 with a platinum anode. The production jumped, while the power required per ton of bleach was lowered from 100-125 hp. to 80-90 and, of course, in later years to 60-70. The real feature of the electrolytic cell dawned with Acheson graphite anodes. The original plant in Berlin had grown from seventy-two cells, with a production of 3 to 6 tons of bleach per day, to a plant with about 800 cells and a maximum production of 80 to 90 tons 35 per cent bleach. The water wheels that formerly furnished power for the sawmill and caused the shutting down of the bleach plant wheels are now furnishing power for the cells as well as all the other wheels in the next lower power house, and half the wheels on the one below that. We have installed 160 of the latest type of Allen-Moore cells, which resemble the original ones only in principle. H. I. Allen, with H. K. Moore, developed the cell from the point where we left it.

About the same time that the LeSueur cells were started in Berlin, N. H., in 1898, an installation of Carmichael cells was started at the Westbrook, Me., plant of the S. D. Warren Paper Co. These cells used platinum wire anodes and the gravity principle of separation. They were not a commercial success.

The history of the development of the diaphragm electrolytic cell emphasizes the well-known point that new processes are best developed by a well-organized corporation, engaged primarily in some other business that can bear the financial burden of experimental failures and keep on until success crowns its efforts.

What Constitutes Unfair Trade Practice?

THE recent citation by the Federal Trade Commission of firms operating in restraint of trade may have caused the question to arise in the mind of the reader as to just what constitutes unfair trade practice. As a matter of general information the following list of unfair methods, taken from a recent address of a member of the Federal Trade Commission, William B. Colver, is given:

Misbranding of articles as regards the materials or ingredients of which they are composed, their quality or their origin or source.

Adulteration of various products, misrepresenting them as pure or selling them under such names and circumstances that the purchaser would be misled into believing them to be pure.

Bribery of buyers or other employees of customers with money, valuable presents, etc., to secure new customers or induce continuation of patronage. The payment of specified percentages of the purchase price of commodities to employees of customers who practically control the purchases through their recommendations has been and still is deplorably prevalent in some industries. The total amount of these commissions runs into enormous sums. If the practice can be prevented it will save much money to the sellers of the goods, making price reductions possible or rendering further increases in prices unnecessary, and tend to better business morals. A variation of this practice is found in bribing an employee of a customer to introduce foreign substances into the product of a competitor, spoiling its usefulness and thus procuring the business of the concern. The commission has suggested to Congress that a Federal criminal law against commercial bribery should be passed, and this suggestion has been vigorously approved by many great associations of business men.

Unfair Methods Against Competitors

The payment of bonuses by manufacturers to the salesmen of jobbers and retailers, with or without the knowledge of their employers, to procure their special services to push the goods of the manufacturer has likewise been condemned.

Procuring the business or trade secrets of competitors by espionage on their plants, by bribing their employees or by similar means.

Procuring breach of competitors' contracts for the sale of commodities by misrepresentation or by other means.

Enticing away of valuable employees of competitors in such numbers as to disorganize, hamper or embarass them in business.

Making of false or disparaging statements respecting competitor's products, his business, financial credit, etc.

False or misleading advertising. There are obviously many varieties of this practice. A few of the statements condemned have been those respecting prices at which goods are sold, methods employed in the advertiser's business which if true would give it advantages over competitors in the matter of prices; misrepresentation that goods are sold at cost; false claims to Government indorsements of products, and advertising special cut-price sales at which goods are sold at the usual or ordinary prices.

Widespread threats to the trade of suits of patent

infringement for selling or using alleged infringing products of competitors, such threats not being made in good faith but for the purpose of intimidating the trade. False claims to patents or misrepresenting the scope of patents. Statements of this character have been at times sufficiently broad to give claimants a monopoly of an industry. In one instance a manufacturer procured a patent on a variation of a well-known and long used process of manufacturing a product and thereafter claimed to have a monopoly of the product, threatening all competing manufacturers and the trade with suits for infringement.

Tampering with and misadjusting the machines sold by competitors for the purpose of discrediting them with purchasers.

Trade boycotts or combinations of traders to prevent certain wholesale or retail dealers or certain classes of such dealers from procuring goods through the usual channels.

Passing off of the products of one manufacturer for those of another by imitation of product, dress of goods, or by simulation of advertising, or of corporate or trade names.

Misrepresenting the materials of which competitors' products are composed, and the financial standing of competitors, preventing competitors from procuring advertising space in newspapers or periodicals by misrepresentation respecting their financial standing or other misrepresentation calculated to prejudice the advertising medium against them.

Misrepresentation in the sale of the stock of corporations.

Sale of rebuilt articles of various descriptions—for example, rebuilt automobile tires and of old motion picture films slightly changed and renamed—as and for new products.

Harassing competitors by fake requests for estimates on bills of goods, for catalogs, etc.

Giving away of goods in large quantities to hamper and embarass small competitors.

Sales of goods at or below cost to accomplish the same result.

Sales of goods at or below cost as "leaders," coupled with statements misleading the public into the belief that they were sold at a profit by reason of the sellers' superior facilities for manufacturing, purchasing, etc.

Bidding up the prices of raw materials to a point where the business is unprofitable for the purpose of driving out financially weaker competitors.

Unfair Methods in Dealing with Customers

Loaning, selling at cost, or leasing to dealers at nominal considerations, storage and merchandising outfits such as pumps and tanks for gasoline and coffee urns for coffee, on the condition that they be used only in the distribution of the products of the manufacturer. The effect of the widespread use of this method is to render it very difficult, if not impossible, for competitors coming into a field to find purchasers among the trade, since the equipment of dealers must be used only in the distribution of products of particular manufacturers. To illustrate the consequences of the practice, in one instance a very large corporation which had been engaged in foreign trade sought, after the opening of the war, to go into domestic business, and found itself practically unable to sell because of outstanding equipment contracts. The expenditure of hundreds of thousands of dollars was required in purchasing the business of concerns with outstanding leases or contracts for the use of equipment before any substantial business could be done. Only the great financial strength of the corporation enabled it to enter the business at all. Of course, in the end the public paid the bill. Such loans or leases of equipment have been prohibited in several industries.

There is the use by monopolistic concerns of concealed subsidiaries for the carrying on of their business, such concerns being held out as not connected with the controlling company.

Intentional appropriation or converting to one's own use of raw materials of competitors by diverting shipments, etc.

Giving and offering to give premiums of unequal value, the particular premium received to be determined by lot or chance, thus in effect setting up a lottery.

Any and all schemes for compelling wholesalers and retailers to maintain resale prices on products fixed by the manufacturers. The commission is seeking with the sportsmanlike aid of the Beech-Nut people, to have this question settled by the United States Supreme Court in a test case. Meanwhile the commission has urged upon Congress a law that will recognize and protect with proper safeguards the good-will property right which a maker of identified goods may have after he has parted title to the goods themselves.

Combinations of competitors to enhance prices, maintain prices, bring about substantial uniformity in prices, or to divide territory or allot customers.

In addition to the practices already enumerated there have been cases where a number of practices associated together were condemned because of their combined effect unduly to restrict competitive opportunity and where it could not be said probably that any single practice standing alone would have been condemned. A clear idea of these can probably only be had by reading the findings and orders of the commission in the particular cases.

Attitude of the Supreme Court

Though the commission was organized in the spring of 1915, only one decision of the Supreme Court of the United States has thus far been had interpreting the provisions of Section 5 of the commission's organic act. This decision actually determined only a point the commission had not pleaded that the particular practice had a dangerous tendency actually to restrict competition. It appears from the opinion, however, that the court is inclined to establish two classes of practices as being in violation of the act: First, those practices which have heretofore been regarded as opposed to good morals because characterized by deception, bad faith, fraud or oppression, and second, practices regarded as against public policy because of their dangerous tendency unduly to hinder competition or create monopoly. Apparently, if a practice have this dangerous tendency it will be regarded by the court as in violation of the act, even though not heretofore declared to be an unfair method of competition.

By far the greater part of the practices thus far condemned by the commission fall within the first class described by the court. Some of them depend for their unfairness, however, on their tendency unduly to hinder competition. Whether such a practice has this tendency depends on the proof in the particular case.

Elements of Design of a Copper Refinery

Certain Features of a Refinery Must Be Settled First, Such as Location, Capacity, Current Density, Tank Dimensions, General Wiring and Switchboard Diagrams, Size of Anode and Cathode Furnaces, Purification System and Type of Silver Refinery

BY LAWRENCE ADDICKS

UP TO the present time electrolytic refining has been conducted almost exclusively in the United States, about 80 per cent of the world's production being treated here. This has been due to several factors. The North American continent has produced the great bulk of the world's output of copper, metallurgical operations have been developed on a larger scale in America than elsewhere and the local copper production has been largely consolidated into a few large groups each capable of supporting one or more large refineries.

LOCATION

Since the war the nations of Europe have developed a new desire to control key industries complete within their own borders, home or colonial, and new tariffs, trade routes, etc., are likely to cause the building of various new refineries. In general the factors associated with the movement of copper from mine to market, rather than those directly connected with refining, such as cost of power, are likely to control the location of a plant. Unless a plant is built to refine a large tonnage from a single group of mines, care must be taken when determining upon its location to consider breadth of both copper supply and market. The result has been to group a number of the American refineries around the port of New York because at that point rail shipments from Western smelters and ocean arrivals from South America conveniently join steamship deliveries to Europe and railroads to New England mills.

One of the advantages of having a refinery close to an Atlantic port is that orders can be filled promptly in the particular shape specified, enabling the European customer to play close to a fluctuating market, which at times would result in a preferential sale. Another objection to locating a refinery at a far distant mine is that a long time elapses between the production of a wirebar and its actual rolling, so that there is no prompt independent check upon the quality of product the plant is turning out. Aside from these considerations, the availability of a suitable coal for furnace work and the existence of a good boiler water together with ample water for condensing must be looked into.

CAPACITY

In the same way external considerations may justify the operation of a plant of a capacity far below the economic size, but the latter is a point of universal interest. In these days of economic disturbances it is very hard to state anything in terms of absolute cost, but a relative diagram may be made, showing with reasonable reliability the relation between plant capacity and operating cost. This has been attempted on a percentage basis in Fig. 1, where it is shown that not much is to be gained, in so far as cost is concerned, by making a plant of larger capacity than 200,000,000 lb. of copper per year. Even this figure, however, is beyond the reach of any but the largest mining groups, so that there will always be a large custom refining business.

TANK HOUSE

Having decided upon the size of plant to be constructed, the next problem is the choice of the current density. This question has already been discussed at length in a previous article (CHEM. & MET. ENG., March 15, 1917), and in turn depends upon several primary factors such as cost of power, silver values, etc. It has also to be remembered that the plant will earn more on its investment when operated at a little higher density than that giving the lowest operating cost. For example, if a certain plant could treat its most economical tonnage of 100,000 tons a year for $20 while by

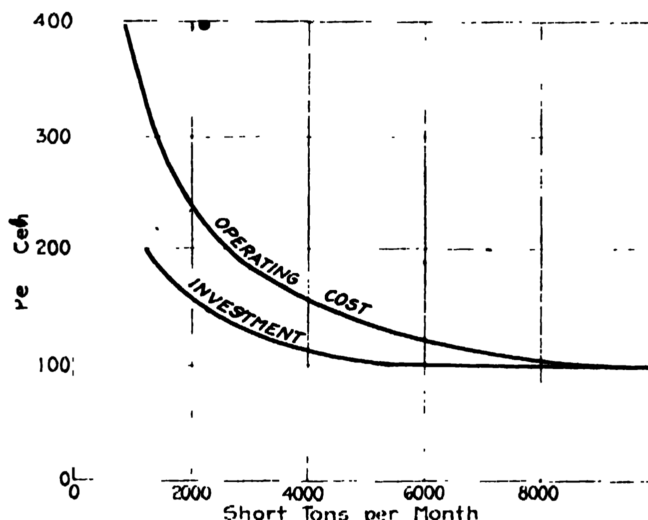


FIG. 1. VARIATION OF COST WITH SIZE OF PLANT

raising the density proportionally it could treat 110,000 tons at $20.30, 120,000 tons at $21, with very little additional capital expenditure, and the refining toll was $25 a ton, then the earnings on 100,000 tons would be $500,000 a year, and on 110,000 tons $517,000, but on 120,000 tons only $480,000. On the other hand, it is generally wise to leave this margin for the growth of the business.

The density having been settled on, tank dimensions have next to be considered. In the earlier plants electrodes about 2 x 3 ft., twenty pairs to the tank, were used with densities around 15 amp. per sq.ft. This gave 3,600 amp. on a circuit, which was in those days a heavy amperage to rectify on a single commutator. Today thirty pairs of electrodes are used without material lowering of the current efficiency and in one plant electrodes 4 ft. square are in successful use, although 3 ft. square is a more popular size where soluble anodes are

employed. With thirty pairs of 3-ft. electrodes and the average density of 20 amp. per sq.ft. the current on a circuit becomes 10,800 amp., still well within the limits of the modern commutator. At an overall current and time efficiency of 85 per cent this current will produce 17,258 lb. of copper per tank per month, or 575 lb. per pair of electrodes.

The spacing center to center of anodes will lie between 4 and 4½ in., depending upon the purity of the bullion treated and the age of electrodes adopted. In general the column of liquor between anode and cathode should be about 1¼ in. across. General practice as to the age ratios of electrodes is indicated in Fig. 2. At the lower densities cathodes and anodes are of identical age, while as the density rises increasing numbers of sets of cathodes are drawn during the life of one set of anodes. The weight of the anode can be obtained by multiplying the expected output per tank-day per pair of electrodes by the days' life determined upon and adding 15 per cent to this figure to allow for anode scrap. From the area and weight (allowing something for porosity) the thickness may be calculated, and this plus 2½ in. will give the anode spacing.

Having settled upon the output per tank-day, the total number of tanks required is at once obtained, and the next question to be considered is the number of independent circuits required. In general the voltage per tank will be somewhere between 0.30 and 0.45 volt. This figure depends upon many factors, the chief being the current density. An average value in practice would be 0.35 volt. To this must be added a sufficient allowance for liberator and stripper tanks. The former require about 2.2 volts when on normal work and 2.5 volts when used for complete removal of copper. Ordinary work would call for 2 per cent of the former and none of the latter, but this depends upon the analysis of the anodes to be handled. Stripper tanks are operated on a somewhat wider spacing than regular tanks, and this means fewer pairs of electrodes, higher current density and higher voltage—say 0.50 volt as compared with 0.35. If we take 80 per cent of the number of electrodes per tank, 24-hr. sheets, allow another 20 per cent for loops and bad production and 10-day cathodes, not forgetting that one stripper blank yields two starting sheets, each regular tank will demand the equivalent of three sheets a day, while each stripper tank will produce thirty-eight sheets a day.

POWER HOUSE

The general power problem will be reviewed in the last article of this series.[1] To this may be added, however, some notes on electrolytic switchboards.

Heavy direct currents are satisfactorily handled by multiblade knife switches with a duty of 50 amp. per sq.in. of sliding contact. Circuits are neither opened nor closed under load, but a circuit breaker with a no voltage release should be placed on each circuit, not as a protection to the generator, the armature resistance of which is too low to "short circuit," but to protect men and apparatus in the tank house. It is not uncommon to have an open circuit due to the crane drawing cathodes by mistake from a tank which has not been cut and heavy arcing may result. A bar or tool laid across lines where any considerable effective voltage is present is promptly "burned out." An automatic engine stop should also be provided in the case of reciprocating engines, as with a sudden release of load due to the opening of the circuit breaker there is always a chance that the governor will act sluggishly, as the steady full load day after day gives it but little exercise.

Recording and integrating instruments are not of great value on the electrolytic switchboard, beyond giving a check on the employees, as hourly readings of the indicating instruments are ample for all records.

Several precautions are necessary in setting instruments on the board.[2] With voltmeters there is little trouble, though the same precautions must be taken with regard to the effect of stray field as stated below for ammeters. The very heavy currents met with in electrolytic work accentuate some causes of error which are ordinarily negligible in switchboard ammeters, and if a limiting error of 1 per cent is to be attained distribution of the current in the shunt, thermo-electric effects, switchboard temperature, magnetic effect of stray field on the instrument and possible dynamo action of the leads must be accounted for. Error of 1 per cent may be taken as the limit of accuracy of the best types of switchboard ammeters for heavy direct current.

Care should be taken to place both shunt and instrument in suitable positions when designing the switchboard. In the first place, the shunt should be obtained from the maker with short bars inserted in the slots

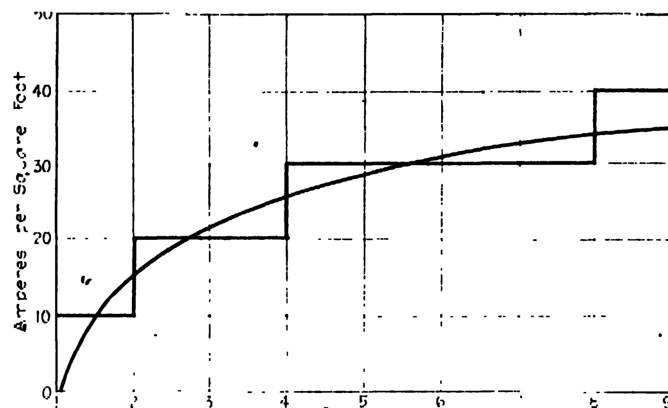


FIG. 2. CROPS OF CATHODES DURING LIFE OF ANODE

usually provided in the shunt terminals, these bars in turn to be bolted to the busbar carrying the current to be measured. In this way the shunt is calibrated with the same distribution of current through the various leaves, as will be the case in after use. It is practically impossible to disconnect a high-capacity shunt down to the slotted terminals and put it back in place again without altering the calibration more or less, due to change in the distribution of the contact resistance between main bar and shunt terminals, and consequent slight change in the amount of current carried by the different leaves of alloy. This, in turn, slightly affects the ratio between drop of potential between binding posts and total current carried. These changes in resistance are very small, but the total resistance of a good 5,000-amp. shunt is but about 0.00001 ohm. There is no way to detect the error introduced in this way except by calibration in place.

Unequal heating of the two shunt terminals will introduce a constant error from the thermo-electric junctions formed where the alloy leaves are soldered on to the copper blocks. This may easily amount to 1 per cent of the full-scale reading, may be either positive or nega-

[1] Publication to follow shortly.

[2] Addicks, *Trans. Am. Electrochem. Soc.*, vol. 9, p. 239.

tive, and will show as a zero error on shutting down the circuit which will gradually disappear as the shunt cools off. Sometimes compensating devices are applied to avoid thermo-electric errors, but if the shunt is so placed in the busbar that the facilities for conducting away heat are approximately equal on both sides, there will be no appreciable error, and such devices should be unnecessary. The alloy leaves of a shunt would be red hot at full load were it not for the heat-dissipating qualities of the large copper terminals. There should be practically equal radiating surfaces of bus bar for 3 or 4 ft. each side of the shunt. If placed close to a switch on one side, there is sure to be a thermo-electric error in the shunt, as high capacity switches frequently run hot. The best plan is not to attempt to place the shunt back of the switchboard at all.

Danger of Overheating Shunt

The temperature at which a shunt runs will depend upon how heavily it is loaded and the opportunity afforded to dissipate the heat generated. The temperature indicated by a thermometer and well placed upon one of the terminal blocks should not be allowed to exceed 200 deg. F., owing to the danger of starting the solder and consequent failure. The temperature coefficient of the alloy used in the resistance leaves is generally so low that no correction to the instrument reading need be applied for the heating of the shunt.

A sensitive millivoltmeter is used to measure the drop. The condition for maximum sensitiveness would require that all of the resistance of the instrument be in the armature of the d'Arsonval type so generally used. And in order that a given resistance may afford as many ampere turns as possible without making too heavy a bobbin, the material must be one low in specific resistance, such as copper. The use of copper means a high temperature coefficient, and in order to keep within 1 per cent on large switchboard ammeters it is always necessary to correct for instrument temperatures. The largest size of instrument—independent of capacity, as change of size for current rating is made in shunt and not in instrument—has a temperature coefficient corresponding to that of pure copper, or about 0.2 per cent per deg. F. The smaller types are lower in temperature coefficient, as the lighter movement gives the instrument designer more leeway. In high-resistance instruments, such as voltmeters, there is a series coil, made of low temperature coefficient alloy, which forms so large a proportion of the total instrument resistance that the coefficient of the whole is negligible.

Stray Field

One of the most important sources of error is the magnetic effect of stray field in the immediate vicinity of a bar carrying several thousand amperes. Instruments should never be placed within 2 ft. of such bars. The iron shield usually provided is not only likely to be faulty as a filter for lines of force of such density, but consequent poles are formed in the case itself.

The magnet of an unscreened Weston portable instrument may be permanently altered by placing the meter too close to such a bar, and this is very easy to do especially in the tank house. Even at a distance of several feet the readings of a portable instrument are thrown out a division or two on the scale and where accuracy is desired the average of two readings with the instrument turned 180 deg. should be used.

The resistance of the leads on a switchboard ammeter is generally about 5 per cent of that of the instrument, and the screw connections must be kept clean. If it is found necessary to lengthen the leads, care must be taken that the resistance is kept constant by a proportionate increase in size of wire used. The leads should be twisted and kept from swinging loosely in the presence of stray field. Otherwise there is a dynamo action which the millivoltmeter is sensitive enough to indicate by a pulsating needle.

When several high-capacity ammeters are in use, it is advisable to have them interchangeable. The various instruments may then be checked at any time by connecting them to the same shunt. Connections should also be arranged, if possible, to put the shunts in series, when they too may be checked.

The question of proper section for busbars has been fully discussed in a previous article (CHEM. & MET. ENG., Nov. 15, 1916). No insulation is used and faced metal to metal joints without amalgam, tightly bolted together, are satisfactory at 200 amp. per sq.in. contact surface. Either rolled or cast bars may be employed. The bars from the switchboard to the tanks are best carried overhead and the positive and negative leads kept some distance apart.

Furnaces

For smooth operating there should be at least six furnaces, three anode and three wirebar units, two of each being in service and one out for repairs. For a capacity of 100,000 tons a year, and allowing for Sundays and holidays out, we should have 600 charges a year of 333,000 lb. each plus scrap, etc., which is a furnace of fair size, although it is possible to build them very much larger.

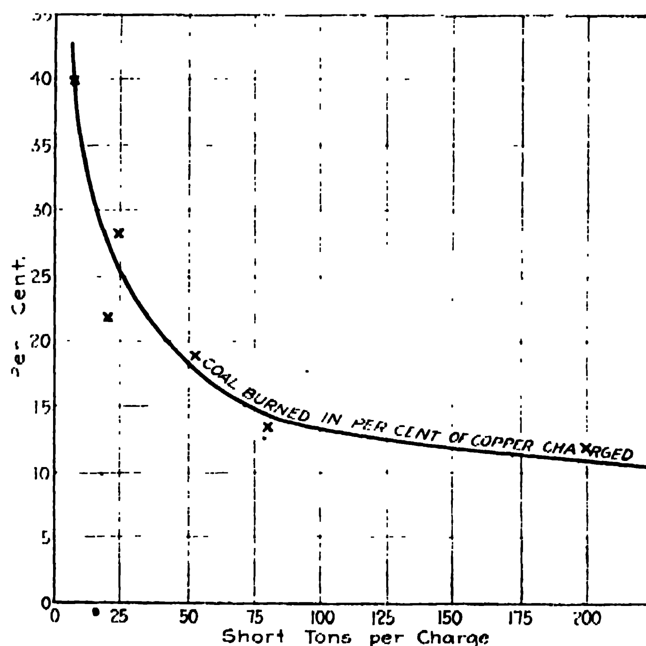


FIG. 3. FUEL RATIO OF FURNACES

The limit of size has been the ability to charge, refine and cast the charge in 24 hr. With hand charging and ladling, using the same men for both operations, 60,000 lb. is a large furnace. If a fresh crew is used for charging and as many ladlers employed as can be accommodated at the ladle door, 100,000 lb. can be reached. With hand charging but mechanical ladling, 300,000 lb. is

possible, using three charging doors. With full mechanical charging and ladling 500,000 lb. is easily reached, and using two charging and ladling machines even a larger capacity can be attained.

The fuel economy increases rapidly with the size of furnace as indicated by the curve in Fig. 3. Labor charges also fall up to the point of mere duplication of machine units. Repairs fall at first, but a very large furnace is likely to incur heavier repairs than one somewhat smaller. This is especially true where too great a span of roof is attempted. A refining furnace is subjected to much greater and more rapid temperature changes than an ore reverberatory.

Small silica furnaces produce excessive slag as they run hot and have an undue proportion of wall exposure. A 40,000-lb. silica furnace will form 4 or 5 per cent of slag on a wirebar charge, whereas a similar furnace of 150,000 lb. or over to the charge can be held down to half that amount. With basic side walls there is a substantial decrease in these figures, and with a full basic furnace operating on a charge of good quality the slag made can be held down to 0.5 per cent or better.

Altogether a furnace casting a charge of 300,000 lb. or more may be considered a thoroughly economical unit.

Silver Refinery

A 100,000-ton plant will call for a silver refining department of reasonable size. At 1.25 per cent slimes there would be four tons of slimes a day to treat, calling for a doré reverberatory of about twenty tons capacity, just the size of the first copper furnaces. It is desirable to use but a single furnace in order to hold at a minimum the large bottom absorption of values. A spare furnace may be held in reserve and in case of accident or at inventory time substituted, the first unit being completely dismantled at that time and its silver content recovered.

A very small plant can best sell its slimes to a lead refinery, but owing to the difficulty in getting a fair sample of such rich material this is not desirable when the tonnage is of any size. Small plants would use a cupel furnace and sulphuric acid parting, while reverberatory smelting followed by electrolytic parting is generally employed in large ones.

While the purifying system affords a suitable outlet for accumulations of sodium salts in the electrolyte, niter may be used to remove the copper from the slimes. Where closed cycle operation is undertaken the copper is generally oxidized by roasting. Either method gives good metallurgical results.

Purifying

The metallurgical principles upon which the choice of a purifying system must be based have been fully covered in a previous article (Chem. & Met. Eng., June 15, 1917).

Where insoluble anode tanks are employed for the complete removal of the copper from batches of electrolyte, ample provision must be made for the very low current efficiency of these tanks. Should a bluestone plant be employed, the design will be based upon the quantity of shipping salt to be produced. The crystallizing tank space employed in different plants varies considerably. A fair average figure, making allowance for the recrystallization of fines, is 58 cu.ft. per short ton per month of marketable bluestone. When estimating the proportion of impurities removed from the electrolyte, it must be remembered that a large part of the copper in the bluestone comes from the shot towers and not from the electrolyte. For each 1,000 cu.ft. of crystallizing space, allowance should be made for, say, 175 cu.ft. shot towers, 375 cu.ft. shot tower receiving tanks, 225 cu.ft. slimes settling tanks, 250 cu.ft. boiling tanks, and 275 cu.ft. iron cementation tanks. These ratios, however, may be varied between rather wide limits to suit individual cases differing in analysis of electrolyte, character of shot, climate, etc.

General

Two main principles should be kept in mind in the program of operation of any plant. The first is that all the impurities possible should be eliminated at the anode furnaces, using basic furnaces if necessary. It is much more costly to throw this burden upon the tank house and silver refinery.

The second is to do everything possible to facilitate uniformity of operating conditions. As a general rule anodes of constant composition, a uniform current density and a single electrolyte should be used throughout the tank house.

Artificial Graphite

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. This company utilizes the electric power generated at the Falls to make graphite from anthracite coal or from petroleum coke. This product is used mainly in lubricants, but it is also used in paints, foundry facing, preventives of boiler scale, and fillers for batteries.

Artificial graphite may be used for any purpose for which natural graphite is employed, according to the United States Geological Survey, except in the manufacture of large crucibles. Patents have been issued recently, however, for methods of manufacturing crucibles in which artificial graphite may be used. Artificial graphite is peculiarly adapted to the manufacture of certain graphite products, among them graphite electrodes, which are not made from natural graphite and for which the demand has greatly increased in recent years. The table below, published by permission of the Acheson Graphite Co., represents only the manufactured graphite that comes into competition with natural graphite.

GRAPHITE MANUFACTURED BY THE ACHESON GRAPHITE CO., 1915-19

	Pounds
1915	5,084,000
1916	8,397,281
1917	10,474,649
1918	9,182,272
1919	8,163,177

New Cold Process for Vulcanizing Rubber

It is reported that a very important discovery of a new process of vulcanizing rubber has been made by Prof. Peachey of the Manchester (England) College of Technology—important because it is a method of cold vulcanizing. It makes use of two gases, hydrogen sulphide and sulphur dioxide, which react on each other to produce water and free sulphur. The professor has found that when crude rubber, either in a solid form or in solution, is treated with these two gases the sulphur produced by their interaction vulcanizes the rubber. If the rubber is mixed with a waste material such as sawdust or leather scraps or paper, and the mixture is vulcanized, the resultant materials will serve a variety of useful purposes.

Properties and Constitution of Glues and Gelatines—V

A Study of Adhesive Properties—The Relation of Jell Strength to Shear Strength; of Jell Strength to Tensile Strength; of Viscosity, Melting Point, Origin of Stock, Joining Pressure and Prolonged Heating to Shear Strength*

By ROBERT H. BOGUE, PH.D.

THE criterion for the value of a glue as a joining agent must, in most cases, be the actual strength developed and maintained by that glue in service, and any method of grading whereby relative strengths are not truly expressed is pernicious and unscientific. Indeed, actual strength tests may be considered as the only absolutely dependable basis upon which to evaluate glues, and for some very particular purposes, as in the selection of glues for airplane service by the United States Forest Service,[75] such tests are consistently made upon all samples before approval. But, in general, strength tests are not made for several reasons. The machinery for making such tests is heavy and expensive. The time required is long—about seven days. The technique requires very careful and precise handling in order to obtain accurate results. Other methods of grading have long been in use, and are believed to be reasonably satisfactory. And, most important perhaps, the strength test itself has ever been more or less unsatisfactory, even in the hands of skilled research men. There are many elements concerned in the results obtainable besides the glue itself. There may be mentioned the hardness and uniformity of grain of wood, and its moisture content; the varying degree of perfection obtained in making the joint; the distribution of the pressure over the surface of the joint; the difficulty of duplicating the joining pressure exactly. These and many other less obvious factors all make for inexact, and not readily duplicatable, results.

NO STANDARD MECHANICAL STRENGTH TESTING METHOD

Again, many methods have been suggested in the literature for making the strength test, but there is as yet no generally accepted method which may be considered as standard. Rudeloff[76] used red beech wood, 185 mm. long, 125 mm. broad, 50 mm. thick, placed so that the glued surfaces crossed at right angles. They were later torn apart. A. H. Gill[77] used maple blocks shaped like cement briquets, glued together endwise, and broken in cement-testing machines. He also made briquets of fullers earth, diatomaceous earth, quartz sand, and sawdust, but could not obtain consistent results. He then dipped strips of filter paper into glue solutions, and when dried broke them with the Mullen paper tester. His results by this method were more concordant. G. S. Hopp[78] molds glue into strips, allows them to dry on tin or aluminum nets, machines down to dimensions desired, and pulls apart in torsion machine. He obtains the stretch and tensile strength, which vary from the average 1 to 3 per cent. The Forest Service of the United States Department of Agriculture has developed a strength test[79] which seemed somewhat more satisfactory than any of the others. Maple blocks are selected which have been carefully cured and are of uniform grain. These are 12 x 2½ x 1 in. They are carefully resurfaced, heated to 40 deg. C. and joined. After subjection to a uniform pressure for 24 hr., and allowed to stand seven days to dry out, these are sawed into blocks such that the area of the joint is exactly 4 sq.in. These are then broken by shearing the two blocks of wood apart. By taking averages of several tests, the results obtained are reasonably concordant.

Because of the unsatisfactory status of the strength test, and in order to determine specifically the relation between other properties of glues, and their strength in service, this series of experiments was undertaken. We will consider:

The Relation of Jell Strength to Shear Strength.
The Relation of Jell Strength to Tensile Strength.
The Relation of Viscosity to Shear Strength.
The Relation of Melting Point to Shear Strength.
The Relation of Origin of Stock to Shear Strength.
The Relation of Joining Pressure to Shear Strength.
The Effect of Prolonged Heating Upon Shear Strength.

THE RELATION OF JELL STRENGTH TO SHEAR STRENGTH

The method used in this, and in all of the other experiments in this paper, with the exception of that section upon tensile strength, was that described as adopted by the Forest Products Laboratory at Madison, Wis. The greatest of care was used in selecting only uniformly grained blocks, in obtaining a perfectly plane joining surface, and making the joint under exactly uniform conditions. The glue was dissolved in varying amounts of water, heated to about 65 deg., and applied to the wood, which was heated to about 40 deg. C. Four test blocks, each with a glued area 2 in. square, were cut from each of the larger glued blocks, and these were placed in a special shearing machine, of the type used by the Forest Products Laboratory, and pressure applied until they broke. The pressure reached and the condition of the fracture were noted.

In the first experiments the joints were pressed together in wooden clamps, care being used to produce as nearly equal pressures as possible on successive joints. The pressure obtained by these clamps was measured by a spring and deflectometer, and found to give a total of about 350 lb., or, as the area of the joint per clamp was about 13 sq.in., a pressure of about 27 lb. per sq.in. was obtained. Dilutions were made of from one part of glue to one and a half of water in the lowest grades up to one of glue to five parts of water in the highest. This was done in an attempt to

*For Parts I, II, III and IV, see CHEM. & MET. ENG., vol. 23, Nos. 1, 2, 3 and 4, July 7, 14, 21 and 28, 1920, pp. 5, 61, 105 and 154.
[75]See *Mech. Eng.*, vol. 41, (1919), p. 382.
[76]*J. Soc. Chem. Ind.*, vol. 37 (1919), p. 743A.
[77]*J. Ind. Eng. Chem.*, vol. 7 (1915), p. 102.
[78]*Ibid.*, vol, 12 (1920), p. 356.
[79]*Loc. cit.*

determine the concentration at which the maximum strength was developed. The glues used consisted of the standard grades from the highest to the lowest of both hide and the bone products. This means that glues with a regular variation in jell strength were used.

An examination of the data furnished from this series of experiments will reveal that although there is in general a decrease in strength with decrease in grade, yet this is by no means consistent. Many low-grade glues have an apparently greater strength than a much higher grade product, and vice versa. But even this feature does not remain in the leastwise constant at the slightly varying concentrations used. In fact, we must accept the conclusion that the results obtained are erratic and altogether undependable.

TABLE XLIV. SHEAR STRENGTH OF STANDARD GLUES AT VARYING CONCENTRATIONS

(Joined in clamps)

Concentration	H_1	H_2	H_3	H_4	H_5	H_6	
1 to 2¼		2,630	2,780	2,300	1,260	1,830	..
1 to 2½	2,240	2,360	2,990	1,710	1,620	1,310	...
1 to 2¾	2,320	2,730	1,880	1,980	2,000	1,470	..
1 to 3	2,500	2,040	2,420	1,720	1,480	1,340	...
1 to 5	640	1,120	840	740	910	470	...
Average except 1 to 5	2,350	2,440	2,515	1,925	1,590	1,485	.
Concentration	B_1	B_2	B_3	B_4	B_5	B_6	B_9
1 to 1½		.....	....	....	.. ..	......	950
1 to 1¾		....	.....	....	....	1,580	710
1 to 2		1,910	1,700	1,740	1,410	1,380	410
1 to 2¼	2,080	2,030	1,920	2,120	1,430	1,460	650
1 to 2½	1,920	1,180	2,020	760	1,490	1,560	...
1 to 2¾	1,420	1,560	1,200	1,500	1,160	.....	...
1 to 3	1,930	....	....	....	.....	.....	...
1 to 5	700	1,010	750	560	580	300	...
Average except 1 to 5	1,835	1,670	1,710	1,530	1,370	1,495	680

It occurred to the writer that, although care was used to obtain equal pressures upon all joints, it might be that such inequalities as did exist in the pressure of joining might be sufficient to account for the inconsistent results obtained. Experiments were therefore initiated which proved this to be the case. These will be described later.

The above experiment was therefore repeated, in part, by placing each set of blocks, after joining, between parallel plates in a torsion machine, and applying a pressure uniformly of 200 lb. to the sq.in. This pressure was selected from the consideration, described hereafter, that at that pressure slight variations in pressure will have only a slight effect upon the strength of the joint, and also that the strength developed at this pressure is nearly a maximum. Only one concentration was used, e.g., one part of glue to two and a half parts of water.

TABLE XLV. SHEAR STRENGTH OF STANDARD GLUES, JOINED IN TORSION MACHINE

Joining pressure, 200 lb. per sq.in. Concentration, 1 to 2½

Hide Glues	H_1	H_2	H_3	H_4	H_5	H_6
Average strength per sq.in.	2,940	2,840	2,390	2,685	2,185	1,980
Per cent wood broken	100	75	15	50	0	0

Bone Glues	B_1	B_2	B_3	B_4	B_5	B_6	B_9
Average strength per sq.in.	2,750	2,310	1,645	1,590	1,360	1,180	485
Per cent wood broken	25	0	0	0	0	0	0

The results were this time satisfactory in that in every case (except one) the strength of the joint varies directly as the grade, or jell strength. The cause of the one exception was at first not understood, but has since been satisfactorily accounted for, and will later be discussed. The maximum strengths were not in every case measured, due to the fact that in the highest grade glues, the glue was stronger than the wood, but by noting the relative percentage of the several fractures which occurred in the wood instead of in the glued joint, our conclusions are relatively satisfactory, and entirely dependable.

Other series were tested with the object of eliminating any possible effect which the viscosity might have upon the strength of the joint. Glues were selected which were of uniform viscosity but of varying jell strength, and tested as before. The results so obtained corroborate the data of the previous experiments, that the strength of a glue in service is a function of the jell strength, and this irrespective of the viscosity. Table XLVI will illustrate this point.

TABLE XLVI. RELATION OF JELL STRENGTH TO SHEAR STRENGTH

Joining pressure, 200 lb. per sq.in. Concentration, 1 to 2½

Jell strength	H_3	H_4+	H_4-
Viscosity (capillary tube)	50	50	50
Average strength per sq.in.	2,670	2,300	1,850
Per cent wood broken	65	8	0

The Relation of Jell Strength to Tensile Strength

It seemed desirable to obtain, if possible, a shearing in which the break would occur entirely within the joint, and not in the wood. It seemed possible that if joints were made and sawed so that they might be pulled apart, the jaws of the torsion machine might hold the fibers of the wood so tightly that they could not slip before the glue at the joint gave way. Accordingly, blocks were joined and sawed into sections 6 x 1 in. and the joint cut to an area of 4 sq.in. The standard glues were used at a concentration of 1 to 2½.

TABLE XLVII. TENSILE STRENGTH OF STANDARD GLUES

Pressed in clamps. Concentration, 1 to 2½

Hide glues	H_1	H_2	H_3	H_4	H_5	H_6	
Average strength per sq.in	540	345	318	340	304	290	...
Per cent wood broken	75	25	50	25	0	0	...
Bone glues	B_1	B_2	B_3	B_4	B_5	B_6	B_9
Average strength per sq.in.	435	390	385	295	230	210	130
Per cent wood broken	25	30	0	0	0	0	0

The desired effect was not, however, produced, as, on pulling apart, the fibers of the highest grade glues slipped through the jaws of the machine. This method did, however, confirm the results obtained by the other method, and placed the order of strength exactly as had been previously obtained. It is noticeable that the pull necessary to break the joint is small in comparison with the push necessary to shear the blocks apart by the other method. As this method had no advantages over the former one, and some disadvantages, it was not used in any further tests.

The Relation of Viscosity to Shear Strength

The actual significance of viscosity in the evaluation of a glue has been a point upon which there has been much diversity of opinion. It is most commonly stated, however, that viscosity is a measure of the water-taking capacity of the glue, which means that a glue with high viscosity may be worked at a greater dilution, and therefore at greater economy, than another one, similar in all respects, except of low viscosity. Indeed, A. H. Gill[*] came to the conclusion that "tensile strength, jelly test and viscosity bear no relation to each other." These

[*] *Loc. cit.*

conclusions were undoubtedly reached through an insufficiency of data, and failure to eliminate all but one variable in any given set of experiments. The author has shown that the strength of a glue is a function of the jell strength, and, in general, the viscosity varies as the jell strength, but a set of glues might easily be selected which would vary regularly in viscosity, but the curve of jell strength might be a zigzag. In this case the strength of the glues, being influenced by jell strength, would probably also be irregular.

Accordingly, groups of glues were selected which

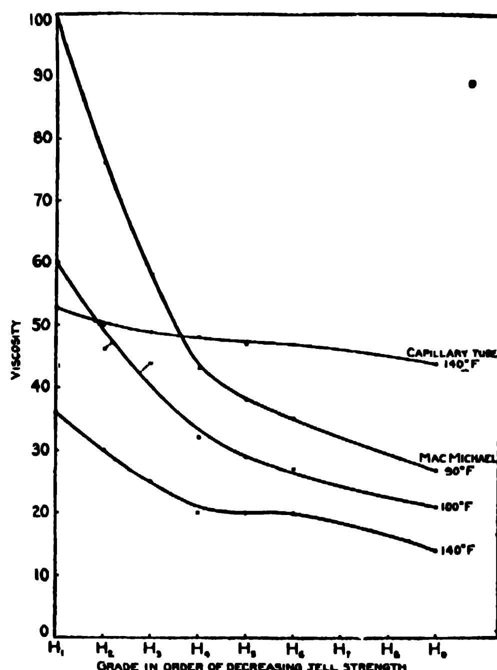


FIG. 22. RELATION OF VISCOSITY TO JELL STRENGTH. HIDE GLUES

were throughout of the same jell strength, and divided into sub-groups, representing varying viscosities. Joints were made with these in the manner already described. The concentration was one part of glue to two and one-half parts of water. They were uniformly subjected to a joining pressure of 200 lb. per sq.in.

TABLE XLVIII. RELATION OF VISCOSITY TO SHEAR STRENGTH.

Jell strength	H_3	H_3	H_3
Viscosity (MacMichael 140 deg. F.)	36	28	24
Strength per sq. in.	2,640	2,330	2,275
Per cent wood broken	30	6	0

The data show that in all cases the strength of the joint is greater with the high viscosity glues, and decreases regularly as the viscosity.

The Relation of Melting Point to Shear Strength

It has been demonstrated that the strength of a glue in service is a function both of the jell strength and of the viscosity. Were we to consider jell strength as the measure of strength, then, although probably three-quarters of all glues would be correctly evaluated, yet the remaining quarter, due to an abnormally high or an abnormally low viscosity, would be either stronger or weaker than the grade they were assigned to represent. And if we considered viscosity (as usually taken at 140 deg. F.) as the measure of strength, the same reasoning would assign an even greater proportion of glues to grades which were not indicative of their true strength value.

The writer has shown previously[31] that both the jell strength and the viscosity are functions of the melting point. He has also shown that if we take the viscosities at regularly decreasing temperatures the viscosity curve will gradually merge into the jell strength curve. It is, therefore, evident that there must be a curve intermediate between that of the viscosity at 140 deg. F. and the jell strength which will represent more accurately than any other the exact relative value of all glues. This is obviously the melting point curve. It has also been shown that, since the viscosity curve and the jell strength curve merge into one another as the temperature is lowered or raised, a measurement of viscosity at low temperature serves admirably as a measure of melting point.

We are now, therefore, in a position to state with assurance that the strength of a glue is normally always proportional to its melting point, and that the melting-point method of evaluation is inevitably superior in accuracy of grading, with strength in service as the criterion, to either a jell strength or viscosity (at 140 deg. F.) method.

We find that this conclusion explains many points which were otherwise not understood. It has been noted that the order of strength in glues H_3 and H_4 was reversed from what we had expected. But a melting-point determination reveals that in this case H_4 is the higher, and should, therefore, be expected to have a greater strength. Apparent abnormalities in many other glues are similarly accounted for.

In order to determine the exact nature of this

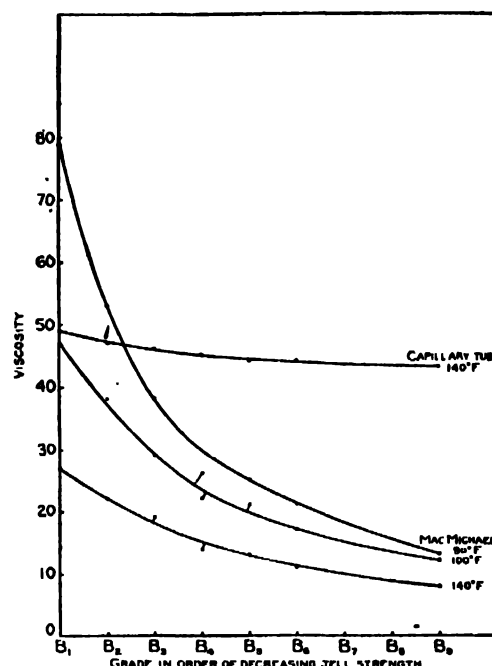


FIG. 23. RELATION OF VISCOSITY TO JELL STRENGTH. BONE GLUES

melting-point strength curve about 300 measurements were made on all grades of glues.[32] Measurements were made at temperatures of 140, 100 and 90 deg. F. A remarkably lengthened curve is obtained at 90 deg. F., of such a nature that there is a difference in the reading of from 5 to 25 points between any two grades. This makes the precise allocation of any glue an easy matter, and not subject to improper grading due to trifling

[31]See p. 64.
[32]See p. 66 for details and method.

variations in technique. The curve at 90 deg. F., or about 32 deg. C., is therefore recommended as the most suitable temperature for the melting-point determination. At lower temperatures many glues would be difficult to handle, and their melting-point curve would doubtless have been drawn too close to their jell-strength curve to serve the end of obtaining the most accurate evaluation.

TABLE XLIX. AVERAGE VISCOSITY (MACMICHAEL) OF ALL GLUES AT 140, 100 AND 90 DEG. F.

	Capillary Tube Viscosity 140 deg. F.	MacMichael Viscosity 140 deg. F.	MacMichael Viscosity 100 deg. F.	MacMichael Viscosity 90 deg. F.
H_1	53	36	60	100
H_2	50	30	46	76
H_3	49	25	44	58
H_4	48	20	32	43
H_5	47	20	29	38
H_6	47	20	27	35
H_9	44	14	21	27
B_1	49	27	47	79
B_2	47	22	38	53
B_3	46	19	29	38
B_4	45	14	22	26
B_5	44	13	21	25
B_6	44	11	17	21
B_9	43	8	12	13

A summary of the data is given in Table XLIX and the curves are shown in Figs. 22 and 23.

THE RELATION OF ORIGIN OF STOCK TO SHEAR STRENGTH

It seemed very desirable to know if the nature of the origin of the stock used in the manufacture of glue might affect the strength of the product in some way that might not be revealed by the customary tests of jell strength or viscosity. Accordingly, glues were selected as follows: Series C consisted of glues of uniform test and produced from similar stock. Series D consisted of glues of uniform test but each group made from different types of stock. Series E consisted of glues of varying test and obtained from similar stock. Tests were made in the usual manner, at a concentration of one part of glue to two and a half parts of water, and joined at a pressure of 200 lb. per sq.in.

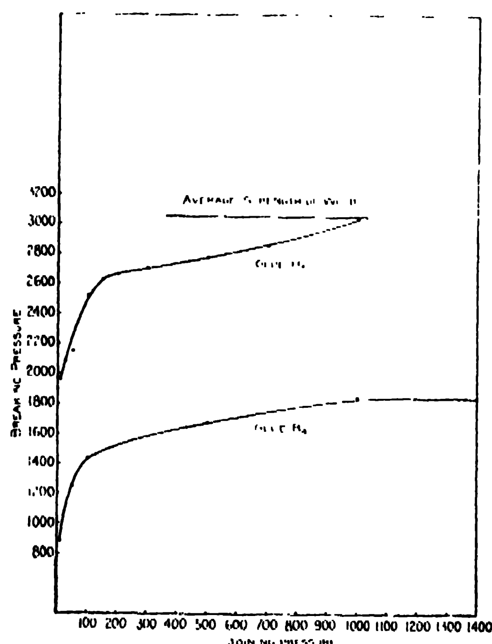


FIG. 24. EFFECT OF JOINING PRESSURE UPON STRENGTH

The results obtained do not reveal any variation in strength with the type of stock used which is not *similarly revealed* by the measurements of jell strength and viscosity. In series C the strength of the three sets are practically identical, as would be expected from their uniform test and similar origin. In series D the jell strength is nearly constant, but the nature of the stock varies, and the viscosity varies. The strength is found to vary as the viscosity. In series E the

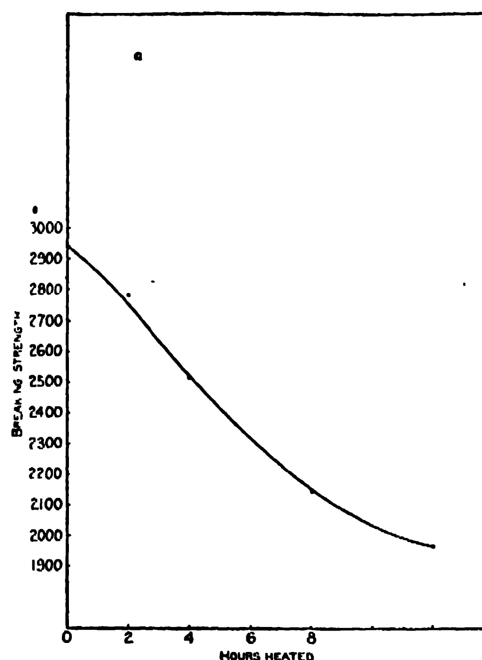


FIG. EFFECT OF HEATING A HIGH-GRADE GLUE IN SOLUTION UPON STRENGTH

strength is found to vary as the jell strength and viscosity, which run parallel, regardless of the fact that the glues are derived from similar stock. So it seems

TABLE L. INFLUENCE OF ORIGIN OF STOCK UPON STRENGTH

Joining pressure 200 lb. per sq. in. Concentration 1 to 2½

Series C: Uniform test; similar stock:			
Jell strength	H_3	H_3	H_3
Viscosity (capillary tube 140 deg. F.)	51	51	51
Strength per sq.in.	2,260	2,325	2,280
Series D: Uniform test; different stock			
Jell strength	H_2	H_2—	H_2
Viscosity	53	52	51
Strength per sq.in	2,900	2,710	2,440
Series E; Varying test; similar stock:			
Jell strength	H_3+	H_4	H_6-
Viscosity	53	52	46
Strength per sq.in.	2,720	2,155	1,690

that a consideration of the jell strength and viscosity, or the melting point, will correctly establish the value of the product with reference to strength, regardless of the origin of the stock.

THE RELATION OF JOINING PRESSURE TO SHEAR STRENGTH

As soon as it became evident that slight variations in the pressure at which the blocks were joined produced a decided variation in the strength of the joint, experiments were started to establish exactly the relation which existed between the joining pressure and the strength of the joint. A medium-grade hide glue and a medium-grade bone glue were used. They were made up to a concentration of one part of glue to two and a half parts of water, and on joining subjected to pressures of from 10 to 1,400 lb. per sq.in. This was accomplished by pressing between the parallel plates of a torsion machine.

The data obtained, when plotted, reveal curves which show the strength to increase very rapidly with increase in joining pressure up to about 200 lb. per sq.in. Beyond this point the strength continues to increase gradually up to 1,000 lb. per sq.in. The hide glue had here obtained nearly the strength of the wood. On increasing the joining pressure of the bone glue beyond this point no further strength was developed, but it remained constant to 1,400 lb. per sq.in. It is at once evident that if maximum strength is desired a high pressure should be used—certainly not less than 200 lb. to the sq.in. And not less important it should be pointed out that a low-grade glue at a high pressure may be made to do the work and produce joints of as great strength as a high-grade product at a low pressure.

TABLE LI. EFFECT OF JOINING PRESSURE UPON STRENGTH.
(Concentration, 1 to 2½.)

Joining Pressure.	10	25	50	100	150	200	300	500	700	1,000	1,400
Glue H_5	1,965	2,080	2,160	2,520	2,615	2,660	2,700	2,785	2,860	3,030	
Glue B_4	885	...	1,255	1,435	..	..	...	1,675	...	1,845	1,845

A summary of the data is given in Table LI, and the curves are shown in Fig. 24.

THE EFFECT OF PROLONGED HEATING UPON SHEAR STRENGTH

Some joiners are in the habit of buying the highest grades of glue and heating them in solution for some time before using. This process is known to lower the viscosity and the jell strength, but it results in increased tackiness and the joiners who practice this method claim they can produce stronger joints than by any other procedure. In order to ascertain if heating could actually produce a stronger product, in spite of its apparent contradiction to theory, the highest grade glue was subjected to heating at about 80 deg. C. for periods of 2, 4, 8 and 12 hr. The concentration was one part of glue to two and a half parts of water. The joining pressure was 200 lb. per sq.in.

The data show the strength of the glue to decrease regularly as the period of heating, and when plotted show nearly a straight line. This conclusion agrees with results obtained by Linder and Frost,[8] who find that a heating at 150 deg. F. for 20 hr. produces a loss in strength of 30 to 45 per cent. Our data show that in 2 hr. the strength has dropped from H_1 to the equivalent of H_{2-}; in 4 hr. to H_4; in 8 hr. to H_8; and in 12 hr. to H_5. This experiment affords conclusive proof that the heating of a glue produces a distinct and very appreciable loss in strength, and that this loss in strength is proportional to the period of heating.

TABLE LII. EFFECT OF HEATING UPON STRENGTH. GLUE H_1
Temperature, 80 deg. C. Joining pressure, 200 lb. per sq. in. Conc., 1 to 2½

Hours heated	0	2	4	8	12
Viscosity (MacMichael 140 deg. F.)	220	105	68	54	50
Strength per sq. in.	2,940	2,785	2,515	2,145	1,965

The averages are given in Table LII and the curve is shown in Fig. 25.

SUMMARY OF RESULTS

The following conclusions may be drawn from the several experiments described in this paper:

The strength of a glue in service is a function of the jell strength.

The strength of a glue is a function of the viscosity.

The strength of a glue is directly proportional to the melting point.

The melting-point method for evaluation of glues by the process described is recommended as yielding a true index of actual strength in service.

Variations in the origin and type of stock used in the manufacture of glue produces no variations in the strength of the product which are not made manifest by jell strength, viscosity, or melting-point determinations.

The strength of a glued joint varies directly as the joining pressure applied, up to about 1,000 lb. per sq.in. Below 200 lb. to the sq.in. the variation is large. Above that the variation is small.

The strength of a glue decreases regularly as the period of heating in solution.

The method of testing the strength of glued joints as developed by the Forest Products Laboratory at Madison, Wis., is recommended to scientific workers as one which, with careful technique, will give satisfactory results.

[8]*Eng. News*, vol. 72 (1915), p. 178.

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New Jelly Product From Grape Juice Waste

As a result of the increased use of grape juice particularly since prohibition went into force, a new product has been developed from the waste material left after the expulsion of grape juice. This waste product, called pomace, is composed of the skins and pulp and can be made into a fine jelly.

The United States Department of Agriculture, in co-operation with the large grape juice producers in the state of New York, have made experiments with this material, which show that a jelly comparable in cost with apple jelly can be made. In addition the seeds may easily be separated and an edible oil made from them.

Legal Notes

BY WELLINGTON GUSTIN

Establishing the Market Value of a Product—The Damages to a Purchaser for Resale

Judgment for George O. Seward against the Pennsylvania Salt Manufacturing Co. has been reversed by the Supreme Court of Pennsylvania and a new trial awarded. The suit was one for damages for an alleged breach of contract in the purchase of hydrate alumina. The salt company is located at Natrona, Pa., and Seward is a metallurgical engineer of New York. The latter sought to purchase the chemical product for use during 1916, and the company offered to furnish him 100 tons a month from March to December, inclusive, 1916, at 4c. per lb. f.o.b. Natrona, net cash, offer open until November, 1915. On Nov. 11, 1915, Seward wrote the company accepting the offer of 100 tons monthly.

The company requested the name of the buyer so that contracts might be written up, etc. Seward did not reply to this request, and on Jan. 22, 1916, the company again wrote that as it had heard nothing from him since its request, it assumed his plans had not developed as anticipated and therefore the matter was considered a "dead" issue, but Seward replied that the matter was not a "dead" issue and that he would send shipping instructions before March 1, for the 100 tons to be delivered to him during March.

COMPANY REFUSES TO DELIVER

The shipping instructions were given, but the company refused to deliver the specified hydrate alumina or any part thereof and set up as a defense that the offer to sell was made upon the faith of an express parol agreement that Seward was to organize a new company for the manufacture of aluminum by which all of the chemical products should be used and none resold, and that otherwise the offer would not have been made.

It was admitted that no new company was organized nor was the product required in Seward's business. Correspondence between the parties referred to companies in which he was interested and to a proposed new company. But this constituted no agreement as alleged by the salt company. To establish that parol evidence was introduced and largely relied upon. The jury found for Seward and the court awarded him $34,500.

DIFFICULT TO ASSESS DAMAGES

Upon the appeal the important question was that of damages. The Supreme Court stated several important rules that should be here repeated. The general rule is that in an action for failure to deliver goods according to sales contract the measure of damages is the difference between the contract price and the market value at the time and place of delivery, with interest [2 Sedgwick on Damages (9th Ed.) par. 734]; and plaintiff may recover such damages without having supplied his wants elsewhere. The trial judge so instructed the jury, but the difficulty in this case was the lack of evidence of market value. The only proof as to that was the amount for which Seward contracted to resell 25 tons of the March delivery, and the price at which the company supplied its other customers during the months in question. Those sales were individual transactions in small amounts and not made in the open market, and not sufficient to establish the market value, especially of such quantities, said the court.

Hydrate alumina is manufactured at other chemical works, but there was no evidence as to price for which it there sold, or as to its general selling price in open market. It may not at all times be possible to establish a general selling price, and in such cases actual market value may be shown by proof of facts and circumstances fixing to a reasonable degree of certainty the amount the product would bring if offered at ordinary sale.

NO MARKET VALUE FOR HYDRATE ALUMINA

Again, where a product is not obtainable in the open market a plaintiff could recover his actual damages by proving such damages through showing that he required the products in his business, that he procured them elsewhere, or made them, at a cost greater than the contract price. In this case Seward proved no such actual damages. In his behalf it might be urged that he could have resold the hydrate alumina at a profit. But, said the court, how can it be determined that an article without market value can be resold at a profit? The chances thereof are too speculative to form the basis of a recovery. (106 Pa., 237.) Moreover, the anticipated profits on a resale are not recoverable unless in contemplation of the parties when the original contract was made, and here they were not. (26 L.R.A., N.S., 1,191.)

Therefore, unless the proof shows the subject of the contract had a market value, and that greater than the contract price at the time of delivery, so as to bring the case within the general rule above stated, the buyer can recover only nominal damages.

The judgment against the salt company was reversed because the lower court erred in treating the evidence as sufficient to justify a finding of market value, which it was not.

Debtor's Check Not Payment Until Check Is Paid

Payment by check was the subject of a recent decision where plaintiff had sued for the agreed value of goods sold defendant. On appeal the Supreme Court said that a check of the debtor in liquidation of his own debt is not payment until paid, unless in some very special case such check was taken in absolute extinguishment of the debt—which case can hardly be supposed.

The acceptance of buyer's check by sellers did not constitute payment, where no payment had been made on check, and this is true although the sellers had previously accepted buyer's checks as payment when checks were paid; the only inference, if any, from such practice being that tender of check would prevent the sellers from asserting a default by reason of non-payment or non-tender.

If for any reason the seller failed to deposit the buyer's check, such buyer is bound to keep his tender of payment good, and when sued to pay the money into court. Further, the court said, the mere fact that the sellers of goods, under agreement giving the buyer a right to certain discount upon payment within a certain time, permitted the buyer to deduct the discount on two or three occasions when payment was not made within the time of the credit did not give the buyer a right to such deduction in all subsequent transactions.

Molybdite: Its Occurrence, Detection and Determination in Partly Oxidized Molybdenite Ores

A Review on the Composition of Molybdite Ore, Its Occurrence and Concentration—Chemical Test for Molybdite in the Presence of Molybdenite — Outline of Methods for Qualitative and Quantitative Analysis

BY J. P. BONARDI*

THERE are several oxidized molybdenum minerals found in the United States,[1] but none are of commercial importance at the present time except molybdite ($Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$), which commonly occurs with molybdenite as an alteration product and the recovery of which is difficult by the flotation process of ore dressing in use for the sulphide mineral. Oil flotation has proved so successful, especially on low-grade disseminated molybdenite (MoS_2) ores assaying below 0.5 per cent Mo, that it is being used almost exclusively for making high-grade concentrates. Molybdenum in the form of the oxide is unrecoverable by the ordinary flotation processes adopted for the recovery of the sulphide mineral; consequently, it tends to go to waste along with the tailings. The seriousness of this loss can be judged when it is known that one of the largest molybdenite orebodies in this country, situated at Climax, Col., carries from 10 to 20 per cent of the molybdenum content in the form of the above-mentioned oxide mineral.

It is said that the flotation mill at Climax for treating the crude ore has at present a capacity of 1,000 tons a day; and at this rate of production the ore reserves already developed in this ore deposit alone insure steady operation for more than thirty years. The importance, then, of recovering the molybdite mineral should not be overlooked or underestimated. The application of sodium sulphide (Na_2S) to a flotation charge under the proper conditions has resulted in recovering a considerable part of the oxide mineral. One of the chief difficulties in a sulphidizing treatment is the fact that molybdic oxide is readily soluble in an alkaline solution, so that the sulphidizing treatment must be carried out in as near a neutral solution as is possible. Molybdenum can, however, be recovered from an alkaline solution by adding $CaCl_2$ until causticity has been neutralized, followed by vigorous boiling.[2] The determination, then, of the oxide mineral becomes an important factor in metallurgical calculations, especially so if the relative floatability of each mineral is desired. A search through the literature revealed the fact that no methods were given for the determination of molybdite in molybdenum minerals.

Besides the large known deposit at Climax, it is commonly the case to find that oxidation of the molybdenite on the outcrops of such veins has resulted in the formation of considerable molybdite. Usually it disappears entirely at depth, excepting the case at Climax, where it occurs practically throughout the orebody at present blocked out. The oxidation is still prominent down to 350 ft. below the surface.[3]

Horton,[4] in speaking of molybdite, states:

"Molybdite is a hydrous ferric molybdate ($Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$) and theoretically contains 39.63 per cent of molybdenum. . . . It is an alteration of molybdic acid (liberated by the oxidation of the molybdenite) and limonite. The formation of the limonite in many cases may have resulted from the weathering of pyrite which is commonly associated with the molybdenite, simultaneously with or previous to the weathering of the molybdenite.

"For many years the erroneous idea has existed that molybdite agrees in composition with the artificial molybdic trioxide obtained by oxidizing molybdenite. The present textbooks on mineralogy almost universally persist in this error, giving the composition of molybdite as MoO_3, and stating that the pure mineral contains 66.7 per cent of molybdenum. That such is not the case was first called to the author's attention by chemical tests of a sample of molybdite which from microscopic examination seemed to be practically pure. The presence of a large percentage of iron was determined, and the same results obtained from tests on other samples of molybdite from different localities led the author to believe that the iron was an essential part of the mineral. Schaller[5] had not only proved the presence of combined iron in molybdite but had definitely established its composition as $Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$."

TESTS FOR MOLYBDITE

Regarding tests for molybdite, Schaller[5] writes:

"On heating the mineral in a closed tube abundant water is easily given off and the mineral assumes a dark-olive color. On further heating it again becomes lighter in color. On heating the mineral in a crucible the color changes are very marked. At first the yellow mineral darkens and becomes a dark gray, then it becomes a light yellow, and on further heating changes to a deep orange color. If the mineral now be allowed to cool, the orange changes to yellow and back to orange again on reheating. If the dark-colored material be allowed to cool, it retains its dark gray color and on reheating passes through yellow to the orange. On heating for some time at a higher temperature, the mineral, on cooling, becomes a permanent bright green. By further heating all the molybdenum is volatilized and the dark-red ferric oxide remains. The mineral is readily soluble

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[1]Described by Horton, F. W., "Molybdenum: Its Ores and Their Concentration," Bu. of Mines Bull. 111 (1916).

[2]Bonardi, J. P., "Metallurgy of Wulfenite," CHEM. & MET. ENG., vol. 21, 1919, pp. 364-369.

[3]Haley, D. F., "Molybdenite Operations at Climax, Col.," Bull. A.I.M.E., August, 1918, p. 1183.

[4]Horton, F. W., "Molybdenum: Its Ores and Their Concentration," Bureau of Mines Bull. 111 (1916).

[5]Schaller, W. T., "Mineralogical Notes—Ser. 1," U. S. Geol. Survey Bull. 490, 1911, pp. 84-93; also Am. J. Sci., 4, 23, 1906, p. 297.

in hydrochloric acid and is decomposed by ammonia. After awhile, all the molybdenum goes into solution, leaving the insoluble ferric hydroxide."

Qualitative and Quantitative Tests for Molybdite in the Presence of Molybdenite

The following chemical test for molybdite in presence of molybdenite has been tried out in the laboratory of the Golden Station of the U. S. Bureau of Mines, and has proved reliable for detecting molybdenum down to 0.01 per cent molybdenum on the basis of a 1-g. sample. A complete solution away from the sulphide mineral can be effectively made by one of the three following reagents: A 10 per cent solution of hydrochloric acid, a 10 per cent solution of ammonium hydroxide, or by a 5 to 10 per cent solution of sodium carbonate. The ore is ground fine, placed in an Erlenmeyer flask, 200 c.c. of water added and then enough of one of the above reagents to make a 10 per cent solution. This is then boiled for thirty minutes, filtered and washed. Before filtering the HCl solution it is made first ammoniacal to precipitate out the bulk of the iron. Any of these three methods of solution will completely dissolve the oxide of molybdenum in a boiling solution without affecting the sulphide to the least extent. This has been thoroughly tried out and has always given reliable results. Pure molybdenite was given the same treatment, but none was found in solution in any of the three cases.

The filtered solution of any one of the above filtrates is then tested for molybdenum by the thiocyanate test as follows: The filtrate if alkaline is acidified with HCl and some H_2O_2 added to oxidize any reduced iron or molybdenum that might have passed through into the filtrate. This is boiled to drive off most of the excess H_2O_2 and is then made ammoniacal. If any iron hydroxide separates out, filter and wash. To the filtrate, which is now free from iron, aluminum and silica, make acid with HCl, add some ammonium or potassium thiocyanate and immediately follow by zinc. If any molybdenum is present, a bright cherry-red color will develop which will disappear only on standing for a prolonged period, depending upon the amount of molybdenum present in the solution to be reduced. If hydrogen peroxide is added to the solution after the cherry-red color has developed, the color disappears, but will return as soon as the peroxide has been reduced. This color reaction with thiocyanate is very definite and certain, but if the mistake is made by adding the zinc first, which reduces the molybdenum, and then later followed by the thiocyanate, scarcely any color will be developed. When only traces or small amounts of molybdenum are present, a concentration of the cherry-red color can be obtained if the solution is shaken with a small volume of ether, when any color in the liquid will be extracted by the ether and intensified as a golden brown in the ether rings that form at the top of the liquid on standing. The thiocyanate color produced when iron is present in solution soon changes colorless, by the addition of zinc, usually before the cherry-red color of the molybdenum starts to develop.[a]

Weigh 5 to 10 grams of the finely pulverized molybdenite ore into a 400 c.c. Erlenmeyer flask. Add 200 c.c. water and then one of the following: 20 c.c. strong ammonia, 20 c.c. concentrated HCl, or 15 g. Na_2CO_3 and boil vigorously for 30 min. Wash the sides of the flask down with water, filter and wash. To the filtrate, if alkaline digestion was made, add HCl to acid, followed by a few c.c. of hydrogen peroxide and boil. Hydrogen peroxide is also added to the HCl filtrate; this oxidizes the iron which might have been carried in solution in a reduced condition. Next, add ammonia in excess and heat. If any precipitate settles out—consisting of iron, alumina and silica—filter and wash. If large in amount, dissolve in HCl and reprecipitate, wash and filter. The molybdenum now in the form of soluble molybdate should have a volume of approximately 350 c.c. Make the solution acid with HCl, using methyl orange as an indicator, adding about 5 c.c. excess of acid. Add 5 to 10 g. ammonium acetate—enough to decompose the free mineral acid—and 2 to 5 c.c. of acetic acid. The solution is next heated to boiling and precipitation of the molybdenum is now made in the hot solution by titrating the molybdenum content in the solution with a lead acetate solution (about 18 g. crystallized lead acetate per liter) added slowly from a burette until a test drop taken from the solution gives no color change with a drop of freshly made tannic acid solution (about 0.10 g. dissolved in 20 c.c. of water) used as an outside indicator. The disappearance of the brown color indicates when all the molybdenum has been removed from solution by precipitation. Next add 2 or 3 c.c. excess of the lead acetate solution and place the beaker back on the hot-plate and keep at or near the boiling point until the precipitate has crystallized and settled.

When settled, filter hot and wash well with hot water; if precipitate is bulky, wash with a 2 to 3 per cent solution of ammonium acetate. The washed filter is placed in a fireclay annealing cup and ignited at a dull red heat. After complete ignition of the paper, cool and weigh directly. The weight of the $PbMoO_4$ times 0.2615 gives the weight of the molybdenum in the precipitate, from which the percentage can be calculated.

The size of the sample taken for an analysis should be chosen if possible as not containing over 0.15 g. molybdenum (equivalent to 0.25 g. MoS_2), since above this amount the precipitated lead molybdate will be too bulky to handle to the best advantage. Hydrogen peroxide can not be added in the digestion of the sample along with the alkali or acid, since in combination with these reagents a chemical action will take place on the sulphide mineral, molybdenite, and render it appreciably soluble. A large excess of lead acetate should be avoided.

The following results are typical of an analysis carried out as outlined, showing the comparison of results as obtained by the three methods on the same sample of partly oxodized molybdenite ore containing a total of 5.2 per cent molybdenum, the molybdenum content being distributed in approximately the ratio of 1:1 between molybdite and molybdenite mineral.

Wt. of Sample, Grains	Treatment—½ Hr. of Boiling	Wt. $PbMoO_4$	Per Cent Mo
5	200 c.c. H_2O + 10 g. Na_2CO_3	0.4820	2.52
5	200 c.c. H_2O + 25 c.c. HCl	0.4770	2.49
5	200 c.c. H_2O + 30 c.c. NH_4OH	0.4800	2.51

The writer wishes to acknowledge the assistance rendered by Max Shapiro in conducting a series of analyses and to Dr. S. C. Lind, superintendent of the Golden station, who has made many valuable suggestions.

Three samples of pure molybdenite, on the same treatments, gave no test for molybdenum in the filtrates.

Golden, Col.

[a]Treadwell, F. P., and Hall, W. T., Analytical Chemistry, vol. I, 1912; pp. 437-438.
Kedesdy, E., "Detection of Molybdenum," *Chem. Abs.*, vol. 7, 1913, p. 3940.
Prescott, A. B., and Johnson, O. C., Qualitative Chemistry, 1912, p. 97.
Horton, F. W., citation 4, p. 40.

Synopsis of Recent Chemical & Metallurgical Literature

Resistance of Silk and Linen Fabrics to Weather Conditions and Ultraviolet Rays.—To determine the influence of changes in weather conditions and of ultraviolet rays on silk and linen fabrics, LEO VIGNON has conducted a series of experiments, the results of which he presented before the French Academy of Sciences (*Compte Rendus*, May 31, 1920, pp. 1,322-1,324).

The influence of changes in weather has been studied by submitting bands of silk and linen fabric (0.2 m. x 0.05 m.) during June and July, to these conditions:

(a) Sunlight. Bands stretched on wooden frames covered with window glass were exposed vertically to the sun's rays in a dry place from 10 a.m. to 4 p.m. for 45 consecutive days.

(b) Dry Heat. Bands dried for 20 min. at 100 deg. C. were quickly placed in a bottle containing dry calcium chloride and closed hermetically. The bottle was then kept heated in a drying stove to 60-65 deg. C. for 3 hr. per day for 45 consecutive days; during the remainder of each day the bottle was kept at atmospheric temperature and not submitted to the sun.

(c) Wet Heat. The test was similar to that for dry heat but instead of calcium chloride, the bottle contained a few c.c. of water.

(d) Moisture and Sunlight. Bands placed in a large bottle containing a little water were exposed to the sun from 12 noon to 6 p.m. for 45 consecutive days.

(e) Moisture and Diffused Light. The bottle containing the bands as in the previous test was kept in a closed place out of the sun for 45 consecutive days.

The results obtained are tabulated in Tables I and II.

TABLE I. ACTION OF THE WEATHER ON SILK FABRICS

Test	Resistance to Tearing Kg. per M.		Average	Decrease per Cent	Final Aspect of the Fabrics
Fabric used	1900	1920	1910		Grayish white
(a) Dry sunlight	1580	1600	1590	20	White
(b) Dry heat.	1900		1900	0 5	No change
(c) Wet heat	1660	1680	1670	13	Somewhat yellowish
(d) Moisture and sunlight	1360		1360	30	Green and black moldiness, no odor
(e) Moisture and diffused light	1740	1760	1750	9	White moldiness, odor

TABLE II. ACTION OF THE WEATHER ON LINEN FABRICS

Test	Resistance to Tearing Kg per M		Average	Decrease per Cent	Final Aspect of the Fabrics
Fabric used	1540	1560	1550		Grayish white
(a) Dry sunlight	1280	1300	1290	20	White
(b) Dry heat	1380		1380	12	No change
(c) Wet heat...	1300 -	1340	1320	15	Somewhat yellowish
(d) Moisture and sunlight	1060	1100	1080	31	No change
(e) Moisture and diffused light.	440 -	560	500	68	Abundant green and white moldiness, strong odor

The influence of ultraviolet rays has been studied with 0.17 m. x 0.05 m. bands placed at a distance of 0.1 m. from a Heraeus lamp. To eliminate the action of the ozone which is formed around the lamp the tests were performed near an open window to have an atmosphere with small quantities of ozone. The temperature of the band was around 25 deg. C. The results obtained are given in Table III.

TABLE III. ACTION OF ULTRAVIOLET RAYS ON SILK AND LINEN FABRICS

Fabrics	Silk: Resistance to Tearing, Kg per M.	Silk: Decrease, per Cent	Linen: Resistance to Tearing, Kg. per M.	Linen: Decrease per Cent
Before exposure	1,600		1,800	...
After 24-hr. exposure (0 1 m. from lamp)........ ...	1,300	20	580	68
Before exposure. .	1,540		1,780	.
After 48-hr. exposure (0.1 m. from lamp)...............	925	40	Below 200	Above 89
Before exposure	1,520	.	1,780	...
After 96-hr. exposure (0 1 m from lamp) . . .	817	48	Below 200	Above 89
Before exposure	1,660	.	1,840	..
After 72 hr exposure (0 3 m from lamp) .	1,470	17	1,520	18

The conclusions arrived at are that fabrics of animal origin (silk) are more resistant than those of vegetable origin (linen) to the influences of weather and ultraviolet rays. This can be explained by the fact that albuminoid molecules resist hydrolysis better than the cellulose molecules.

Elutriation Tests of American Kaolins.—The May, 1920, issue of the *Journal* of the American Ceramic Society prints an original paper by H. G. SCHURECHT of the Bureau of Mines on this important subject.

The classification of clays according to grain size is important because many physical properties are to a limited degree functions of the size of grain. A more complete knowledge of the fineness of grain of our domestic kaolins would be valuable in determining American substitutes for foreign clays. The paper contains a complete record of the tests with tables. Chemical analyses, microscopic examination, sieve analyses, and elutriation or washing analyses were all carried out, and determinations were made as to relation between velocity of flow and diameter of particles. Tap water was compared with distilled water in the elutriation tests. The writer sums up the results of his extensive work as follows:

The elutriation of kaolins should be carried on with distilled water instead of tap water, as the soluble salts in tap water cause the clay particles to coagulate and settle as larger grains.

The residue in each can should be thoroughly stirred each day to overcome the error due to settling of fine particles on the sides of the cone. This may be done by stopping the water flow and gently blowing air through the stem of the thistle tubes. Each sample should be elutriated for at least three days to insure a complete separation or until the overflow from the last can is clear.

Results check more closely when the residues are stirred at intervals and when distilled water is used in place of tap water.

The clays should be deflocculated and fed into the elutriator drop by drop, and during this period the velocity of the flow should remain about one-third below maximum.

It was found that the Georgia, South Carolina and Pennsylvania kaolins tested in this investigation contain a high per cent of clay-like substance below 0.010 mm., comparing favorably with the English china clay in this respect.

The North Carolina kaolins tested showed a comparatively low per cent of fine or clay-like substance.

English ball clay contains an extremely high per cent of fine material, 98.55 per cent being carried away by a flow of 0.0197 mm. per sec. Only 40.75 per cent of English kaolin was carried off by this velocity. It is evident that the greater plasticity and bonding strength of ball clays, as compared to kaolins, is due largely to their finer grains.

The observed diameters of the particles, as separated with distilled water, correspond reasonably closely to the calculated results obtained by using Schone's empirical formula.

Properties and Uses of Lime.—General Information of interest to chemists and chemical engineers on the properties and uses of lime will be found in the second edition of Bureau of Standards Circular 30.

Lime is made by heating limestone under certain conditions, whereby it is decomposed into an escaping gas, carbon dioxide, and a non-volatile residue, lime or quicklime. This lime, when treated with water, hydrates, or slakes. If water is used in great excess, a paste results; but if the amount is properly regulated, the hydration yields a dry powder, which is called hydrated lime. Since natural limestones contain more or less magnesia, iron, silica, etc., the quality of the lime will depend to some extent upon the nature and amount of these foreign materials. It will also depend upon the way in which the stone is burned.

As a material for building construction, hydrated lime is better adapted than quicklime because it eliminates the labor usually required to do the slaking. It is used very largely as a brick mortar, as an ingredient in concrete, and in the scratch and brown coats of plaster. A particular grade of hydrated lime, noted for its plasticity, is sold as finishing lime and is used for the white coat of plaster.

Limestone, quicklime, and hydrated lime are used to a large extent as chemical reagents in the manufacture of other materials. In some of these industries the quality of the lime is of minor importance. In others, the use of only one of the three forms of lime is satisfactory, and the quantity and kind of impurity which the lime may contain is definitely specified.

Eighteen of the most important chemical industries that use lime are enumerated. Brief descriptions of these industries are given, showing why and how they use lime, and the quality of lime which they require.

A list of the tests of lime which are usually made includes chemical analysis, rate of hydration, plasticity, sand carrying capacity, time of set, compressive strength, proportion of waste, and fineness.

Inks.—The Bureau of Standards has recently issued Circular 95, giving general information on the subject of inks. The composition and manufacture are discussed only briefly, but the methods of testing which are in use at the Bureau of Standards are given in sufficient detail to enable any chemist to use them. After a brief introduction on the history of ink, there are discussions of writing and copying inks, ink tablets and powders, marking, canceling, stamping, duplicating and sympathetic inks. The methods used for the laboratory examination of all but the last of these kinds of ink are next taken up. Under the analysis of writing inks, for instance, are the following headings: Total solids, ash, iron, sulphuric anhydride, tannin, dye, chromium, penetration, fluidity, keeping quality and resistance to light and reagents. For the other kinds of ink there is not such a variety of tests necessary. The circular closes with a short bibliography.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Removal of Sodium Sulphate From Solutions.—Sodium sulphate may be removed from solutions which are saturated or nearly saturated in respect to this salt by treating with a quantity of calcium sulphate sufficient to form the double salt $CaSO_4.Na_2SO_4$ commonly known as glauberite. The double salt is removed by filtration and digested with sufficient water to break it up into a mixture of solid $CaSO_4$ and a solution of Na_2SO_4. (1,343,443; F. A. FREETH, of Sandiway, and H. E. COCKSEDGE, of London, England; June 15, 1920.)

Chrome Alum.—Ferrochrome when ground to a fine powder dissolves in sulphuric acid, the solution being complete in two to three days when working on a manufacturing scale. The presence of lead accelerates the solution of the ferrochrome. The resulting solution is treated with potassium chloride or sulphate and the chrome alum crystallized out. Prior to the addition of the potassium salt, the iron content of the solution may be reduced about one-half by crystallizing out ferrous sulphate. (1,343,725; GUSTAF H. HULTMAN, of Stockholm, Sweden; June 15, 1920.)

Manganese Dioxide Depolarizer.—When manganese carbonate (prepared by the interaction of solutions of manganese sulphate and sodium carbonate) is subjected to an oxidizing roast at 325 to 425 deg. C., manganese dioxide is formed according to the equation:



$$2MnCO_3 + O_2 = 2MnO_2 + 2CO_2$$

This reaction is accelerated by the presence of chlorides or chlorine containing materials in the roast. Thus the addition of ½ to 8 per cent sodium chloride greatly decreases the time and temperature required for roasting. (1,343,390; HAROLD C. CHAPIN, of Cleveland, Ohio, assignor to National Carbon Co.; June 15, 1920.)

Ammonium Perchlorate From Sodium Perchlorate and Ammonium Sulphate.—A nucleus solution is prepared at 100 deg. C. to contain 12.2 per cent ammonium perchlorate, 6 per cent sodium perchlorate and 15.5 per cent sodium sulphate. To this solution is then added the proper amounts of sodium perchlorate and ammonium sulphate, to produce a solution containing 32.5 per cent ammonium perchlorate, 5.5 per cent sodium perchlorate and 12 per cent sodium sulphate, and the anhydrous sodium sulphate which separates at this temperature is removed. The filtrate is diluted with a quantity of water so that, when cooled to 20 deg. C., the resulting solution will contain 11.7 per cent ammonium perchlorate, 6.8 per cent sodium perchlorate and 14.9 per cent sodium sulphate. The solution is then cooled to the above-mentioned temperature and the pure ammonium perchlorate removed. The mother liquid from the ammonium perchlorate is concentrated by evaporation until it has the same concentration of dissolved salts as the original nucleus solution. (1,342,956; GUY C. GIVEN, HOWARD S. MCQUAID and RALPH A. LONG of Tamaqua, Pa., assignors to Atlas Powder Co.; June 8, 1920.)

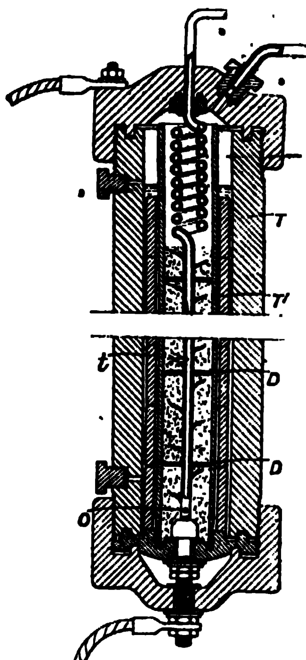
Removal of Nickel From Zinc Sulphate Solutions.—H. L. SULMAN and SAMUEL FIELD, of London, England, first remove by usual methods such metals electro-negative to zinc as iron, arsenic, antimony, copper and cadmium; this solution freed from these metals is treated with finely divided zinc dust at a temperature of 80 to 100 deg. C. The nickel remaining in solution after this treatment is less than one part per million. (1,341,601; assigned to the Metals Extraction Corp., Ltd.; May 25, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Effecting Reactions at High Pressure and at High Temperatures. — In carrying out reactions at high temperatures—for example, the synthesis of ammonia —it is necessary to protect the outer pressure-sustaining wall of the apparatus—for example, by interposing a layer of liquid, such as fused potash-soda mixture—that is stable, inert and a poor conductor of heat. According to the present invention, movement of the liquid such as would vitiate its protective action is prevented by a filling consisting of a pile of rings of a material that is a poor conductor of heat and has the property of removing any hydrogen, if this is one of the reacting-gases, dissolved by the liquid; such a material is magnetic oxide of iron. (Br. Pat. 140,083—1919. L'AIR LIQUIDE, SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDÉS. G. CLAUDE, Paris, May 12, 1920.)

Catalytic Apparatus for Ammonia. — In apparatus for effecting exothermic reactions in gases, the latter are led to a mass of catalyst through a tube which also serves to convey electric current into the apparatus for starting or promoting the reaction; preferably, the tube itself acts as the heating element and it may also serve as a heat interchanger between the products of the reaction and the incoming gas. The invention relates particularly to apparatus for use in the synthesis of ammonia. In the apparatus shown, the reaction tube T', containing the catalyst, is enclosed in a pressure-sustaining tube T, and the latter is protected by molten material in which is immersed heat-insulating material. The reaction gases are led in through the tube t which forms the heating-element and is provided with a series of bars to support the catalyst and with earthenware or china disks D to obviate short-circuiting; the gases pass through the whole length of the tube and escape through an opening O at its lower end. In the free space above the catalyst the tube is coiled to provide a heat interchanger, and to prevent undue rise in temperature this part of the tube is thicker and of a better conductor, or the spirals are short-circuited. In use, a heavy current of low voltage is passed through the tube in order to produce a temperature gradient between the reaction-tube and the outer wall T comparable with that obtaining during the normal working of the apparatus; by this, the protective material is fused regularly, and overdue strains on the tube T are obviated. (Br. Pat. 140,089 — 1919. L'AIR LIQUIDE, SOC. ANON. POUR L'ETUDE ET L'EXPLOTATION DES PROCÉDÉS. G. CLAUDE, Paris, May 12, 1920.)



CATALYTIC APPARATUS FOR AMMONIA

Tanning. — To accelerate tanning processes, compressed or liquid air, or oxygen in a more or less compressed state, is brought into contact with the hides. The hides to be tanned are placed in closed pits into which there is admitted either pure water or water containing tanning substances and air or oxygen compressed more or less strongly according to the nature of the hides. The closed pits containing the hides may be supplied from a central pit, the liquid being in constant circulation and, if necessary, filtered on leaving the central pit. (Br. Pat. 140,092—1919. TANNAGE RATIONNEL MEURANT, SOC. ANON., Liége, Belgium, May 12, 1920.)

Electrolytic Production of Alcohols, Glycols, Ethers, Hydrocarbons and Oxygen.—Aldehyde or paraldehyde, derived from acetylene, is electrolytically reduced to alcohol or ethyl acetate. An acid electrolyte is employed, such as sulphuric acid of 5 to 10 per cent strength, or a solution of sodium bisulphate, phosphoric acid or an organic sulphonic acid. If a mercury compound is added, acetylene may be passed directly into the liquid instead of being separately converted into aldehyde. In the production of alcohol, anode oxidation is prevented by a diaphragm, but for ethyl acetate, the diaphragm is omitted or an inefficient one employed. The cathode may be of lead, pure or antimoniated, and optionally amalgamated or electroplated with lead; or a body of mercury may be used. Suitable materials for the anode are platinum, lead, oxide of iron, carbon and graphite. The last two impart an agreeable bouquet to the alcohol. When alcohol is to be produced, a cathode density of 2 to 3 amp. per sq.dm. is employed, and the temperature is not allowed to rise much above 40 deg. C. About 10 per cent of aldehyde is initially added to the electrolyte; a subsequent addition may raise the proportion of organic substance above 30 per cent. If the temperature, concentration of acid or aldehyde, current density, or duration of treatment is increased, byproducts are obtained, such as 1 to 3 butane-diol, crotonyl alcohol, butyl alcohol, and ethyl ether. Catalytic dehydration of the first or second of these gives butadiene. Oxygen, with or without ozone, is evolved at the anode, and may be utilized for metal-working, purification of waste waters and sewage, or oxidation of nitrous vapors. (Br. Pat. 140,115—1919. P. V. H. PASCAL, Angoulême, France, May 12, 1920. See also Pat. 148,527—1919, May 19, 1920).

Catalytic Hydrogenation. — An aluminate of a heavy metal such as nickel is used as the catalyst in the hydrogenation of unsaturated organic compounds such as fatty acids and their esters. The catalyst is prepared, for example, by mixing solutions of nickel sulphate and sodium aluminate, washing the precipitated nickel aluminate, and afterward treating the dried aluminate at a temperature of 300 to 400 deg. C. with a current of hydrogen. The aluminate may be precipitated in an inert carrier such as kieselguhr. (Br. Pat. 140,371—1919. NORDISKE FABRIKER DE-NO-FA. AKTIESELSKAP, Christiania, May 12, 1920.)

Third Meeting, International Union of Pure and Applied Chemistry

THE third meeting of the International Union of Pure and Applied Chemistry was held in Rome June 22 to 25, under the presidency of Prof. Charles Moureu, member of the Institut de France. There were present representatives of Belgium, France, Great Britain, Italy and the United States, the five countries which founded the Union. (See CHEM & MET., vol. 21, pp. 234, 424.) Seven new countries were admitted unanimously; they are: Canada, Denmark, Spain, Greece, Holland, Poland and Czechoslovakia.

The following were the delegates to the general assembly:

For Belgium: Frédéric Swarts, professor at the University of Gand, and Dr. René Lucion, former president of the Société de Chimie de Belgique.

For Denmark: Einar Billman, professor of chemistry of the University of Copenhagen, and M. Warming.

For France: Prof. G. Bertrand, president of the Société Chimique de France; F. Bordas, professor at the Collège de France; Jean Gérard, general secretary of the Union Internationale de la Chimie; Paul Kestner, president of the Société de Chimie Industrielle; Prof. L. Lindet, member of the Institut de France; Ch. Lormand, chemist at the French Department of Agriculture; Camille Matignon, professor at the Collège de France, vice-president of the Société de Chimie Industrielle; Ch. Marie, general secretary of the Société de Chimie Physique; Prof. Charles Moureu, president of the Union Internationale de la Chimie, and M. Nicolardot, of the Paris Ecole Polytechnique.

For Great Britain: Sir William Pope, professor at Cambridge University, president of the Society of Chemical Industry, and Mr. Hay, technical delegate of the Reparation Commission.

For Greece: M. Zenghelis, professor at the University of Athens.

For Italy: G. Bruni, professor at the Polytechnic of Milan; Senator C. Ciamician, professor at the University of Bologna, president of the Associazione Italiana di Chimica generale ed applicata; F. Garelli, professor at the Polytechnic of Turin; R. Nasini, professor at the University of Pisa; L. Parodi-Delfino, vice-president of the Associazione Italiana di Chimica generale ed applicata; G. Oddo, professor at the University of Palermo; M. Plancher, professor at the University of Parma; Senator E. Paterno. professor at the University of Rome, president of the Consiglio Nazionale di Chimica; F. Quartieri, administrator of the Societa Italiana Prodotti Esplodenti, and A. Peratoner, professor at the University of Rome.

For Holland: R. H. Kruyt, professor of physical chemistry at the University of Utrecht, president of the Nederlandsche Chemische Vereeniging.

For Poland: M. Kowalski, professor at the Polytechnic of Warsaw.

For Czechoslovakia: E. Votocek, professor at the Polytechnic of Prague, president of the Bohemian Chemical Society.

For the United States: Dr. Charles L. Parsons, general secretary of the American Chemical Society.

The meeting took place at the Corsini Palace, Academia Nationale dei Lincei.

Mr. Nicolardot spoke on the needs for standardizing the methods of chemical analyses for foods and proposed the establishment at Paris of a permanent international bureau with this aim in view.

Mr. Crismer presented the report on the creation of an international institute of chemical standards. It was voted to organize such a bureau, which shall comprise three divisions, namely: chemical standards, standards for pure products used in research work, and standards for technical products.

Mr. Matignon read a report on the importance of thermochemical data and proposed the creation of a commission composed of specialists of the different countries, members of the Union, to prepare and submit a project for the establishment of thermochemical standards.

Mr. Trincheri spoke on the juridic value of sealed letters in the applications for patents, and the following motion was adopted after lengthy discussion:

> The International Union of Pure and Applied Chemistry shall constitute a commission composed of members competent in the technical and juridic aspects of the problems relating to patents, and the first problems to be studied shall be the juridic value of the sealed letters and the creation of an international patent.

It was also voted that Italy shall prepare the project for such an organization.

INTERNATIONAL COMMISSION OF ATOMIC WEIGHTS CREATED

The study of the report of W. D. Bancroft, chairman of the Division of Chemistry and Chemical Technology of the U. S. National Research Council, on the International Commission of Atomic Weights, resulted in the creation of an international commission of atomic weights. The members proposed for this commission are Messrs. Clarke, Thorpe and Urbain.

Prof. Oddo presented a motion that the revision of the table of atomic weights shall be decennial and to take the atomic weight H = 1 as the basis of the system.

Mr. Marie made the motion that the International Committee of the Tables of Constants shall be included in the Union. This was approved.

To make the work of the conference more useful and to attract the attention of the respective governments on the importance of the work of the Union, the following motion was adopted at the request of the Danish delegation:

> The International Union of Pure and Applied Chemistry hopes that all the delegates of the nations members of the Union will try to have their countries recognize the work of the Union as of public utility.

The Union will present to the Italian Government the proceedings of the conference *in extenso* with the request that they shall be communicated officially to the governments of all the participating countries.

In closing the meeting it was decided to accept the invitation of the Polish Government to hold the 1921 meeting in Warsaw.

Laboratory for Low Temperature Work to Be Established

A cryogenic laboratory is to be established at once in Washington in connection with the helium work being done by the Bureau of Mines. The necessary funds for equipping the laboratory and conducting the work are being allotted to the Bureau of Mines from appropriations made to the Army and Navy Departments. The work in this new laboratory will be directed by R. B. Moore, the chief chemist of the Bureau of Mines.

Current Events
in the Chemical and Metallurgical Industries

Dye Division of the American Chemical Society

The Dye Division of the A. C. S., which had its inception first as a Dye Symposium, then as a Dye Section, is now a duly organized part of the American Chemical Society. The division is undertaking to carry on regular and systematic work for the benefit of the dye industry of America in general, and the users of dyes, manufacturers of dyes, and dye chemists in particular, laying, of course, especial emphasis upon the chemistry of dyes and dyeing.

It is the duty and the privilege of every chemist in America who is interested in the chemistry, manufacture or use of dyes to enroll himself as a member of the American Chemical Society and of its Dye Division, to attend and to participate in the semi-annual meetings. The advantage will be mutual, both to the members and to the industry.

It is planned, as soon as funds permit, to compile and distribute a directory of dye chemists who are registered in the Dye Division of the A. C. S. Further information may be obtained from the secretary, R. Norris Shreve, 43 Fifth Ave., New York City.

High-Grade Silica for Los Angeles

Another forward step has been taken by southern California ceramic interests in the opening of the new $100,000 plant of the Western Silica Co. at 2300 East 52d St., Los Angeles. With an initial output of thirty-five tons of washed silica per day, an amount which will soon be increased, this plant assures the development of the large deposits of high-grade silica in Antelope Valley, and assures for the industry a local supply of a product which has formerly had to be shipped from Illinois to the Coast. The silica from portions of these deposits runs over 99 per cent in purity, and is suitable for the highest grade of glass and ceramics. Charles E. Kaltenbach of Newark, N. J., a well-known silk goods manufacturer, is backing the new company, and Telfair Creighton is superintendent.

American Concern to Manufacture Ichthyol

The drug ammonium sulpho-ichthyolate, manufactured by the Meadows Oil & Chemical Corp. from an American fossiliferous marine deposit, is soon to appear on the market. Its germicidal action against *Staphylococcus py. au.* and *B. coli* is identical with the German product, but its penetration, particularly in high dilution, is from 200 to 400 per cent greater, and its therapeutic value has been found to be far superior.

Holyoke Mills Close for Repairs

The annual shut-down of the Holyoke mills began Saturday, July 31. The closing period was five days for the paper mills, and ten days for the balance of the factories. This closing is for the purpose of making necessary repairs to the canals. The paper mills will hardly regard it as an unmixed evil at this time, as it will enable them to accumulate at least a small reserve of pulp.

Importance of Italy's Water Power

Samuel M. Vauclain, president of the Baldwin Locomotive Co., on returning from a long business trip through Europe, declared that conditions in the countries he had visited were quite different from what is generally believed in America, and the rapidity with which those countries return to normal conditions would be according to the credit which they are able to obtain from abroad.

Conditions in Italy are better than in other countries. In fact, Italians are already producing and selling their products. If they could get better railway transportation they might even increase their export business, but they are handicapped by the lack of coal.

Despite this, however, due to its hydro-electric developments, Italy possesses some industries which can compete with the most important of those nations more favorably situated.

Several prominent manufacturers, realizing the seriousness of the coal situation, have rapidly substituted hydro-electric power. Among them was the Fiat Motor Works, which obtained control of the Mont Cenis Hydraulic Power Co. and can now generate 200,000,000 kw. throughout the year.

It is interesting also to note that the Italian Government has taken steps to electrify more than 6,000 km. of railway so as to reduce to a minimum the use of coal. Heat power being substituted by water power, coal consumption will be reduced by more than one-third. Thus in the very near future, when Italy will be able to utilize all the water resources so lavishly provided by nature, she will have solved one of the hardest problems which most European nations are now facing with great anxiety.

New Pulp and Paper Mill for Fort William, Ontario

Preliminary work has just begun on the plant for the new pulp and paper mill in Fort William, Ont. Its name is the Fort William Pulp & Paper Co. (Ltd.). It is said that the plant will cost about $3,000,000, and when in full operation will employ 1,000 men and turn out approximately 100 tons of pulp daily. The raw product will be obtained from the nearby forests, and the necessary power will come from Kakabeka Falls, about twenty miles distant.

Judgment Affirmed Against Chemical Companies

In the two actions brought by Joseph and Catherine Stellwagon against the S. Wander & Sons' Chemical Co., Inc., the Appellate Division of the New York Supreme Court, Fourth Department, has affirmed judgment against the Chemical company.

In the case of the Walker M. Levett Co. against the British Aluminum Co. judgment for the former was appealed from by the latter, but the Appellate Division of the New York Supreme Court has affirmed judgment against the Aluminum company.

Organization Plan of the Federal Power Commission

The plan of organization of the Federal Power Commission was worked out at a meeting of the commission in Washington July 27. The work of the commission is to be divided into the following activities: Engineering, accounting, statistical, regulatory, licensing, legal, operation. The engineering division is regarded as the most important, as it must make: General investigation of the electric power industry; general investigation of water-power sites and estimates on cost of development; estimates of amount and value of power available at Government dams; examinations, cost estimates and reports to Congress on projects recommended for construction by the United States; examinations and reports to Congress on projects for which it is recommended that the cost of navigation facilities be supplied in whole or in part by the United States; preparation of plans for development of streams and stream systems upon which applications for licenses are made; construction plans proposed by licensees; physical valuation of properties in rate-making proceedings and when existing plants are brought under the act; determination of necessary repairs required for maintaining projects in effective operating condition; determination of adequate depreciation reserves upon properties; determination of operating rules necessary for protection of life, health and property.

The immediate direction of the engineering activities will be under the engineer officers who will act as chief engineer of the commission.

For convenience in administering the act the country has been divided into five districts. The headquarters of these districts will be in Washington, St. Paul, St. Louis, Denver and San Francisco. Branch offices will be maintained in each of those cities at which notifications may be made and announcements given out.

Interstate Commerce Commission Issues New Coal Order

The issuance of a second New England coal order by the Interstate Commerce Commission, which repeals order No. 6, issued June 19, is expected to relieve the coal shortage in that section of the country. The experience with the former order enabled the operators and the railroads to determine accurately just what had to be done to move the tonnage necessary to insure an adequate supply for the northeastern group of states.

The new order places a single agent in charge of all tidewater facilities at Hampton Roads. The exact tonnage which must be moved each month is allotted to each of the tidewater railroads serving coal fields.

The railroads promise to supply sufficient cars at all mines assisting in furnishing the New England tonnage, to make maximum production possible. If this is done there will be enough coal left after the New England allotment is furnished to supply their other customers.

There is no disputing that the President two weeks ago was seriously considering the appointment of a Fuel Administrator and the restoration of governmental control over the coal industry. The harmonious way in which the operators and the carriers worked out the plan provided in the new New England order is said to have satisfied the White House that the situation will be met.

Factors Contributing to Anhydrous Ammonia Shortage

Despite some improvement in the transportation situation the shortage of anhydrous ammonia remains acute. Additional information gathered by Government specialists shows that the following factors are contributing to this shortage: The increased demand for anhydrous ammonia for refrigeration purposes; overproduction of ammonia cylinders; diversion of some of the ammonia liquor to make ammonium sulphate; the coal strike, which cut down the production of ammonia liquor; the switchmen's strike, with its resulting embargoes, which has caused slow movement to the consumer and has delayed the return of cylinders for refilling.

An important factor in increasing the amount of refrigeration at this time is the unusually large amount of meat which is being held in storage. Europe is producing more meat and other food products. This has enabled the Europeans to diversify their diet and the consequence is smaller purchases of American meat. A great deal of South American meat has been brought in and it, too, must be held in storage.

Following the armistice many coking plants closed, which reduced the production of ammonia liquor. Production was curtailed further by the influence exerted by the action of the Government in throwing 100,000 tons of ammonium sulphate on the market. It will be recalled that ammonium sulphate sold for pre-war prices for six months after the signing of the armistice. The farmers of both this country and England, however, had been educated during the war to use ammonium sulphate instead of sodium nitrate for fertilizing. This contributed largely to the rapid increase in the demand for sulphate. The attractive prices for sulphate are thought to have stimulated the making of sulphate in preference to anhydrous ammonia. It appears that the situation was not anticipated and sufficient retorts are not available for the liming of sulphate and the consequent production of anhydrous ammonia.

Artificial Silk Plant to Be Erected Near Buffalo

The du Pont Fibersilk Co., a company recently incorporated for the manufacture of artificial silk, has purchased a plant site of 100 acres on the shores of the Niagara River. The factory is to have 200,000 sq.ft. floor space and will employ about 700 persons. Active work on the plant is expected to commence some time in the spring.

This company was formed as the result of an agreement between E. I. du Pont de Nemours & Co. and the Comptoir des Textiles Artificiel of Paris, France, a company which controls practically all of the largest artificial silk plants of Europe.

Decision Delayed as to Site of Non-Metals Experiment Station

Matters have arisen which will delay the final decision as to the location of the non-metals experiment station of the Bureau of Mines. Dorsey A. Lyon, the Bureau's supervisor of stations, and R. B. Moore, its chief chemist, have submitted a report to Dr. Cottrell, the director of the Bureau, setting forth the advantages and the disadvantages of each of the localities under consideration. It may be that Dr. Cottrell will visit some of the proposed sites before making his decision.

Papers to Be Read at T.A.P.P.I. Meeting

In addition to the program published in our issue of July 28, page 167, the following papers of technical interest will be read and discussed:

Quick Method of Determining the Presence of Sulphate Fiber in Paper, by R. E. Lofton and H. F. Merritt.

New Felt Cleaning Device as a Means of Increasing Production, by C. A. Woodcock.

Boiler Room Efficiency Increased by a new Mercury Boiler, by W. L. R. Emmett.

A Continuous Mixing System for Newsprint Mills, by C. N. Allen.

Automatic Cooking Control for Sulphite Digesters, by E. J. Trimbey.

Preliminary Report for a New Method of Testing Lime and Cement Bags, by P. L. Houston.

Curtailing Bleach Consumption by Adding Sulphur to Digester Liquor, by George K. Spence.

Discussion of Substitutes for Alum and Rosin in Sizing Papers, led by W. E. Byron Baker and Max Cline.

It is of the utmost importance that the chairman of the local committee of arrangements, Charles F. Rhodes, International Paper Co., Glens Falls, N. Y., be notified, by means of reply postal cards sent previously, of members' intention to attend the fall meeting, it being necessary to arrange in advance for transportation for mill visitations, as well as luncheons, dinners, etc.

Members are again reminded of the necessity of making individual requests for room accommodations at hotel headquarters, Grand Union Hotel, Saratoga Springs, N. Y.

New Cold-Storage Plant at Liverpool

Consul Horace Lee Washington reports from Liverpool, England, that a cold-storage plant, claimed to be the largest and most up to date in Europe, is nearing completion at the Alexandria Dock, Liverpool, constructed by the Union Cold Storage Co. The first section of the plant, opened in August last, has a capacity sufficient for the storage of 11,000 tons of foodstuffs. When completed the total cubic capacity will be over 3,000,000 ft. and the accommodation will approximate 30,000 tons of eatables, including meat, fish, poultry, game, eggs, butter and cheese. The equipment will be the most modern obtainable. In order to avoid exposure of meat in transport from ship to the plant the adjacent dock sheds have been fitted with a system of conveyors which enables the meat to be picked up at any point and conveyed under direct cover to the plant, thus avoiding any break in refrigeration. The building is in direct railway communication with the main railway systems of the country.

New Lubricant Company

The Graphite Oils Co. (Ltd.) recently offered for public subscription 150,000 shares of £1 each to take over the going concern called Graphite Oils (Ltd.), of Glasgow. Fifty thousand shares (making the total capital £200,000) were issued in part payment of the purchase price to the vendor company.

According to the prospectus, the vendor company was established in 1913 to test and develop the discovery of a method for the manufacture of lubricating oils and greases with natural graphite in suspension therein. The uses of graphite as a lubricant, the prospectus remarks, were formerly limited, "because the engineer could not find a means whereby it could be held in suspension in oil, and so could be carried with the oil into the internal workings of engines and bearings," but the process employed by the company has now rendered this possible.

Book Reviews

NON-TECHNICAL CHATS ON IRON AND STEEL AND THEIR APPLICATION TO MODERN INDUSTRY. By *Le Vergne W. Spring*, chief chemist and metallurgist of the Crane Co., Chicago. New York: Frederick A. Stokes Co. 358 pp., 294 illustrations and diagrams.

This book is a collection of articles by Mr. Spring which appeared in the Crane Co.'s house organ called the *Valve World*, so arranged as to give a comprehensive series of popular talks on iron and steel from a scientific standpoint. It is interesting from cover to cover; written in an entertaining and agreeable style, and contains a great deal of information that the user of steel and the intelligent layman should know.

The work properly begins with an early history of iron; then the raw materials are considered, then the blast furnace, and following this comes a chapter called "A General Glimpse Ahead." This has less to do with the future development of the industry than with a survey of the many varieties of iron and steel now known and in use. It is a glimpse ahead for a pig of iron.

It is fair to say that the science of ferrometallurgy, as representative of the organization and arrangement of particles in ferrous alloys, is still too undeveloped to make explanations or even guessing easy. For this reason, and with no reflections on Mr. Spring, we wish the book were better than it is. We haven't got beyond the stage of rather messy thinking in regard to the philosophy of iron and steel, and we can hardly expect to get out of it until we know more than we do. What is most needed is research in pure chemistry without any thought of utilities. Here is a great field.

The author is not speculative and he does not point out what may be done at some future date. It is feared that with the death of Joseph E. Johnson, Jr., a great deal of valuable research on the behavior of iron ore when smelted with oxygen in the place of air has been lost. It is known that too much iron vaporized in his tests, but he believed that he was on the road to illuminating information and possibly to marked economies, but, as he told the reviewer a few weeks before he was run over and killed by an automobile, he was "not yet ready" to publish.

After Mr. Spring's "Glimpse Ahead" there follow chapters on Wrought Iron, Cementation and Crucible Steels, Bessemer Steel, Open-Hearth Process, Cast Iron, Malleable Cast Iron, Alloy Steels, High-Speed Steels, Mechanical Treatments, Rolling, Rolling Rods, Wire and Wire Drawing, Pipe and Tubes, Seamless Steel Tubes and Transformations and Structures of the Steels. This last was a hard chapter, and, considering the little real information that we have in comparison to the sum total yet to be discovered, it was well done. The book closes with an equilibrium diagram of iron-carbon alloys.

In treating such a big subject within a limited space it is possible, of course, to think up a great variety of important features of the subject that might have been treated which are either merely mentioned or that have not been discussed at all. But on the whole I think Mr. Spring is to be congratulated on writing in popular form (which takes more space by far than technical writing) a great deal of useful information in relation to his subject. An intelligent foreman in a machine shop, a steel mill or a foundry is likely to be a more intelligent foreman after he has read it. ELLWOOD HENDRICK.

Personal

HOWARD C. ADAMS, formerly chief estimator for Tate-Jones & Co., Inc., has joined the George J. Hagan Co. of Pittsburgh, as engineer in its liquid fuel department.

CHARLES H. BREED, until recently metallurgist with the Brown Cork & Seal Co., of Baltimore, has joined the staff of Daniel M. Luehrs, industrial consulting engineer, Cleveland, Ohio, as consulting metallurgist in charge of the metallurgical laboratories.

EDWARD B. ELLICOTT, recently Colonel in the Chemical Warfare Service, has become associated with A. M. Castle & Co., iron and steel merchants, Chicago, in the capacity of chief engineer.

Dr. CHARLES H. FULTON, professor of metallurgy of the Case School of Applied Science, has resigned to become head of the department of mining engineering at the Missouri School of Mines, Rolla, Mo.

LLOYD HALL has accepted a position with the Boyer Chemical Laboratory Co. as research chemist in charge. He was formerly connected with the Chemical Warfare Service.

E. H. HEUMANN, until recently connected with the chemical department of the Crown Cork & Seal Co., Baltimore, Md., has joined the staff of Daniel M. Luehrs, industrial consulting engineer, Cleveland, Ohio, as chemist in charge of the chemical laboratories.

EUGENE F. HICKSON has resigned his position as first assistant chemist in the paint and varnish section of the Bureau of Standards to accept a position as associate engineer in the department of technical control of the American Writing Paper Co., Holyoke, Mass.

WALTER R. KIRNER is now associated with the synthetic chemistry department of the Eastman Kodak Co.'s research laboratory. Mr. Kirner was Lieutenant in the Chemical Warfare Service.

L. D. LE FORGE of the Bureau of Chemistry, Department of Agriculture, gave a talk recently before the Chicago Chemists' Club on corncob products. He exhibited some samples of paper, glue, woodstuffs and cellulose made from corncobs. He is co-operating with the Forest Products Laboratory, Madison, Wis., on paper manufacture.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, is in Golden, Col., assisting in the winding up of the affairs of the Bureau of Mines station, which is to be moved to Reno. Before his return to Washington he will visit Reno and the United States helium laboratory at Petrolia, Tex.

H. B. NORTHRUP, who has been associate professor of metallurgy at the Pennsylvania State College, State College, Pa., for nine years, has resigned to become chief metallurgist of the Diamond Chain & Manufacturing Co., Indianapolis, Ind.

ALFRED M. STAEHLE, formerly editor of the *Blast Furnace and Steel Plant*, has assumed his new duties in the industrial section of the department of publicity of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

IRVING JOHN STAFFORD has resigned his position as assistant superintendent of the No. 2 mill of the Strathmore Paper Co., at Woronoco, Mass., to accept a position as associate engineer in the department of technical control of the American Writing Paper Co., Holyoke, Mass. Prior to his entry into the paper industry, Mr. Stafford was associated with the Dow Chemical Co., Midland, Mich., as manufacturing chemist on electrolytic magnesium.

A. H. TAYLOR, who has been chief of the photometer section of the Bureau of Standards, has resigned to take up a research position with the Nela laboratories, where he will be associated with Dr. Luckiesh.

J. VAN ACKEREN, operating superintendent of the Koppers Co., arrived in New York July 28 on the S.S. Noordam from Rotterdam, after a visit of several months in Europe.

Obituary

JAMES MITCHELL, president and organizer of the Alabama Power Co., died at St. James, L. I., on July 22 after a year's illness from paralysis. Mr. Mitchell was born at Pembroke, Canada, fifty-four years ago, but his family moved to Milton, Mass., when he was a boy. As a young man he worked for the Thompson-Houston Co., now part of the Lynn works of the General Electric Co. He was a pioneer in electric railway development in South America, but during the past decade had devoted his time to his greatest work, the Alabama Power Co. Besides his widow, Mr. Mitchell is survived by two children, John Malcolm, a junior at Cornell, and Miss Marion Mitchell.

LUDWIG GATTERMANN, professor of chemistry at Freiburg, died on June 20, 1920. He was born in April, 1860, studied chemistry in Göttingen and was for a time assistant to Victor Meyer at Göttingen and later at Heidelberg. In 1900 he became professor of chemistry at the University of Freiburg. He contributed greatly to the development of organic chemistry. Among his most important works are: "Electrolytic Reduction of Aromatic Nitrogen Compound," "On Aromatic Thioketones," "Direct Synthesis of Aromatic Aldehyde," "Chemistry of Silicon," "Dyes and Other Derivatives of Anthraquinone" and a textbook on "Practical Methods of Organic Chemistry."

Current Market Reports

The Iron and Steel Market

Pittsburgh, July 30, 1920.

Rail transportation conditions, as regards the shipment of pig iron and steel products, have rounded the turn. The point is well passed at which the rate of pig iron and steel accumulating at works ceased to increase and the point has probably been reached, or at least closely approached, at which the total of accumulations is not increasing. The next period would be one of gradually moving the accumulations in addition to moving the current production. In the Chicago district there has already been somewhat of a clean-up, whereby the stocks of accumulated material are greatly reduced. In the Pittsburgh and Youngstown districts the shipments are still short of production, but not by as large a margin as formerly, and not a few mills have in the past week shipped approximately as much as they produced. The shipments do not invariably represent the current production, for some mills are shipping finished products from stock and at the same time accumulating semi-finished material, the object being to make the stocks of more mobile character, it being recognized that some of the finished steel made lately to customers' specifications would not be acceptable if not shipped until its turn came.

COAL CAR OUTLOOK BETTER

As noted in the last report, iron and steel interests were entertaining the hope that within a short time the coal mines will be supplied with as many cars as they were able to load, whereupon any further increase in transportation would permit of more transportation being given to the iron and steel industry. Evidences are accumulating that the point is near at hand. One coal operator in the Pittsburgh district, for illustration, has admitted that with his present 70 per cent car supply he is loading all the coal his miners will produce. They could produce more if they worked full time, but that they will not do as a rule, when the tonnage rate is where it stands.

There is no question that the railroads as a whole are functioning better from week to week, whereby the total

volume of transportation is increasing. It is a case of reducing inefficiency of the physical equipment, not of additions to equipment. There will be additions in future, but no large additions in the nearby future. The iron and steel industry is convinced that the railroads are not operated as efficiently as they could or should be. This judgment is supported by various comparisons, one of these being that certain roads which in the past were considered rather poorly equipped physically and mentally are now functioning much better than other roads that have had very good reputations.

Transportation and Steel Consumption

The steel industry considers transportation the most vital factor, or at least one of the two most vital factors in the matter of steel trade prosperity. Better transportation conditions are wanted not merely for the sake of steel products being moved to customers with more facility, but largely for the sake of steel consumers and potential consumers receiving such transportation service upon their other raw materials or upon their finished products that they will have occasion to operate at better rates and thus have greater use for steel.

The other of the two most important factors bearing upon the nearby future of the steel trade is the matter of money and credit. With the present strained financial situation there is no room for sufficient initiative in the undertaking of large construction work, and this applies to the construction of railroad facilities as well as of other things. In the conduct of the present steel business there is no lack of money apparent, but expansion is prevented. The pig iron and steel producers are carrying little if any paper of their customers, payments being good, nor are the producers borrowers to any extent. The business that is being done is financed without any difficulty, but growth in demand is restricted by present financial conditions.

Quiet Markets

The pig iron, semi-finished steel and finished steel markets have all been very quiet in the past week, even quieter than in previous weeks of the proverbially dull midsummer period. There is no definite trend by which the future can be gaged. With such a light demand for steel one might expect steel prices to decline, and undoubtedly many buyers do entertain such an expectation. Pir iron, however, is high relative to steel prices, and yet pig iron, as quotable in the open market, is displaying a distinct advancing tendency. Bessemer, basic and foundry iron in the local market are all quotable $1 a ton higher, at $47 for bessemer and $46 for basic and foundry, f.o.b. valley furnaces. The advances have occurred through there being insistent demand for relatively small lots of prompt iron, when it is the delivery rather than the iron that the purchaser is buying, for the purchaser may indeed have considerable tonnages of iron due him on old and lower priced contracts, the iron not being shipped because cars are not available or because the furnace has had its output restricted by coke scarcity.

In prices for finished steel products for prompt shipment there has been a gradual lowering for many weeks past, prompt prices tending to reach the level of prices for deliveries within a few months. While this trend continues, in general, sheets have had a movement of their own and are higher priced for prompt shipment than a fortnight ago.

The Chemical and Allied Industrial Markets

New York, July 30, 1920.

The chemical market is in the grip of the usual dull midsummer season. Very few inquiries are heard and as a result the market for the most part remains in the same position as previously reported. It is noticeable, however, that this condition is having a salutary effect upon the trade as a whole, as it gives producers a chance to catch up on some of their overdue contracts, and dealers will be better able to meet the fall buying season when it arrives. The *acids* have remained quiet during the week, the only change being in *citric*, which is held firm by producers at 80c. in car lots and 82@84c. in less than car lots. Most of actual trading in *alum* recently is resale, quotations running at 6@6½c. per lb., while the manufacturers' price has continued at 4½c. With the increase in the cost of production, however, the leading concerns have advanced their quotations to 5@5½c. for *ammonia lump* and 8@8½c. for *potash lump*, while *chrome lump* holds firm at previous levels of 15¾@18c. per lb. for car lots. As was noted some weeks ago, the *barium chloride* situation seemed to be becoming easier and with the arrival of fresh supplies in this market the quotation has come down from a nominal figure of $170@$180 per ton to an actual figure of $160, at which price there were actual orders placed during the week. *Copperas* also came down and although there is not enough material on spot to meet the demand the current quotation is $2.20@$2.50 per cwt., against $2.75@$3, the recently prevailing price. *Potassium salts* remained firm in general with *chlorate* advanced to 19@19½c. per lb., due principally to the difficulty manufacturers are experiencing in increased plant expenses.

Coal-Tar Products

This market seems to have assumed a healthier tone, although there has not been any noticeable upward price movement. The reason for this is larger supplies. The present dullness caused by the dropping out of the buying market of tanners and textile interests is rather an advantage to coal-tar producers, giving them the opportunity to catch up in their contracts. *Napththalene* is the exception, as no material in even medium sized quantities is available. Resale lots are still changing hands at figures ranging between 19c. and 21c. per lb. The improvement in supplies of *dinitrotoluol* has caused a slight drop in this item, which can be had at 35@40c. per lb., against 40@45c. of the previous week. *H acid* can also be obtained in larger quantities, with $2@$2.25 per lb. the prevailing quotations, and *orthonitrotoluol*, which has been quiet for some time, is listed at 35@40c. per lb.

Naval Stores

Quotations on *rosins* are the same as last reported, although there was considerable activity the first part of the week and there was a general advance of about 30c., but during the last few days the tone of the market has weakened and today the former prices prevail. *Turpentine* fared a little better, making an advance of 11c. and keeping in that position, current quotation now being about $1.69 per gal., and this is practically a nominal figure, as there is scarcely any material available in the local market.

Oils

The prevailing dullness in this market remains unbroken. Buying interest in *cottonseed* is quiet and evidently awaiting a price readjustment on the new seed. Current quotation is $13.40@$14. There has been a firmer tone manifested in *soya bean* during the week, although business is by no means near normal at the prevailing figure of 10⅝c. per lb. *Peanut* oil is one of the weakest items on the list, inquiries being few. Offerings continue in small way on a 12¼@12½c. per lb. basis.

The Baltimore Market

Baltimore, Md., July 29, 1920.

The fertilizer manufacturers are now beginning to show more interest in the purchase of their supplies for the fall as well as next spring season. Labor conditions are still very unsatisfactory, with no indications of any improvement, and it is the consensus of opinion of the manufacturers that they will experience considerable difficulty during the next few months in getting enough cars to ship their products.

During the past week the market on cottonseed meal has eased up, and this material is now obtainable for summer as well as fall shipments at less than tankage, even without taking into consideration the value of phosphoric acid and potash in cottonseed meal. Off-grade meal for August shipment is quoted as low as $8 per unit of ammonia delivered Baltimore, no charge for phosphoric acid, potash or bags. Prime 43 per cent meal is being quoted for September-December shipment from the South at $8.25@$8.50 per unit of ammonia. Figuring the value of phosphoric acid, potash and bags, this brings the ammonia down to the basis of about $7.60@$7.85 per unit.

The acid phosphate market during the next few months is closely sold up, and on account of the car situation, producers are not disposed to commit themselves to too heavy a tonnage to move by cars, even during the later months. Prices remain unchanged at $20 per ton for 16 per cent grade, in bulk, with run of pile testing 17 to 18 per cent being quoted at $19.50 per ton of 2,000 lb., in bulk, basis 16 per cent. It is not so much a question of price with the producers as it is of being able to fill the orders and take care of their regular trade. There is no improvement in the phosphate rock situation, and occasional resale lots are readily taken up with prices ranging from $15 to $16 per gross ton ex vessels Baltimore. Sulphuric acid is also in short supply, and when all conditions are taken into consideration, it can be readily understood that the present market will be maintained for some months to come.

Tankage

There is practically none of this material now finding its way from the West to this section, as the fertilizer manufacturers realize it is impossible for them to compete for the desired makes with buyers who require this material for feeding purposes. The Eastern market remains unchanged, and prevailing price of $8 per unit of ammonia and 10c. per unit of B.P.L., basic c.a.f. Baltimore, is still considered a shade under the market, but business can be worked at this figure. Some of the producers have their views pitched at this price f.o.b. shipping point, but buyers are slow to take hold at this figure.

Nitrate of Soda

This article has been somewhat more active than for some time past, and with the falling sterling exchange, it is possible to shade $4 per 100 lb. for October-December arrivals, and $4.10 for January-April arrivals. However, any material improvements in the exchange situation will naturally be reflected in importers' prices.

Potash

During the past week there has been considerable agitation over the fact that the German syndicate is trying to hold up the American buyers by charging them twice as much for potash as they sell to other countries. While there is no concerted action on the part of American fertilizer manufacturers, at the same time they have been strongly advised to defer the purchase of their requirements of potash over the remainder of this year another thirty days at least, which is felt will have the desired effect on the German Government, which from reports has already been bringing pressure to bear on the syndicate to reduce prices to an equitable basis in order to move a good tonnage. Up to the present time only about one-fifth of the tonnage of German potash has been shipped since April 5 that would have been shipped had prices been on a reasonable basis. Spot stocks, however, are being firmly held on the basis of $2.20@$2.25 per unit for kainit and $2.65 for muriate, with no manure salt offering and no important shipments on the way. The demand, however, is very light, as fall mixtures are usually much lower in potash than during the spring season.

Fish Scrap

The catch of fish in the Chesapeake Bay remains moderate and stiffening up in prices is noticeable, while the nominal market is $7.50 and 10c. for dry scrap f.o.b. factories. This price is subject to catch and "if made." Producers are well sold up and every indication points to the fish factories having a banner season.

Bone Meal

There is no change in the market, which is practically bare of both raw and steamed bone meal, 3 and 50 per cent still being held at $54 per ton, in buyers' bags, f.o.b. Baltimore, and every indication points to this price being maintained. Raw bone meal is a trifle firmer and very scarce; resale lots now being held at $64 per ton in second-hand bags f.o.b. basis Baltimore.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	....-....	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboy	cwt.	16.20 -	16.25 - ....
Boric, crystals	lb.	.15 - .15½	.16 - .19
Boric, powder	lb.	.15 - .15½	.16 - .20
Citric	lb.	.78 - .80	.82 - .84
Hydrochloric (nominal)	cwt.	2.00 - 3.00	3.10 - 4.00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		....-....	....-....
Nitric, 40 deg	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.60 - .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.25 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 16.00	....-....
Sulphuric, 60 deg., drums	ton	....-....	....-....
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	... - ...
Sulphuric, 66 deg., carboys	ton	....-....	....-....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - ....
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.	....-....	.74 - .77
Tungstic, per lb. of WO	lb.	....-....	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.	....-....	3.25 - 3.30
Alcohol, Methyl, pure	gal.	....-....	3.50 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	....-....	1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	....-....	1.05 - 1.10
Alum, ammonia lump	lb.	.05 - .05¾	.05½ - .06
Alum, potash lump	lb.	.08 - .08¾	.09 - .09½
Alum, chrome lump	lb.	.15½ - .18	.19 - .20
Aluminum sulphate, commercial	lb.	.04¾ -	.. - ..
Aluminum sulphate, iron free	lb.	.06 -	-
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.34 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - .13½	.13½ - .14½
Ammonium nitrate	lb.	.09 - .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08¼ - ....
Amylacetate	gal.	....-....	5.00 - ....
Amylacetate tech.	gal.	....-....	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .25
Barium chloride	ton	150.00 - 160.00	....-....
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.09½ - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		....-....	....-....
Blue vitriol (see copper sulphate)		....-....	....-....
Borax (see sodium borate)		....-....	....-....
Brimstone (see sulphur, roll)		....-....	....-....
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3.55	....-....
Calcium carbide	lb.	.04½ - .04¾	.04¾ - .05½
Calcium chloride, fused, lump	ton	25.00 - 30.00	35.00 - 45.00
Calcium chloride, granulated	lb.	.01½ - .01¾	.02 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	....-....	4.50 - 6.50
Calcium peroxide	lb.	....-....	1.50 - 1.70
Calcium phosphate, monobasic	lb.	....-....	.75 - .80
Calcium sulphate, pure	lb.	....-....	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.14 - .15	.16 - .17
Carbonyl chloride (phosgene)	lb.	....-....	.80 - 1.05
Caustic potash (see potassium hydroxide)		....-....	....-....
Caustic soda (see sodium hydroxide)		....-....	....-....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.	....-....	2.00 - 2.05
Copperas (see iron sulphate)		....-....	....-....
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	....-....	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		....-....	....-....
Epsom salt (see magnesium sulphate)		....-....	....-....
Ethyl Acetate Com. 85%	gal.	1.35 -	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		....-....	1.75 - ....
Formaldehyde, 40 per cent (nominal)	lb.	....-....	.57 - .65
Fusel oil, ref	gal.	....-....	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	....-....	....-....
Glauber's salt (see sodium sulphate)		....-....	....-....
Glycerine	lb.	....-....	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	....-....	.03 - .20
Iron sulphate (copperas)	cwt.	....-....	2.20 - 2.50
Lead acetate, normal	lb.	....-....	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	....-....	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	....-....	1.50 - ....
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .1[illegible]
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	....-....	3.25 - 3.[illegible]
Nickel salt, double	lb.	....-....	.14 - .1[illegible]
Nickel salt, single	lb.	....-....	.13 - .1[illegible]
Phosgene (see carbonyl chloride)		....-....	....-....
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	....-....	.35 - .37
Potassium bichromate	lb.	.50 - .55	.57 - .60

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 – $0.56	$0.57 – $0.58
Potassium bromide, granular	lb.	..... –	.90 – .95
Potassium carbonate, U. S. P.	lb.	..... –	.47 – .50
Potassium carbonate, crude	lb.	.20 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.17 – .17½	.18 – .20
Potassium hydroxide (caustic potash)	lb.	.30 – .33	.35 – .38
Potassium iodide	lb.	..... –	3.35 – 3.60
Potassium nitrate	lb.	.17 – .17½	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 – .....
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .40
Potassium sulphate (powdered)	ton	$225.00 – 240.00	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	40.00 – 50 00
Silver cyanide (nominal)	oz.	..... –	1.25 – .....
Silver nitrate (nominal)	oz.	..... –	.63 – .70
Soda ash, light	100 lb.	..... –	3.20 – 3.50
Soda ash, dense	100 lb.	..... –	3.55 – 3.65
Sodium acetate	lb.	..... –	.10 – .15
Sodium bicarbonate	100 lb.	2.50 – 2 75	3.00 – 3.50
Sodium bichromate	lb.	.22 – .24	.26 – .27
Sodium bisulphate (nitre cake)	ton	7.00 – 8.00	9.00 – 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08¼ –	.10 – 11
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.50 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.11 – .12	.12½ – .13
Sodium cyanide, 96-98 per cent	lb.	.25 – .30	.32 – .35
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	–	6.25 – 7 00
Sodium hyposulphite	lb.	..... –	.03 .04
Sodium molybdate	lb.	2.50 –	3.25½ – .....
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4 00
Sodium nitrite	lb.	.16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04¾ .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – 05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½ .10	.10½ – .11
Sodium sulphite, crystals	lb.	.04 – 0 4½	.04½ – .05
Strontium nitrate, powdered	lb.	.17½ – .18½	.19 – .20
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	25.00 – 30.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	..... –	3.80 – 4 35
Sulphur, roll (brimstone)	100 lb.	..... –	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½ – .44	.45 – .46
Tin oxide	lb.	..... –	..... – .....
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.13 – 13½	.13½ – .17
Zinc cyanide	lb.	.45 – 49	.50 – .60
Zinc dust	lb.	.11 – 12	.12 – .13
Zinc oxide, U. S. P.	lb.	.17 – .25	–
Zinc sulphate	lb.	.03½ – .03¾	.04 – 06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1 40	$1.50
Alpha naphthol, refined	lb.	1 60	1 70
Alpha naphthylamine	lb.	.53	.56
Aniline oil, drums extra	lb.	33	.34
Aniline salts	lb.	.40	.42
Anthracine, 80% in drums (100 lb.)	lb.	.90	1 00
Benzaldehyde (f.f.c.)	lb.	2.00	2 10
Benzidine, base	lb.	1.35	1 40
Benzidine, sulphate	lb.	1.15	1 25
Benzoic acid, U.S.P.	lb.	.90	1 00
Benzoate of soda, U.S.P.	lb.	.80	.90
Benzol, pure, water-white, in drums (100 lb.)	gal	33	40
Benzol, 90%, in drums (100 lb.)	gal	.33	38
Benzyl chloride, 95-97%, refined	lb.	.35	.40
Benzyl chloride, tech	lb.	25	.35
Beta naphthol benzoate (nominal)	lb.	3 50	4 00
Beta naphthol, sublimed (nominal)	lb.		
Beta naphthol, tech (nominal)	lb.	85	95
Beta naphthylamine, sublimed	lb.	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	19
Ortho-cresol, in drums (100 lb.)	lb.	23	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1 05	1 15
Cresylic acid, 95-97%, dark, in drums	gal.	1 00	1 05
Cresylic acid, 50%, first quality, drums	gal.	.65	75
Dichlorbenzol	lb.	.08	10
Diethylaniline	lb.	1 50	1 60
Dimethylaniline	lb.	1 35	1 45
Dinitrobenzol	lb.	.30	.37
Dinitroclorbenzol	lb.	.32	35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	.40	.45
Dinitrotoluol	lb.	.35	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	40
Diphenylamine (nominal)	lb.	80	.85
H-acid (nominal)	lb.	2 00	2 25
Metaphenylenediamine	lb.	1.25	1 30
Monochlorbenzol	lb.	.18	.20
Monoethylaniline	lb.	2.00	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	..
Naphthaline, flake	lb.	....	.19
Naphthaline, balls	lb.	....	.19
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	1.25
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.35	.40
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1 35	1.40
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.50	2.65
Paratoluidine	lb.	2.00	2.25
Phthalic anhydride	lb.	.60	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.20
Pyridin	gal.	2.00	3.50
Resorcin, technical	lb.	4.25	4.50
Resorcin, pure	lb.	6 25	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	.52
Salicylic acid, U. S. P.	lb.	.50	.60
Salol	lb.	.90	1
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	.26
Sulphanilic acid, crude	lb.	.32	.35
Toluidine	lb.	1.70	2.50
Toluidine, mixed	lb.	.45	.55
Toluol, in tank cars	gal.	.35	.....
Toluol, in drums	gal.	.38½	.40½
Xylidine, drums, 100 gal.	lb.	.50	.65
Xylol, pure, in drums	gal.	.37	.45
Xylol, pure, in tank cars	gal.	.35	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	.45
Xylol, commercial, in tank cars	gal.	.23	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	$0.39
Beeswax, refined, light	lb.	.39	.40
Beeswax, white pure	lb.	.63	.68
Carnauba, No. 1. (nominal)	lb.	1.00	1.05
Carnauba, No. 2, regular (nominal)	lb.	.85	.88
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.19	.19½
Montan, crude	lb.	.23	.25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.10	.10½
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	.12
Paraffine waxes, refined, 125 m.p.	lb.	.12½	.....
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½	.15½
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18½
Stearic acid, single pressed	lb.	.24	.25
Stearic acid, double pressed	lb.	.25	.26
Stearic acid, triple pressed	lb.	.27	.28

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.30
Pine oil, pure, dest. dist.	gal.	1 80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal	2 00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$12 25	$16 25
Rosin E-I	280 lb.	16 60	16.75
Rosin K-N	280 lb.	17 00	17 20
Rosin W. G.-W. W.	280 lb.	17 25	17.50
Wood rosin, bbl.	280 lb.	15 00	
Spirits of turpentine	gal.	1 69	
Wood turpentine, steam dist.	gal.		
Wood turpentine, dest. dist.	gal.		
Pine tar pitch, bbl.	200 lb.		8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	15 00
Retort tar, bbl.	500 lb.	15 00	15 50
Rosin oil, first run	gal.	70	
Rosin oil, second run	gal.	.73	
Rosin oil, third run	gal.	.92	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0 40
70-72 deg., steel bbls. (85 lb.)	gal.	38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0 32	$0 33
Upriver coarse	lb.	23	24
Upriver caucho ball	lb.	.23	24
Plantation—First latex crepe	lb.	.32½	...
Ribbed smoked sheets	lb.	.31½	...
Brown crepe, thin, clean	lb.	.30	
Amber crepe No. 1	lb.	.30	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0 17	$0.18
Castor oil, AA, in bbls.	lb.	.19	
China wood oil, in bbls.	lb.	18	.19
Coconut oil, Ceylon grade, in bbls.	lb.	16	
Coconut oil, Cochin grade, in bbls. (nominal)	lb.	17½	17½
Corn oil, crude, in bbls.	lb.	.16	16½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10	.11
Cottonseed oil, summer yellow	lb.	.13½	15½
Cottonseed oil, winter yellow	lb.	.19	
Linseed oil, raw, car lots (domestic)	gal.	1 20	
Linseed oil, raw, tank cars (domestic)	gal.	1 30	
Linseed oil, boiled, car lots (domestic)	gal.	1.35	

Olive oil, commercial	gal.	3.00 —	3.10
Palm, Lagos	lb.	.10½ —	.
Palm, bright red	lb.	.10½ —	.
Palm, Niger	lb	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½ —	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.65 —	.
Rapeseed oil, blown, in bbls	gal.	1 70 —	.
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	.11

FISH

Winter pressed Menhaden	gal.	$0.90 —	$1 05
Yellow bleached Menhaden	gal.	0.95 —	1 05
White bleached Menhaden	gal.	1 00 —	1 25
Blown Menhaden	gal.	1.00	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	-$25 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00	— 20 00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8 00	- 10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00	- 25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16 00	— 19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12 00	—
Barytes, floated, f.o.b. St. Louis	net ton	26 50	— 28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11 00	11 25
Blanc fixe, dry	lb.	.05½ —	06
Blanc fixe, pulp	net ton	60 00	80 00
Casein	lb.	15 —	18
Chalk, domestic, extra light	lb.	.05 —	06
Chalk, domestic, light	lb.	.04½ —	05½
Chalk, domestic, heavy	lb.	.04 —	05
Chalk, English, extra light	lb	.05	.07
Chalk, English, light	lb	.05	.06
Chalk, English, dense	lb.	.04½	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	— 12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	— 40.00
China clay (Kaolin), imported, lump	net ton	25.00	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	60 00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	8.00
Feldspar, crude, f.o.b. Maine	net ton	7 50	10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00	— 20 00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00	— 20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00	
Fuller's earth, powdered, f.o.b. Fla	net ton	18 00	
Fuller's earth, imported, powdered	net ton	35.00	40 00
Graphite (dust polish grade 30%) Ashland, Ala	lb.		01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	—	02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	...... —	.05
Graphite, crucible, 90% carbon Ashland, Ala	lb.	—	.10
Graphite, crucible, 85% carbon	lb	—	08
Graphite, crucible, 88% carbon	lb		09½
Graphite, crucible, 90% carbon	lb.		10½
Pumice stone, imported, lump	lb	04	50
Pumice stone, domestic, lump	lb	[illegible]	
Pumice stone, ground	lb.	04	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		17 00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	7.50
Shellac, orange fine	lb	1 35	
Shellac, orange superfine	lb	1 45	
Shellac, A. C. garnet	lb	1 65	1 75
Shellac, T. N.	lb	1 20	1 30
Soapstone	ton	15.00	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9 50	14 00
Talc, roofing grades, f.o.b. Vermont	ton	8 00	9 00
Talc, rubber grades, f.o.b. Vermont	ton	9 00	15 00
Talc, powdered, Southern, f.o.b. cars	ton	12 00	15 00
Talc, imported	ton	60 00	70 00
Talc, California Talcum Powder grade	ton	20 00	35 00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90 -	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90	95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45	53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75	
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40	
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100	
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90-	100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55-	...
Silica brick, f.o.b. Birmingham	1,000	51-	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50-	55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	17	.18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	19	20
Ferro-manganese, 76-80% Mn.	gross ton	200 00	- 225.00
Spiegeleisen, 18-22% Mn.	gross ton	75.00	
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 50 —	3.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77 —	.85
*Coke, foundry, f.o.b. ovens	net ton	18.50 —	20.00
*Coke, furnace, f.o.b. ovens	net ton	18.00 —	19.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	.
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	....	25 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02 —	...
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.72½ —	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.60 —	65
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	.
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½—	.....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.50 —	7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb	2 75	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	.
Zircon, washed, iron free	lb.	.10 —	...

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	8 00
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	49.50
Lead, New York, spot	9 25
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8 25
Zinc spot, E. St. Louis	7 90@8 40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2 50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@85
Iridium	oz.	350.00
Palladium	oz.	80.00
Mercury	75 lb.	88.00@90.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	15.50@15.75
Copper, light and bottoms	13.75@14.25
Copper, heavy cut and crucible	16.25
Brass, heavy	9.50@10.00
Brass, light	7.25@ 7.75
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@ 5.00
Lead, heavy	7.25@ 7.50
Zinc, scrap	5.00@ 5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3.97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.62	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.62	4.12	3.37	....	3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25	....	....	....
Plates, ¼ to 1 in. thick	4.68	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Amer. Bolt Wks., 39th St. and 10th Ave. N., has awarded the contract for the construction of a steel addition to forge shops, to C. M. Allen. Estimated cost, $25,000.

Arizona

MESA—The South Side Community Hospital, c/o Berlin, Swern & Randall, archts., 19 South La Salle St., Chicago, is having preliminary plans prepared for the construction of a 3-story, 42x100-ft. hospital. A small chemical laboratory will be installed in same. Estimated cost, $125,000.

Connecticut

BRIDGEPORT — The Amer. Tube & Stamping Co., 471 Hancock Ave., will build a 1-story, 50x160-ft. annealing building on Wordin Ave. Estimated cost, $30,000. Work will be done by day labor.

SUFFIELD — The Fords Wawbeek Springs, Inc., c/o Walter E. Dibble, archt., 317 Main St., Springfield, Mass., will soon award the contract for a 1- and 2-story spring water plant. Estimated cost, $50,-000.

WATERBURY- M. J. Daly & Sons, 543 Bank St., has awarded the contract for the construction of a 1- and 3-story factory for the manufacture of sheet metal, to the G. S. Chatfield Co., 138 Division St. Estimated cost, $85,000.

WATERVILLE—The Berbecker & Rowland Mfg. Co., Main St., has awarded the contract for the construction of a 3-story, 40x180-ft. factory for the manufacture of metal goods, to the Torrington Bldg. Co., 197 Water St. Estimated cost, $100,000.

WINDSOR LOCKS — C. H. Dexter & Sons, Inc., has awarded the contract for altering the present tissue paper manufacturing building, to the Bent-Bartlett Co., 43 Ann St., Hartford. Estimated cost, $20,000.

Georgia

SAVANNAH - - The Bd. Educ. plans to build a 3-story, 148-224-ft. school. A chemical laboratory will be installed in same. Estimated cost, about $1,000,000. William B. Ittner, Bd. Educ., St. Louis, Mo., archt.

Illinois

CHICAGO — The Enterprise Paint Mfg. Co., 854 West Van Buren St., has awarded the contract for the construction of a 5-story, 44x60-ft. paint factory on Van Buren and Peoria Sts., to the O. W. Rosenthal Co., 84 East Jackson St. Estimated cost, $50,000.

GRANITE CITY—The Bd. Educ. is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $280,000. William B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., archt.

Indiana

GARY—The Universal Slag Brick & Tile Co. is building a 1-story, 100x200-ft. brick plant. Estimated cost, $200,000. Silica, Brick & Eng. Co., engr.

Iowa

DES MOINES—The Mid-West Steel Co., c/o Des Moines Steel Co., 4th St. south of Tuttle St., plans to build a 2-story steel manufacturing plant. Estimated cost, $200,000. J. VanLew, pres.

NEWTON—The Newton Fdry Co. has awarded the contract for the construction of a 2-story, 106x300-ft. foundry, to the A. H. Newman Co., 517 Hubbell Bldg., Des Moines. Estimated cost, $100,000.

Louisiana

NEW ORLEANS—S. Ohnstein will soon award the contract for the construction of a 1-story factory on Colapessa St., for the Union Paper Products Co., 109 Tchoupitoulas St. Estimated cost, $125,000. Emile Weil, Whitney Central Bank Bldg., archt.

Maryland

BALTIMORE - The Natl. Bitulithic Enamel & Paint Co., Lawrence and Woodall Sts., will receive bids about Aug. 9 for the construction of a 3-story, 100x150 ft. addition to the enamel and paint plant. Estimated cost, $100,000. J. R. Broderich, mgr.

Massachusetts

EAST EVERETT -The Boston Varnish Co., 2d St., has awarded the contract for the construction of a 1-story, 40x60-ft. addition and altering the present plant on East Summer St., to J. E. Locatelli Co., Inc., 46 Cornhill St., Boston. Estimated cost, $30,000. Noted July 21.

HOLYOKE—The Hampden Glazed Paper & Card Co., River Side, has awarded the contract for the construction of a 4-story, 92x291 ft. factory on Water St., to the Casper Ranger Constr. Co., 201 Devonshire St., Boston, at $165,000.

WHEELWRIGHT — The George W. Wheelwright Paper Co., 70 Franklin St., Boston, has awarded the contract for the construction of a concrete sedimentation tank at its Hardwick mill, here, to the H. P. Cummings Constr. Co., Ware.

Michigan

DETROIT—The General Forgings Corp., c o J. D. Edwards, 54 Lafayette Blvd., plans to build a 2-story, 65x210-ft. drop forging shop.

Minnesota

MINNEAPOLIS The Western Chemical Co. plans to build a 3- to 5-story patent medicine factory on Malcolm Ave. and University Ave., South Chemical equipment will be installed in same. Estimated cost, from $125,000 to $150,000. A. G. Kranz, Hutchinson, pres. Downs & Eads, 803 Phoenix Bldg., archts.

Missouri

BROOKFIELD—The School Bd. is having preliminary plans prepared for the construction of a 2-story school. General chemical laboratories will be installed in same. Estimated cost, $105,000. A. W. Baker, secy. W. E. Hulse & Co., 309 Securities Bldg., Des Moines, archt. Noted June 30.

ST. LOUIS—The Blanke-Baer Chemical Co., 1710 Morgan St., plans to build a modern, factory for the manufacture of jellies and preserves on King's Highway. Estimated cost, $150,000.

New Jersey

EDGEWATER—The United States Aluminum Co. plans to construct a large addition to its plant.

JERSEY CITY—J. T. Ryerson & Sons, manufacturers of steel, 230 West Side Ave., plan to build an addition to their plant. Estimated cost, $50,000.

MONMOUTH JUNCTION—The Alcoholic Products Corp. has awarded the contract for the construction of a plant addition, to Barney Ahlers, 110 West 40th St., New York City. Estimated cost, $50,000.

TRENTON—The Acme Rubber Co., East State St., has awarded the contract for the construction of a 1-story, 90x300-ft. rubber plant addition on East State St., to the N. A. K. Bugbee Co. 206 East Hanover St. Estimated cost, $60,000.

Ohio

CANTON—The Timken Roller Bearing Co., Dueber Ave., plans to build a 1 and 2-story addition to present plant on 18th St., S. W. Estimated cost, $75,000.

CLEVELAND—The Jordan Motor Car Co., 1052 East 152d St., has awarded the contract for the construction of a 2-story japanning building at 1070 East 152d St., to the Hunkin-Conkey Constr. Co., Century Bldg. Estimated cost, $100,000.

CLEVELAND - The U. S. Leather Co., c/o E. B. Cassett, East 13th St. and Euclid Ave., plans to build a 1-story, 100x300-ft. factory on Broadview Rd. Estimated cost, $100,000.

FOSTORIA- The Willys Light Corp., 221 Cherry St., Toledo, has awarded the contract for the construction of a 1 story, 120x211-ft. foundry for the manufacture of iron castings, to H. J. Spieker, Elm and Utica Sts., Toledo Estimated cost, $125,000.

MARION- George B. Gascoigne, consult. engr., 1446 East 116th St., Cleveland, has been engaged to report upon sewerage and sewage disposal improvements. Estimated cost, $600,000. T. S. Cathers, city engr.

WARREN—The Bd. Educ., c/o J. Buckwalter, has awarded the contract for the construction of a 2-story, 125x150-ft. addition to the East Technical High School, and a 2-story, 110x182-ft. addition to the West Technical High School, to the Shustrump Co., Youngstown. Laboratory equipment will be installed in same. Estimated cost, $850,000. Noted July 28.

Pennsylvania

ELYSBURG- The Bd. Educ. is having plans prepared for the construction of a 2-story, 60x80-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. Richter Lee, 32 South 17th St., Philadelphia, archt.

JOHNSTOWN—The Peris Products Co. has purchased a site on Sheridan Ave., and plans to build a 2-story, 47x157 ft. factory for the manufacture of soap products. Estimated cost, $150,000.

PHILADELPHIA—The Electric Storage Battery, Allegheny and 19th Sts., has awarded the contract for the construction of a number of buildings, including a forming room, pig lead manufacturing building, jars and castings buildings, etc., to William Steele & Sons Co., 16th and Arch Sts.

PITTSBURGH—The Oliver Iron & Steel Co., 10th and Muriel Sts., has awarded the contract for the construction of a 2-story, 28x60-ft. water purification plant which will have a capacity of 20,000 gal. per hour, to the Cuthbert Bros. Co., Bessemer Bldg. Estimated cost, $35,000.

Rhode Island

PROVIDENCE—J. F. Concannon, Chalkstone Ave., has awarded the contract for the construction of a 1-story, 75x125-ft. laundry, to the Interstate Constr. Co., 29 Weybosset St. Estimated cost, $28,000.

PROVIDENCE - The Franklin Process Co., 29 Promenade St., has awarded the contract for the construction of a 2-story, 110x170-ft. dye house, to J. R. Bickford, 509 Westminster St. Estimated cost, $150,000. Noted July 28.

Tennessee

MEMPHIS—The Continental Piston Ring Co., 650 Marshall St., is building a 150x217-ft. factory.

Texas

HODGE- The Trans-Continental Oil Co. plans to build a wax plant here. Estimated cost, $750,000. W. S. Barwick, supt.

West Virginia

WHEELING—The city plans to install a mechanical filtration system. Estimated cost, $1,500,000.

Wisconsin

CEDARBURG—Fred Schuette, City Clk., will receive bids until Aug. 24 for the installation of 2 sewage disposal tanks, etc.

MILWAUKEE—The Eslein Sheet Metal Wks., 1001 30th St., will build a 1-story, 30x120-ft. sheet metal works addition on 30th St. Estimated cost, $8,000. Work will be done by day labor.

MILWAUKEE — The Patton Paint Co., 213 Lake St., has awarded the contract for the construction of a 2-story, 70x106-ft. varnish factory and a 60x112-ft. warehouse on Lake St., to the Amer. Contg. Co., 198 Milwaukee St. Estimated cost, $180,000. Noted July 7.

SHEBOYGAN—The Tomah Rubber Wks., 176 16th St., Milwaukee, plans to build a 2-story, 80x160-ft. factory for the manufacture of rubber goods.

WAUKESHA—The Waukesha Fdry. Co., 340 B'way, has awarded the contract for the construction of a 1-story, 120x300-ft. foundry, to the Federal Bridge & Structure Co. Estimated cost, $50,000.

WHITEFISH BAY—The city is having plans prepared for the construction of a sewage disposal plant, filter beds of sand and crushed syphons. Estimated cost, $20,000. Parsons & Orbert, 627 M. & M. Bank Bldg., engrs.

Alaska

UNALASKA ISLAND—The Amer. Whale Products Co., 8 South Dearborn St., Chicago, will soon award the contract for the construction of a whale oil plant along Udagak Bay. Plans include refining and fertilizer plants, oil tanks, etc. Estimated cost, $1,000,000. Woltersdorf & Bernard, 138 North La Salle St., Chicago, archts.

Alberta

ATHABASKA — Mackenzie Basin Fisheries will soon receive bids for the construction of a cannery along Black Bay, here. L. Baxter, Sidney, N. S., engr.

Cuba

HAVANA — The Anglo-Saxon Hospital, c/o Berlin, Swern & Randall, archts., 19 La Salle St., Chicago, is having plans prepared for the construction of a 5-story hospital. A chemical laboratory will be installed in same. Estimated cost, $600,000.

Ontario

BRANTFORD—The Cockshut Plow Co. will receive bids until Aug. 8 for the construction of a 70x200-ft. foundry and forging building. Estimated cost, $150,000.

GODERICH — The Town Council is receiving bids for the installation of an automatically controlled chlorinating plant. Mayor Wigle, Chn. of the Committee.

GRIMSBY—The Grimsby Pickle Co. will soon award the contract for the construction of a 3-story, 40x80-ft. pickle factory. Estimated cost, $40,000.

PETROLEA — The Adams Wagon Co. plans to build a 1-story, 70x200-ft. forge shop and is in the market for equipment for same. Estimated cost, $25,000.

SUDBURY—The Canada Creosoting Co. plans to build a 1- and 2-story creosoting plant. Creosoting equipment will be installed in same. Estimated cost, $50,000.

Quebec

MONTREAL—The Canadian Rubber Co., Ltd., Inspector St., has awarded the contract for the construction of a 1-story, 40x 50-ft. rubber factory on Notre Dame St., E., to George M. Martin & Co., St. Catherine St., W., Westmount. Estimated cost, $12,-000.

Industrial Notes

CANADIAN ABRASIVES, LTD., has been organized with a capital of $100,000, and ground has been broken for the erection of a plant which is to cost $50,000, on Mason St., Victoria. The Provincial Government, through the Department of Industries, has granted the company a loan of $22,000 at 6 per cent interest. The company will manufacture abrasive papers and powders from natural products. At several points in British Columbia there are extensive deposits of high-grade silica and garnet sands.

WILSON-MAEULEN CO., New York City, has appointed S. C. Horn representative for the Cincinnati district, with an office at 311 Commercial Tribune Bldg.

ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces recent sales of electric furnaces to Dodge, Carrigan & Favorite, of Philadelphia, Pa., and the Electric Steel Products Co., of Turners Falls, Mass.

HAMLIN & MORRISON, Philadelphia, Pa., announce the opening of a branch at 10 East Lexington St., Baltimore, Md., on Aug. 2, 1920, where they will specialize in sampling and weighing. All analytical work will continue to be done at the Philadelphia laboratory.

THE QUIGLEY FURNACE SPECIALTIES CO., New York City, has appointed W. A. Toohill sales representative for the Dayton, Ohio, territory. Mr. Toohill was for some years metallographist with the International Motors Co. at the Plainfield and New Brunswick, N. J., plants of that company.

THE KNOXVILLE IRON & STEEL CO., Knoxville, Tenn., is preparing to use powdered coal for puddling, busheling and reheating furnaces as well as for boilers to replace its present hand-fired method. Contract has been closed with the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City, for a complete system, including coal-milling plant and equipment for distributing and burning the pulverized fuel by the Quigley compressed air system. Work on this installation is to be started immediately.

THE CLEVELAND CRANE & ENGINEERING CO., Wickliffe, Ohio, is publishing a bi-monthly house organ entitled *Crane-ing*. This paper is an intentional effort to create immediate inquiries and subsequent sales for Cleveland cranes, and is a most interesting and well illuminated presentation.

MEIGS, BASSETT & SLAUGHTER, INC., chemical engineer, 210 South 13th St., Philadelphia, Pa., has taken over the interest of Dr. Samuel P. Sadtler in the firm of Samuel P. Sadtler & Son, analytical and research chemist, and has incorporated the same as Samuel P. Sadtler & Son, Inc. Dr. Sadtler is retained as the expert consultant and S. S. Sadtler has been made president, Dr. H. P. Bassett and B. G. Slaughter vice-presidents, and C. C. Meigs secretary and treasurer.

W. S. QUIGLEY, president of the Quigley Furnace Specialties Co., sailed for Europe on the Cunard liner Imperator on July 15. His trip is for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

THE ANGELUS HEEL & RUBBER CO. is installing new equipment in its factory at 1417 N. Main St., Los Angeles, and in the near future expects to begin the production of rubber tubing, stopples, etc., for the drug and chemical trade of the Pacific Coast. The present output consists chiefly of mechanical goods, especially rubber soles, heels, and valve disks. W. E. McCarty is president and general manager and Emmet Long is factory superintendent.

NEW YORK TESTING LABORATORIES, L. R. Seidell, managing director, has been awarded the contract for the chemcial, physical and electrical testing of approximately 400,000 ft. of fire alarm telegraph and police signaling cable, and wire by A. E. Roche, engineer, for the City of Troy, the inspection being under the supervision of G. Brinton Jack, Jr., director of inspection and tests.

Manufacturers' Catalogs

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., is issuing a new two-color, 24-page booklet on elevator controllers. This booklet, which is known as Publication 840, illustrates the new controllers and emphasizes their simplicity, quiet operation and smooth acceleration. Carbon-to-copper standardized power contacts are used, which are interchangeable on a.c. or d.c. controllers of the same rating. Acceleration is obtained by time limit relays of simple design, which furnish the same comfortable smoothness of acceleration in spite of widely varying load conditions. The last few pages are devoted to auxiliary apparatus for use with elevator controllers, which includes reversing switches, floor selectors, various limit switches, car switches and door switches.

THE GRISCOM-RUSSELL CO., New York City, calls attention to Bull. 1111, entitled "Stratton Air Separator," which tells of the successful removal of water from compressed air.

YARNALL-WARING CO., Philadelphia, Pa., has published a folder description of its Yarway pipe-joint and Yarway holtite pipe clamps. It will gladly furnish copies of the folder upon request.

P. H. & F. M. ROOTS CO., Connersville, Ind., has just received from the press Cat. 68, 2nd edition. This attractive 48-page booklet gives descriptions and illustrations of the many types of blowers for foundry cupolas, steel converters, oil furnaces, gas appliances, filtration and agitation, and also tables of sizes of the blowers.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

New Publications

THE FOREST PRODUCTS LABORATORY, Madison, Wis., announces the following circulars for distribution: Key for the Identification of Native Woods Used for Chairs and Other Furniture; 12 pages and appendix. Glues Used in Airplane Parts; 28 pages, illustrated; report No. 66, prepared for the Naval Advisory Committee for Aëronautics, 1920. The Effect of Kiln Drying on the Strength of Airplane Woods; 69 pages, illustrated; report No. 68, prepared for the Naval Advisory Committee for Aëronautics. Drying Lumber by Means of Superheated Steam; 1 page, with diagram of kiln; reprint from lumber journals. Suitability of Cotton Hull Fiber for Paper Manufacture; 6 pages, 1 chart; reprint from trade journals, April, 1920. Information for Dry Kiln Operators on Drying Hardwoods for Furniture and Similar Products; 14 pages with charts and tables.

THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH of the University of Pittsburgh has issued its seventh annual report on the Industrial Fellowships of the Mellon Institute, by Raymond F. Bacon, director.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Suggesting the Old Divining Rod

THE DESIRE to detect the presence of valuable mineral deposits in the earth without engaging in the arduous and expensive task of digging for them has always appealed to men, whether engaged in mining or not. Knowing that ores and minerals of fabulous value have been located and uncovered by one means or another, it is not surprising that human ingenuity should be requisitioned in an effort to "see into the ground" and thus gain a substantial advantage in locating needed materials and acquiring wealth. Thus we have run the gamut of devices from the divining rod of the charlatan to the more pretentious and reasonable machines for measuring electrical resistance in parts of the earth's crust. The common characteristic of all of them is that they do not "work." That is, no important and valuable mineral bodies, metallic or non-metallic, have been located by their use, save only extensive magnetic surveys to fix the approximate position of large superficial deposits of iron ore.

But hope springs eternal; and where should it be more aspiring than in Germany? Reduced to financial straits and having to rely mainly on economic resources with which to pay her bills and rehabilitate her industries, what more natural than that her subjects should turn to ready means of discovering hitherto unknown mineral deposits within her borders? And since physical exploration takes time and money and offers no certainty of result why not devise means for doing this from the surface and thus steal an economic march on the rest of the world?

Comes now therefore out of Germany "processes and practical means . . . developed to a high state of perfection for definitely locating many mineral and non-mineral deposits in the earth, from above ground." We confess to skepticism. It sounds suspiciously like the "stannophone" which excited so much merriment at the last New York meeting of the A.I.M.E., and by means of which the presence of tin in the earth's crust could be detected by the "cry" of the metal.

But in this case our interest is held and our skepticism perhaps modified by assurance on the part of a responsible investigator that he has "investigated the matter most thoroughly for several weeks," and further, that he has "gone to great pains to have some particular indications of the apparatus checked by borings." We let Mr. HOLZ speak for himself elsewhere in this issue in a letter which he has written from Germany. His opinion and judgment in other matters have been sound and have commanded respect. He has sponsored useful scientific devices well known in the metallurgical world. Whether he has been deceived in this instance remains to be seen, and we shall wait with interest for further developments.

The Engineer And His Thinking

AT THE organizing conference of the Federated American Engineering Societies held in Washington last June one of the speakers referred to "the kind of thinking" of the engineer. Not once, but many times, was the phrase reiterated, in varied form, until it became the theme of the speaker in his argument for the recognition of the engineer, scientist and technologist as a potent but neglected force in public affairs. "It is the engineer's thinking for which he seeks recognition, as well as his works." The phrase is worthy of closer inspection and analysis. What is the engineer's kind of thinking? How does it differentiate him from his fellow citizens; from lawyers, financiers, business men, merchants, clerks, the men on the street? What leads him to do his kind of thinking? And what is, or would be, the value of bringing that kind of thinking to bear on public affairs?

A man's habit of thought is the product principally of his environment -of his associations, training and experience. Out of them he acquires a characteristic viewpoint that determines his activities and modifies his opinions. From them he gets his ideas of efficiency, responsibility, fitness, integrity and reliability, all of which affect his usefulness as a citizen as well as his worth in his occupation. Measured by this yardstick let us see what kind of thinking we may expect from the engineer.

His training and education bring him early into contact with the inexorable laws of nature which are the foundation of his later work. With these he may not trifle and yet gain success. No amount of brilliant and clever argument will enable him to ignore the simplest laws of physics and mathematics. If he were not inherently honest he would soon become so or retire as a failure in his profession. Facts must be faced; materials of construction must be used for purposes for which they are best fitted; efficiency must characterize the performance of a machine; analysis must prevail instead of guesswork; tradition must be abandoned in favor of absolute knowledge; reason must prevail and law must be obeyed. The whole preparation of the engineer for his professional work makes him exact, precise, honest, efficient, unshackled by tradition, aggressive in attacking a problem, sound in analysis and judgment, and fearless in execution.

All of these are splendid traits and qualities for citizenship and government as well as engineering. In fact we are beginning to recognize government as a vast engineering undertaking, in which the fitness and integrity of men are fundamental necessities. By his training the engineer will bring a broader mind to bear on public problems than will the lawyer, financier or merchant. He will select men with much the same

care and investigation that he selects materials. He will demand efficiency and good management, because those things are essential to successful business, and government is the greatest business of all. He will excel at organization and management, for these elements are primary in his scheme of things. And when it comes to great public works which are essentially engineering there is no argument as to the necessity for technical control and direction.

The engineer's kind of thinking fits him for almost any position in our scheme of government, unless it be in the judiciary; and even there we have increasing evidence of the need of technical advice. But certainly in the executive and legislative branches of government the engineer can find a widening field for his services. Officials, boards and commissions are in growing need of his advice and counsel. Civilization is becoming more complex, research and investigation are bringing to light things unknown to the non-technical citizen, and government is demanding wider and more comprehensive knowledge. Respect for law and order, which lies at the very basis of the engineer's training, is the imminent need of the world. These are the things for which the engineer's kind of thinking fits him, and to which he can bring a new and valuable force in his capacity as a citizen and government official.

State Ownership of Radium in New York

THERE are several interesting phases to the recent purchase by the State of New York of two and one-quarter grams of radium salt valued at $225,000. In the first place, it is the first instance in the United States of public purchase and control of a therapeutic agent. But more important, perhaps, it marks the conservation for domestic benefit of a resource that our country was in danger of squandering; New York's supply of radium was produced from carnotite ore mined in Colorado and refined in New Jersey. Further it is an example of public benefaction in the interest of all the people, after years of experiment which demonstrated fully the value to the substance as a cancer cure.

Of the therapeutic value of radium emanations in the treatment of cancer we have no doubt. The testimony of eminent physicians is in accord on that subject, and in the past few years there has been a sufficient quantity of radium available in several hospitals to make experiments in large numbers. Private philanthropy in co-operation with federal agencies was hitherto largely responsible for making available substantial quantities of radium—much more than private practitioners could afford and more in one lot than was collected elsewhere. It has remained for New York, however, to take the step which it has long been evident must be taken by either state or federal governments if the people are to benefit materially and quickly from this great natural resource. And while New York has made the purchase for the benefit of all the people and will extend service gratuitously without regard to state residence, other states should follow her example. It is known that the resources the of the United States in radium are limited; and the world's supply, for that mátter, is not large. And if all that has been and will be produced were to be applied to scientific and medical purposes, it would still be an expensive substance calling for Government purchase and control. The use of radium in the arts is inconsistent with its value and should be discouraged.

Iron and Steel Export Trade

THERE are various ways of looking upon the matter of iron and steel export trade. The worst way is to consider it a means of relieving ourselves of surplus product, or of "dumping" the tonnage needed to enable the iron- and steel-making industry to operate at capacity, so that the production cost of the entire tonnage may be reduced. "Dumping" was developed by the Germans as a system prior to the war; at no time was it a settled policy of American manufacturers, though to a limited extent it was practiced in a few of the years of the last decade of the nineteenth century. As a rule our iron and steel exports rise and fall much as our production fluctuates, whereas if we were exporting for the purpose of working off surplus product or engaging surplus capacity exports would fluctuate inversely to the fluctuations in domestic demand.

From the national economic standpoint iron and steel exports may be viewed as helping greatly to make up our merchandise trade balance. The iron and steel exports reported for the fiscal year ended last June amounted to $933,000,000, while our imports of iron and steel, including iron ore, totalled $39,000,000, showing a favorable balance in iron and steel of about $900,000,000. In all merchandise our favorable balance was $2,873,000,000. Thus iron and steel may be said to have contributed almost one-third to the country's trade balance. While the criticism might be made that a favorable merchandise trade balance is not an unalloyed blessing at this time, much the same sort of comparison could have been made in the pre-war years, when the merchandise balance was absolutely essential.

After all, however, the nomenclature of statistics may be productive of misconception. What are "iron and steel exports"? They represent the commodities the Bureau of Foreign and Domestic Commerce has designated as to be included under the heading "iron and steel." There are included such diverse materials as scrap and wire nails, pig iron and enameled bath tubs, rails and typewriters. Now it is perfectly true that typewriters are made chiefly of iron and steel, but these materials also enter largely into the manufacture of passenger automobiles and trucks, which are not returned in the official statistics under iron and steel. Magnetos and transformers are also made chiefly of iron and steel, but they are not reported as such, being included with "electrical machinery and appliances," whereby they take their place, properly enough, with incandescent lamps, batteries, insulated wire and spark plugs.

We exported 553,860 gross tons of steel rails in the last fiscal year, which was certainly quite a tonnage, but the value assigned, $32,000,000, was just on a par with the value of our exports of gasoline engines and fell short of the value of the steam locomotives exported.

From the economic viewpoint, which is what really counts, it makes a great difference whether an exported commodity represents largely minerals which are of low value in the exporting country but of high value in the importing country or represents chiefly the product of labor. A common view is that we ought to export the products of our labor and keep our mineral resources for ourselves, but it is quite unsafe to generalize. We have trillions of tons of coal in the ground and Italy has practically none. Why should we be indisposed to sell coal to Italy, but, on the other hand, sell to Italy

annually millions of dollars' worth of engines and typewriters? The essence of international trade is that of exchange. We should export what we can produce most readily, whether it is a rail or a typewriter, and import what we find it most difficult to produce. Rails and typewriters are totally different things, even though the statistics put them both in as "iron and steel."

Courts of Law Err Through Lack of Knowledge

INSIDIOUS pleadings by lawyers in chemical patent cases and consequent decisions by misled judges are establishing mal-traditions which will work many wrongs in future cases. It is now said that "analogy defenses to novelty are substantially excluded in chemical cases."

A review of several cases shows that the courts hold that "reasoning by analogy in a complex field like chemistry is very much more restricted than in a simple field like mechanics"; that "chemistry is essentially an experimental science and that chemical prevision is as impossible today as it was in former times"; that "in chemistry you almost entirely fail to predicate the result—it is a mere question of result from experiment." Another court submits that "a machine which consists of a combination of devices is the subject of invention, and its effects may be calculated *a priori*; while a discovery of a new substance by means of chemical combinations of known materials is empirical, and discovered by experiment." Still another states that "analogy does not go a long way in chemistry."

Chemistry is an exact science and the field is quite readily predictable. The judges are confusing chemistry with the cookery practiced by the old alchemists. Were this attitude of the courts correct, the manufacturer of synthetic nitric acid, for instance, might hold patents for all reactions his product undergoes with other compounds, although easily predicted through the action of nitric acid made from Chilean saltpeter. The great mass of development work done in recent years is based on prediction by the research chemist.

Surely our modern scientists will not stand idly by while the judiciary calmly classifies present-day chemistry with the alchemy of the obscure ages, and through decision based on tradition brings disaster to important industries.

Materials Handling Section of the A.S.M.E.

LAST week the initial meeting of the Materials Handling Section of the American Society of Mechanical Engineers was held in New York. ROBERT M. GATES, who has been most active in organizing the Section, stated that it must be a bureau of information—complete in its scope, specific in its knowledge of the physical and economic conditions and unbiased in its conclusions. This is to be done by having special meetings on particular subjects, meetings jointly with other sections, other organizations or associations, by taking part in all local and national problems relating to the purpose of the Section.

An invitation has been extended by Mr. ROTH to the Section to take over the Materials Handling Symposium to be held at the Chemical Exposition on the twenty-second of next month. In doing this the Section will perform its greatest function in bringing together the men who design the equipment and those who use it. F. M. FEIKER, in his address before the Section, emphasized the fact that it was not an interdiscussion among the engineers themselves on materials handling that was needed but the propagation of the best thought on these problems throughout industry. To do this in the chemically controlled industries, in our opinion, the Section can find no better medium than the Symposium to be held at the Exposition.

Considerable discussion was brought forth on what the scope of the programs should be. Some thought the limit should be set at studying the broad, underlying principles, some believed the matter should be taken up in the smallest details, and others thought the human element should be considered the center about which everything revolved. There is no doubt that materials handling embodies a problem having numerous factors and disregard of any one of them is apt to give bad results. However, it is probable that these factors will have to be pulled loose, picked apart and studied individually before any comprehension of the composite whole can be had.

In Support of the Chemists' Club Library

LIBRARIES are the hallmarks of culture in our modern civilization, evidences of enlightenment, badges of learning, signs of national appreciation of art and literature. Among cultivated people they are supported with scrupulous care; under bolshevism, on the other hand, we are told, libraries are the first public institutions to suffer neglect and abandonment. The comment is significant.

Some time ago we raised our voice in the interest of libraries as important factors in the industrial development of cities and the regions surrounding them. Our reference at that time was particularly to the western part of the United States, but it applies with equal force, to the East. Accordingly we are glad to lend our support to the appeal of the Chemists' Club library in New York City for funds with which to enlarge and extend its service to the chemically controlled industries of this country, and particularly in the metropolitan district.

There is no adequate measure of the value of a first-class complete chemical library, and aside from that of the Chemists' Club there is none in the United States worthy of the name. The Club is the logical custodian of such a library, and the industries in the metropolitan district are equally the logical beneficiaries of it if they will make use of it. It is estimated that 35 per cent of the chemical industries of the United States are located within commuting distance of New York, and it is inconceivable that their work can be conducted efficiently and profitably without tho aid of the best library that it is possible to bring together. Only those who use a library constantly can realize how it supplements the laboratory and the plant. As evidence of the service which a complete chemical library can render, it is cited that the German Reichsanstalt, before the war, was able to answer directly from the literature about 80 per cent of the industrial problems submitted to it. The cost doubtless was insignificant in comparison with the expense that would have been involved in duplicating researches and investigations that had already been made. In urging the chemical industries to respond to the appeal of the Chemists' Club, we feel that we are presenting an opportunity for service to themselves.

Readers' Views and Comments

Is Synthetic Petroleum Possible?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Of the many great problems now confronting the world probably none is greater than that of providing a bountiful and cheap supply of petroleum. The petroleum of the United States is now rapidly approaching exhaustion. What supplies may be hidden in the other parts of the world are as yet unknown, but in any event the cost of petroleum to the people of the United States must necessarily increase and go very much beyond that heretofore experienced. Sir E. Mackay Edgar last spring predicted that in ten years the United States would be buying from England 500,000,000 bbl. of oil annually. If this should occur the price to be paid would certainly be $10 or more a barrel, which would make the price paid by our people a fabulous sum.

When it is known that petroleum is composed of approximately 80 per cent carbon and 20 per cent hydrogen, also the ease and cheapness with which these elementary substances can be procured, one naturally considers the possibility of producing petroleum synthetically from those elementary substances. In the belief that man is capable of so handling elementary materials as to form or produce any product that Nature has produced by the association of elements, the problem of the production of petroleum does not seem to be insurmountable.

To solve successfully the problem of the synthetic production of petroleum it is, of course, necessary that we have a starting point. The labor and time necessary for the accomplishment of the feat will be shortened by a thorough investigation of Nature's method. In the oil shales of Colorado, Wyoming and a number of our Western states it is conceivable that we have a starting point for this investigation. We have reasons for believing that the shale as removed from the earth does not contain petroleum, this product being produced by application of heat to the rock. Evidently Nature has so associated the carbon and hydrogen within the rock that the simple act of heating will cause their union in such manner and proportions as to produce petroleum.

There are throughout the United States many chemists who unquestionably would devote study to this problem if it were properly brought to their attention. Many of them have never seen a sample of oil shale nor are they situated so they can procure samples, but should the U. S. Bureau of Mines distribute liberal samples of the oil shale among chemists of the United States, with the suggestion that they endeavor to solve this all-important problem, it is not beyond the bounds of probability that within a very short period this question of the future supply of petroleum would be solved to the immense benefit of the American people.

Many suggestions are now being made that a substitute for gasoline be found. Much attention is also being devoted to the extraction of petroleum from our great deposits of oil shale in the Western states. The Government itself is devoting much attention to these important subjects, but should this problem of the synthetic formation of petroleum be successfully solved in a thoroughly commercial manner all of these vexing questions would be settled. In fact, the results attained might extend beyond the fields we ordinarily consider as those belonging to petroleum. It is not at all visionary to believe in the possibility of causing carbon, from any of the many sources from which it can be obtained, to combine with hydrogen and create petroleum at sufficiently low cost and in sufficient abundance to be used as a liquid fuel. Such a fuel would use our carbon supplies in a much more economical manner than is now being practiced, as for instance where it is burned under a boiler for the generation of steam for power production with a loss averaging more than 85 per cent of the fuel value of the coal.

New York, N. Y. EDWARD G. ACHESON.

Post-War Progress in Germany

To the Editor of Chemical & Metallurgical Engineering

SIR:—A careful survey of the metallurgical, chemical and electrical engineering progress in Germany during the past six years shows nothing new of importance to the U. S. A. The large manufacturing plants and research laboratories had to concentrate during that period entirely on war work and on the creation of substitutes for materials which were not obtainable on account of the blockade.

Nearly all the substitutes which were developed, mostly by the chemical industry, are of no value in peace times, especially since the cost of producing them is higher than the world market value of the genuine article. In some rare cases, where the real product can be purchased only in foreign countries and the substitute is manufactured in Germany at approximately the same price, the tendency still prevails to give the preference to the domestic substitutes, because Germany is forced to keep down to a minimum her importations and her payments to other nations.

An example of this kind is the paper textile industry, which was created during the war and is still quite active. Burlap from India ceased to come in soon after the beginning of the war in 1914, and millions of bags were sorely needed for the transport and storage of cement, sand and all kinds of products. Germany is still producing bags of paper thread and of a mixed burlap and paper thread that looks very much like the real article but does not stand the wear and tear of burlap, especially when moist. I do not believe that such paper bags or the German paper twine would ever be used in America. However, the German paper industry produces very nice rugs, colored in all shades and patterns, wall covering, table covers, window shades and similar articles, artistically decorated, very cheap and sanitary, perfectly satisfactory for the purpose. This industry may outlive the return of normal times.

Another industry which has come to stay in Germany is the manufacture of synthetic ammonia by the Haber process, the only one which permits the economical production of this material independent of the necessity

of cheap electric power. The large German aniline concerns are even at present increasing the capacity of their ammonia plants, not only in order to make Germany independent of foreign sources but especially to be able to export the material and to help pay the big bill.

Wonderful progress—entirely independent of war work—has recently been made in Germany in the utilization of physical forces about which theory still knows very little:

Processes and practical means have been developed to a high state of perfection for definitely locating many mineral and non-mineral deposits (ores, coal, salts, oil, gases, water, etc.) in the earth, from above ground, for accurately determining the position, depth, width and thickness of each such deposit, and for differentiating between the various materials forming the deposit.

The last named feature is of utmost importance; thus if the apparatus is adjusted for lead it is acted upon only by lead, and by nothing else and the number of materials it can be adjusted for amounts to over 100 and is constantly being increased.

Thoroughly practical and reliable apparatus has been developed for this purpose and is already being used with wonderful success in central Europe. Since very little gold is in the treasury of the new German Republic all the payments of billions of marks we hear so much about have to be made in coal, potash, metals and other contents of the earth.

The apparatus mentioned offers unlimited possibilities for locating new fields of mineral deposits and shifts the responsibility onto the laborer to get the stuff out of the German ground, which is full of valuable material. Very large deposits of oil, potash, coal, asbestos, etc., are present in Germany, the majority entirely untouched, and as a matter of fact they will not be touched until Germany knows definitely the amount of the bill it has to pay.

I have investigated the matter most thoroughly for several weeks and have gone to great pains to have some particular indications of the apparatus checked by borings. I have worked with the apparatus personally for quite a time and have also investigated the excellent work the inventor and his staff is doing right along for many prominent mining concerns and the government railroads.

What interests Americans much more than the results of these activities in Germany is the economic importance of such an invention to the United States. Certainly it should be carefully investigated by some governmental agency, and if what seems to be its everyday performance can be transplanted over the ocean, when in the hands of an ordinary field party, then the invention should be acquired by the United States Government.

The entire country could be surveyed, under the joint supervision of the United States Bureau of Mines and the United States Geological Survey, and the United States Government could then grant licenses to operating companies on a royalty basis.

If a practical working arrangement between the United States Government and the operators can be established—and there is no reason why this should not be the case—the financial returns to the Treasury would of course be immense. HERMAN A. HOLZ.

Berlin, Germany.

Phosphate and Manganese Production in the Society Islands

Phosphate is the only mineral produced in or exported from the Society Islands. It is produced and exported by one company, the Compagnie Française des Phosphates, a French corporation with head offices in Paris, and with a capital stock formerly of 6,000,000 francs, all French owned, except for a relatively small amount held in Tahiti. The capital stock is now 11,000,000 francs. This concern, organized in 1908, has the exclusive mineral rights of the island of Makatea, which is about 120 miles north of Tahiti and has an area of roughly 1,200 acres. Two piers about 300 m. long, a part of which length, however, is on shore, have been constructed. Mooring buoys and lighters are used by the loading vessels.

MINING PROCESS IS SIMPLE

The phosphate, as exported, is virtually the soil itself, which is dug with pick and shovel and loaded on cars on a short narrow gage railway and drawn to the works, where it is put through crushing and drying processes. It is sold on a moisture percentage basis. After going through the drying process the product is stored in bins awaiting shipment. Most of the machinery used is of French manufacture.

At the present time nearly all the phosphate is exported to New Zealand. Before the war much of it went to San Francisco, some to Europe, particularly France, and a considerable quantity to Honolulu. It is expected that in the future the product will recover the markets of the pre-war period.

PHOSPHATE PRODUCTION

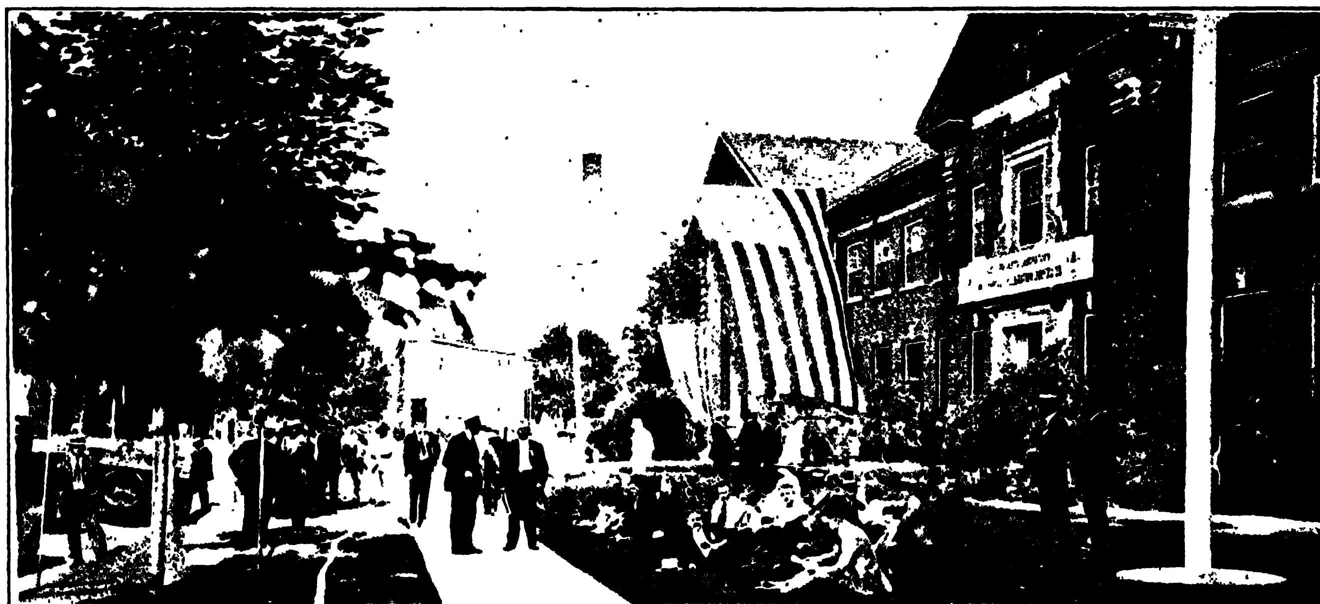
The phosphate soil shipped runs about 80 per cent phosphate, according to the statement of the manager of the company. Before the war the annual production was from 80,000 to 90,000 metric tons. In 1919 the production was approximately 40,000 metric tons, and it is reasonable to expect that the production will rapidly increase.

LABOR PROBLEM RESTRICTS PRODUCTION

The great difficulty encountered in this enterprise, as in all enterprises in this colony, is the difficulty of procuring suitable labor. At present the company employs about 500 workmen and employees, many of whom are Japanese. The French Government has recently enacted a decree providing for the importation of foreign labor, and fixing the conditions of such importation. It remains to be seen whether it will prove profitable to import such labor under the conditions prescribed but the probabilities are that it will, at least for the phosphate company.

MANGANESE INVESTIGATIONS UNDER WAY

There is one island in the group which is known to contain manganese deposits. The owner of the mineral rights has engaged engineers to make an exhaustive investigation, and within the next three or four months it will probably be definitely determined whether there is manganese on this island in paying quantities and whether it can be profitably mined and exported. As matters stand now it is purely a matter of speculation as to whether manganese will be a commercial factor in the colony.



Decennial Celebration Forest Products Laboratory

An Account of the Two-Day Meeting at Madison Celebrating the Decennial Anniversary of the U. S. Forest Products Laboratory—Greater Co-operation on the Part of Industry Asked—National Forest Problems Discussed

EXTENSIVE conservation of our national wealth of wood through more efficient utilization was the keynote sounded throughout the decennial celebration at the Forest Products Laboratory at Madison, Wis., July 22-23. More than 200 visitors from all parts of the country were present, representing every line of wood-using industry, including fifty-nine wood-using associations and companies, eighteen lumber manufacturing associations and companies, the deans of twelve forestry schools, the United States Forest Service, and other visitors and friends. They came to pay tribute to the laboratory's ten-year record of service to American industry.

The opening session of the gathering convened in Agricultural Hall at 10 o'clock on the morning of July 22. H. F. Weiss was chairman. The program of addresses included Mr. Weiss's introductory remarks; "Legislative Measures for Forest Conservation," by Governor Philipp; "Translating Knowledge Into Power," by President Birge of the University of Wisconsin, and "The Fcrest Products Laboratory," by C. P. Winslow, present director of that institution.

After luncheon the program continued with inspection of the work and exhibits of the laboratory. Guides in charge of small parties showed the visitors the various lines of endeavor in which the laboratory is saving millions of dollars a year to the people of the country. Following the inspection trip was a period for recreation consisting of automobile tours around the city, boat rides, and swimming.

Nearly 500 prominent lumbermen, manufacturers and users of forest products, and members of the Forest Products Laboratory attended the banquet in the evening. Burr W. Jones presided as toastmaster. Lieutenant-Colonel W. B. Greeley, Chief Forester of the United States, spoke on "Forests and National Prosperity." Following the address of Colonel Greeley, Max Mason, research specialist of the National Council of Defense, gave an illustrated talk explaining in detail the submarine detector which he perfected during the war and which was successfully used in European waters.

At the Friday morning session John Foley, forester for the Pennsylvania Railroad, was chairman, introducing the speakers as follows: D. C. Everest, secretary and general manager Marathon Paper Mills Co., "Some Problems of the Pulp and Paper Industry"; H. E. Howe, chairman research extension division National Research Council, "America's Place in Industrial Research"; and W. A. Gilchrist, representing the National Lumber Manufacturers' Association, on "Some Problems of the Lumber Industry."

Mr. Weiss Urges Greater Co-operation

"The tendency of the time, I think, particularly on the part of Government and industry, is for these two to work too much apart, this being due largely to a lack of familiarity with each other," said H. F. Weiss, chairman of the opening session, in his introductory remarks. "I believe it is particularly necessary for the Government and the industries to co-operate more wholeheartedly if our country is to play a prominent part in the commerce of the world. In the Forest Products Laboratory the Government has established an institution which is doing much direct good for all of the wood-using industries and indirectly is doing good for all of us, because all of us use wood in some form or other."

Mr. Weiss then introduced the first speaker of the morning, Governor Philipp of Wisconsin.

"Nature would have been a great conservator of

forests if she had permitted trees to grow square rather than round," declared Governor Philipp during his reminiscences of the wasteful methods of the earlier days of the lumber industry.

"It is unfortunate for the country and unfortunate for the timber supply of the country that there was not some control even back in the '60s and '70s, when the great timber supply was here, that there was not some supervision that compelled the use of what we at that time regarded as the class of timber that had no commercial value for purposes to which it could be put and save the high-grade timber—the timber that we need so much today—for the future. But somehow our forefathers did not foresee it. We will not blame them."

Reforestation a National Problem

Concerning an advisable policy of reforestation Governor Philipp said: "This state has had some experience in reforesting. We have attempted, and we have made an honest attempt, to replant some of our cut-over timberlands. Now I have this to say about it. As a state policy it is not a possible thing today.

"The cost of the land, the cost of planting, the cost of the care that the plant needs, the taxes that the state loses provided it reserves this land for forestry purposes, make the price, if we compute it up to the time that the trees might become merchantable, so high as to make it an impracticable thing. Nor is it, in my judgment, a state duty. Let us assume that the state of Wisconsin would plant in the northern part of our state a million acres of young pine. I do not know what it would cost to do it, nor does anyone else know. The best we could do is to make an estimate which would be liable to be wrong, but we would have to wait at least fifty years before we could get any merchantable timber. Now when that timber comes into the market it is not for the state of Wisconsin alone. If it were it would not be a supply for the country, and what we need is a supply for the whole nation. So then those who agitate that the state ought to undertake reforestation would do it upon the basis that it is a state duty merely because we at one time had a forest, and that those states that at one time had forests should now undertake this great business proposition, this great speculative investment, in order that the whole country might have a timber supply. That does not appeal to me. It is not a state duty, it is a national duty. The National Government should recognize it promptly and take hold of the future supply in an efficient manner. The timber supply of the future, the one which is produced, should be the supply of the entire country, and whatever it costs should be the expenditure of all of the people."

Purpose of Forest Products Laboratory

President Birge of the University of Wisconsin emphasized in his remarks the fact that during the last few decades the need had become apparent for a different type of institution, of which the Forest Products Laboratory is an excellent example. The speaker developed the idea that this organization is engaged in assimilating vast stores of technical knowledge accumulated to such an extent that no one man can grasp it all; and of translating these stores of knowledge into power that energizes industry and enables greater things to be done by better and less expensive methods.

Director C. P. Winslow, in speaking of the purposes and work of the laboratory, illustrated the manifold uses of wood in connection with the everyday life of the people. He brought out the great problems of conservation and utilization of forests, of cut lumber and of finished product. He stated that it was the broad purpose of the Forest Products Laboratory to aid the nation in solving these problems.



SPEAKERS AND EXECUTIVE COMMITTEE

He said in part: "The Forest Products Laboratory is called an institution of industrial research. Its object is to acquire, disseminate and apply useful knowledge of the properties, uses, and methods of utilization of all forest products. This is a broad field of almost unlimited scope—the surface has as yet been but partially scratched."

Mr. Winslow gave statistics showing by conservative estimate that the work of the Forest Products Labora-

tory effected an annual increase in production and decrease in waste aggregating $30,000,000. These figures, the speaker said, should prove the value and importance of industrial research.

In concluding, Mr. Winslow indicated the immense program of work yet to be undertaken by the laboratory, saying: "The Forest Products Laboratory is the only institution of organized research engaged upon the problems of these industries, and those problems yet untouched and unexplored are many and of far reaching importance. What, for example, of the possibilities which may result from the development of permanently durable and water-proof glues or adhesives and their application to the use of material too small or of too poor a grade for other service—what of their application to forest economics through the increased value thus given to small second growth material? What of the sulphite pulp liquor problem involving the possibility of utilizing the 55 per cent of the wood fed into the pulp digesters and now lost in the waste sulphite liquors? What of the problems of packing, boxing, and crating of various materials and commodities for shipment and transportation when conservative estimates show a possible theoretical annual saving to the country of $300,000,000? What of the need for improvement and the method of treatment and handling of piling and dock timbers in water infested with marine borers which destroy the piling within eighteen months after placement and cause an annual replacement aggregating millions of dollars in the various harbors of the nation? What of the waning supply of hardwoods and the need for authentic knowledge of the properties of South American and other foreign woods as compared to those of our own country for which they may ultimately be needed as substitutes?"

Conserve and Grow More Forest Products

Lieutenant-Colonel Greeley contrasted the extensive and often wasteful use of wood in this country with the frugality and care with which France conserves her very limited supply of lumber, and he praised the industry and foresight of a people who could build up within an area less than that of our largest state the great industrial nation that France is today.

"The lesson which such things brings home is, in a broad way, the same fundamental truth which underlies many economic problems of the present time—not alone those of America but of the whole world as it strives to get back to normal industry. It is an old and simple axiom. Aside from the will to work which is the foremost quality of any strong nation, its economic and social progress depends in the long run upon the foresight and efficiency with which its natural resources are used."

The speaker showed by statistics the extensive use to which wood has been put in this country and the urgent need of a yet greater supply—the need on the farm, in building houses, in our paper industry, on our railroads, in boxing and crating our commodities, and in our factories.

He spoke also of the diminishing supply of wood, stating that three-fifths of the original supply of timber in the United States is gone and that every year we are taking out of our forests four times the amount of wood that we are growing in them. Moreover, the availability of the remaining timber is rapidly becoming less. Half of the remaining timber of continental United States, Colonel Greeley says, is in the three states bordering the Pacific Ocean. And the true index of timber depletion is not the quantity that is left but its availability.

Colonel Greeley indicated the reason for our decreasing wood supply and the cure for it as follows: "The real cause of our timber depletion is idle forest land. The area of idle or largely idle land is being increased by from three to four million acres annually as the cutting and burning of forests continue. The enormous area of forest land in the United States not required for any other economic use, estimated at four hundred sixty-three million acres, would provide an ample supply of wood if it were kept productive. Depletion has resulted not from using our timber resources but from failure to use our timber-growing land.

"The answer to the forestry problem of the United States is not to use less wood but to grow more—to put our idle acres of burned and logged-off timber land at work growing trees. This is not inherently a difficult thing to accomplish. It is not the Utopian dream of a technical enthusiast. Three-fourths of it lies in preventing forest fires. But it does require an aggressive national policy of reforestation. It requires concerted action by the national and state governments to do the things which must be done by public agencies. It requires the active participation of the private forest owner. It requires a clear definition of public and private responsibilities as to timber-growing land, with an equitable showing of the cost. There is no phase of our whole problem of an assured and perpetual supply of timber that cannot be met by simple and obvious measures once the constructive effort and capacity for organized co-operation of the American people are put behind them."

Greater Support Needed

"If the Forest Products Laboratory is to be of the greatest possible assistance to the pulp and paper industry closer co-operation must exist with the mills, for the final test of any laboratory trial must take place in the mill," remarked Mr. Everest, in discussing several problems of the pulp and paper industry. "Too often information vital to the successful prosecution of a problem is withheld or full and hearty co-operation is lacking. If the mills refuse to give the laboratory their full confidence and at the same time maintain a critical and unsympathetic attitude but little real progress con be made on those problems in which the industry is vitally interested. If, however, they look upon the laboratory as a part of their own organization and treat it as such, correcting its mistakes and commending its successes, the greater portion of any research problem is already solved."

Mr. Everest spoke of the valuable assistance the laboratory is rendering in solving the manifold difficulties confronting the pulp and paper men in these days of decreasing supply of timber and increasing price of labor and the appliances of manufacturers. He believed that inadequate support was being given.

In conclusion he said: "We need this laboratory. Private enterprise cannot buy such facilities and conditions. You who have been privileged to see and know what is being done here must realize that if we are to solve our technical problems relating to timber, its care, perpetuation and proper use we must back this laboratory to the limit, either by inducing Congress to adequately provide for it or by individual subscriptions if necessary."

Prevention of Fires and Explosions in Coal-Tar Chemical Works*

BY NICHOLAS RICHARDSON†

THE problems for the fire prevention engineer in chemical works, and particularly in the synthetic dye industry, are new, peculiar and difficult, and it does not appear that expert chemical directors or advisers give sufficient attention to the accidents that may occur even in well-thought-out processes due to numerous causes which sometimes are foreign to the purely chemical nature of the operation. To one who has had opportunities of observing a wide range of operations and has particularly noted accidents occurring in many processes that were considered non-hazardous by men of experience, many features present themselves that are lost sight of by the man who has concentrated on a few lines only. Although a process may be non-hazardous in its normal operation, failure of mechanical devices to function properly, and unforeseen irregularity in the materials used, may result in hazardous conditions not contemplated.

The following remarks are quite apart from a question of insurance rate, or underwriting considerations, and attempt only to suggest lines on which may be worked out arrangements for reducing to a minimum the losses and interruption of business that may ensue from accidents in the particular operations. The most important is a rigid policy of so detaching and isolating all integral parts that the loss or damage in one will be localized and will not cause the interruption of production of the plant as a whole.

GENERAL DESIGN OF PLANT

Plant to be in units, each as small as practicable, separated and isolated from each other as efficiently as possible.

The vital points of the plant to be located in areas of absolute safety. The boiler and power plant, ice-making or refrigerating plant, the research laboratory with valuable records and the storehouse, where large amounts of finished products may be stored, are points of chief concern.

The location of processes shown to be especially hazardous to be considered with reference to other considerable values in plant and materials.

The location of above-ground tanks containing large quantities of flammable liquids to be considered with regard to the flow of liquid possible from leakage, rupture, etc. When tanks must be near buildings the consequences of falling walls should be considered.

GENERAL TYPE OF CONSTRUCTION

Buildings should be one story in height, and preferably of fire-resistive construction. It must be remembered that non-combustible construction does not necessarily imply fire-resistive qualities, and unprotected steel may have less fire-resistive quality than heavy timber.

The minimum of wall openings is recommended where separate buildings expose each other—blank walls are the most desirable—and necessary doorways should be protected with efficient fire doors.

*From a report submitted by the Underwriters' Bureau of New England to the Atlantic Dyestuff Co., Boston, Mass.

†Watertown, Mass., Arsenal.

The peculiar conditions of certain production buildings point to the advisability of light roofs, except over fusion kettles, etc.

In general it is recommended that the power plant, ice plant, research laboratory, fusion building and drying building be of strictly fire-resistive construction throughout; nitrating buildings, sulphonating buildings and grinding buildings to have fire-resistive walls and light non-combustible roofs, and other buildings to be of as good type of construction as the business warrants, slow burning wood construction for buildings where there are no manufacturing processes not being particularly undesirable.

OTHER POINTS TO BE CONSIDERED IN THE DESIGN OF A COAL-TAR CHEMICAL PLANT

In all buildings where benzol or toluol is used in any way, the floors should be above the surrounding ground level, without hollows or pits of any kind, and have ample ventilation openings at floor level to the outside. The vapors of these hydrocarbons are about three times as heavy as air and do not readily mix with moisture in the atmosphere. Floors of course should be of concrete, asphalt or some similar material. Such buildings must not be located in proximity to other buildings or plant where direct heat or flame is present, and the approach of locomotives must be avoided.

The floors of buildings where azo compounds may be present should be so adequately drained that the collection and drying out of dangerous salts is impossible.

The arrangement of storage tanks for benzol, toluol, fuel oil and other flammable liquids should be carefully considered. The most desirable arrangement is to have all storage below ground. Where above ground, the units should be of as limited capacity as practicable and dikes provided to confine escaping liquid from overflow, rupture, etc., to safeguard buildings, other tanks, wharves, etc., also to conserve the liquids themselves.

Gravity flow into buildings should be avoided.

Where air pressure lifting is necessarily used, the pressure egg should preferably be outside.

Heating arrangements for dealing with frozen benzol should be carefully designed to preclude the possibility of overheating.

Consideration should be given to safeguarding tanks containing flammable liquids against lightning.

The disposition of empty benzol or toluol drums which contain vapors should be considered.

The disposition of tank cars containing flammable materials is very important; the location of sidings where they are discharged or allowed to remain must be considered with regard to damageable property; the record of accidents with tank cars is very bad and too much care cannot be exercised in their use.

SPECIAL FEATURES IN MANUFACTURING

Nitrating. Nitrating benzol, toluol and other organic compounds is a very hazardous process; there are two important points of interest:

The first is the flammable nature of the material used. The vapors of benzol and toluol are heavy and have a considerable explosive range in mixtures with air; ignition is possible from many causes, among which are overheating, electrical power or lighting apparatus, static electrical discharges, and all may be guarded against.

The second is the danger of accident in the actual

nitrating reactions, since failure of temperature control, stirring devices or regulations of flow of materials may have results that are of explosive violence, possibly followed by fire, difficult to control.

Nitrating, therefore, should be carried on in small buildings well away from other parts of the plant and be of non-combustible construction, but designed so that any explosion may be dissipated with a minimum of damage and the loss and interruption of work localized. All nitrating products must be considered as potentially dangerous. While the lower nitrated products may be considered safer than those of a higher degree of nitration, they cannot be considered safe, and in event of a fire even from an extraneous cause, conditions might arise from which explosion or uncontrollable fire would ensue.

Sulphonation. Sulphonation has dangers allied to the above and also due to material that may be treated. In case sulphonators need to be heated, indirect heat in all cases should be adopted; if direct heat from gas, fuel oil or other means is unavoidable, arrangements should preclude possibility of unequal heating and burning through.

Autoclaves. When processes involving use of autoclaves, with heat and great pressure, are used, autoclaves should be in special fire-resistive buildings, or at least in fire-resistive sections, properly cut off from other parts of the building. The dangers of accident with such apparatus have been shown to be great. When certain materials are treated the result of even a trifling accident may be disastrous.

Fusion. In this process, ignition of the contents of fusion kettles frequently occurs, and such apparatus should be in buildings of non-combustible construction.

Drying. Vacuum driers are at all times the most desirable, but where drying is done at atmospheric pressure, driers should be entirely of metal, or non-combustible material, and wooden trays or racks and paper should not be used in them. Drying buildings may often contain high values in nearly finished dyes, when a small fire from any cause may result in great loss of stock.

Grinding. In this operation there is often great hazard; dust may cause an explosive atmospheric condition, and possible igniting causes are many, such as foreign material, electric sparks, etc.; particularly is there danger at the end of a run. Some dyes may heat up in the mill owing to the incompleteness of certain previous reactions, and the grinding of all dyes with picramic acid base is attended with the greatest danger of explosion. Grinding should be done in a separate and small building, each mill should be isolated from others, and it is probable that some form of light non-combustible construction is most desirable.

Distilling. Stills are always liable to accident, and the magnitude of the resultant damage is largely dependent on the material being handled. They should be treated with the same regard to danger as nitrators. Direct fire-heated stills are, relatively, the most dangerous and their use should be avoided, or very rigid precautions taken.

Sulphur Colors. The manufacture of this class of dyes is very dangerous. Nitro and nitroso compounds are used, also sulphur and sulphides, involving the possible production of explosive or spontaneously ignitable substances.

When it is not known exactly what other dyes or intermediates will be manufactured, and also where it is probable that changes and new processes will continually be introduced, it is recommended that a very careful review of all processes and reactions projected, and all materials used or produced, be given with a view solely to their fire hazards before the processes are put in operation.

Storage of Raw Material and Intermediates. The proper and safe storage of many raw and intermediate materials should have attention. Such compounds as picric acid, picramic acid, nitroso compounds, sulphides, chlorates, alcohol, etc., should each be in separate storages.

A storehouse divided into sections of small area by proper fire walls should allow the segregation of materials which may cause trouble due to careless handling, mixing with others, etc.

The storage of acids in tanks outside probably does not call for special attention, but the disposal of spent mixed acids from the nitration processes is important. Accidents have occurred due to nitrated, or unnitrated material, other than the acids, becoming mixed with them.

General Management

Accidents due to carelessness of employees are difficult to guard against. Smoking in all production or storage buildings should be rigidly prohibited. Owing to the difficulty of enforcing this rule it is suggested that a smoking room be provided in a safe location in the plant, where employees are even encouraged to go. It is also recommended that detached buildings be provided for locker rooms, and that employees be not allowed to leave their clothes or belongings in manufacturing buildings, or use driers for hanging wet clothing, etc.

Where processes are continuous, and night, Sunday and holiday work is necessary, it is often impossible to have the efficient supervision that obtains during usual day working hours, and records show that accidents are more liable to occur at these times. This is a peculiarity of the industry and has a great bearing on the hazards of the plant as a whole.

The foregoing remarks are largely directed from a prevention attitude, but an efficient system of fire-fighting appaartus, hydrants, and adequate water supply is assumed, in order that localization of fire may be assured.

Silk Production in Japan

The year just ended in May was one of the best for Japan's silk industry, owing to the prosperity in the United States and the lack of supplies from Europe, says the *Japan Times and Mail* for June 7, 1920. The export figures from June, 1919, to May 31, 1920, reached 517,311 bales, an excess of 50,305 bales over the previous year. The previous largest figure was less than 500,000 bales.

The silk production of the country has attained a remarkable development during the past few years, especially during the war period, in which the world's demand for silk yarns was centered on the Japanese market, owing to the decline or stoppage of the sericultural industry in Europe. Though the sudden depression of the business caused by the financial failures toward the closing part of the silk year dealt a severe blow to the trade, the production for the season was still a record.

The Power Problem in a Copper Refinery

An Outline of the Steam Recovery Possible With Waste Heat Boilers and the Steam Demand for Heating Electrolyte, With a Discussion of the Bearing of These Factors Upon the Problem of Choice of a Prime Mover

BY LAWRENCE ADDICKS

AN ELECTROLYTIC copper refinery may obtain its power from a self-contained steam or gas plant, from an adjacent water power or by transmission, but while each case will call for a different type of power plant as far as the provision of current for the tanks is concerned, the demand for fuel for smelting and for steam for heating liquors will remain unchanged. The fact that both fuel and steam are required introduces waste heat boilers in any event and most refineries have steam-driven electrolytic generators, although there are notable exceptions. The conditions surrounding each case call for individual study of all the factors entering and it is the purpose here merely to point out the general requirements and limitations of the problem as a whole.

In the early plants, before the days of waste-heat boilers and with live steam heating, the total water entering the plant could be considered as utilized as roughly one-third for generation of electrolytic power, one-third for steam for heating and miscellaneous uses and one-third for make-up water in the tanks and at the boshes. The ideal steam-driven plant would, therefore, be one where the steam generated by waste heat at the reverberatories would be sufficient to supply the demands of the engine room, the exhaust from the engine room used for heating and the condensate finally used as make-up water at either the boshes or the boilers. This ideal solution is yet far from being reached, but the very uniform conditions of load and output under which a refinery is run have enabled sufficient progress to be made in this direction considerably to handicap hydro-electric and gas plant competition.

WASTE HEAT BOILERS

It is perhaps most logical to start with the consideration of the amount of steam available as a by-product at the reverberatories.

Given a fair grade of bituminous coal, a modern refining furnace will average eight to nine tons of product per ton of coal burned. As there are two furnace operations and as the anode furnace treats about 15 per cent of anode scrap and as various other items contribute to swell the net tonnage treated in either furnace, a ratio of four to one is safe, giving 25 per cent fuel consumption on a cathode basis.

A properly designed boiler, placed close to the throat of the furnace and equipped with an economizer, can be depended upon to give an average equivalent evaporation of between 6 and 7 lb. of water per lb. of coal fired. We, therefore, have available about 1.5 lb. of steam per lb. of cathode output, or in other terms a 200-ton furnace will develop at least 363 boiler horse-power.

The rate of steaming is not uniform, as although the coal in a large modern furnace is consumed quite steadily throughout the twenty-four hours, the two extremes of poling and charging give large differences in the temparature of the gases leaving the furnace. The situation is graphically expressed in Fig. 1. Where a number of furnaces are feeding boilers in parallel, their operations are usually staggered enough to give a sufficiently uniform steam supply to avoid any serious irregularities in the demand upon the main boiler installation. Where the electrolytic power is obtained by transmission, this variable supply might cause undesirable fluctuations, but in this case most of the steam would be used for heating purposes where considerable

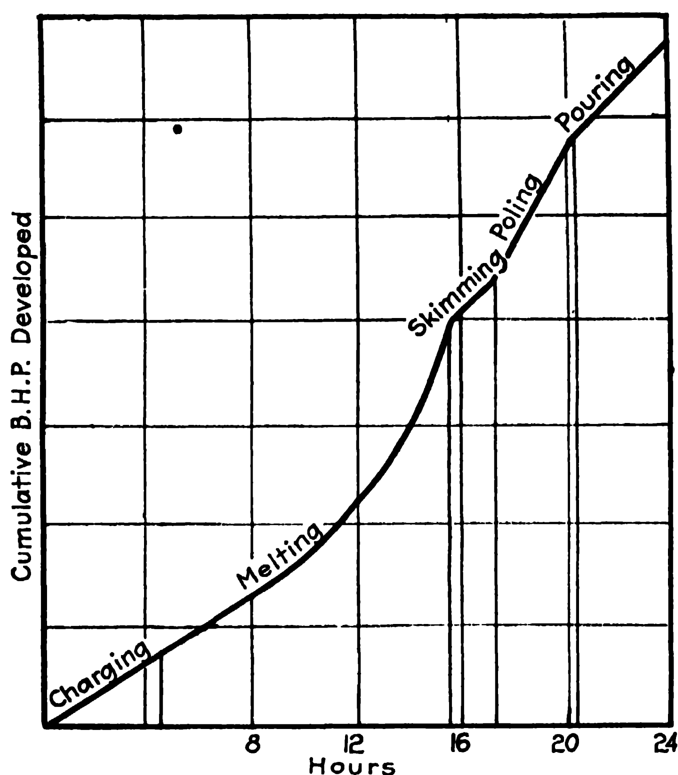


FIG. 1. WASTE HEAT BOILER STEAMING RATE

variations are temporarily permissible. On Sundays the waste heat steam supply is lessened, but so is the miscellaneous demand.

A good general discussion of the whole question of waste heat boiler equipment is given in a paper by Arthur D. Pratt in the *Transactions* of the A.S.M.E. for 1916, vol. 38, p. 599, and of the particular application to copper refining furnaces in an article by Clarence L. Brower in the *Engineering and Mining Journal* for May 22, 1915, vol. 99, p. 892. The secret of successful operation lies in placing the boiler as close as possible to the furnace throat and in the exclusion of air infiltration. A good modern installation obtains a temperature of 1,600

to 1,700 deg. F. in the boiler firebox as against 1,000 to 1,200 deg. in the earlier attempts. The exit gases may be brought down to 500 or 600 deg. F.

ELECTROLYTIC POWER

As has been discussed in a previous article (MET. & CHEM. ENG., March 15, 1917), the power required in the tank house depends upon the current density and the temperature of the electrolyte. In average practice the density will be around 18 amp. per sq.ft. and the temperature about 130 deg. F., in which case the power consumption will approximate 350 kw.-hr. per ton of copper deposited. In general a refinery with a capacity of 100,000 tons a year may be considered large enough to be a thoroughly economical unit and this would call for a dependable power capacity of about 4,000 kw. Whatever type of steam-driven prime mover be adopted, a thoroughly modern power plant of this size should deliver a kw.-hr. at the switchboard for not over 15 lb. of steam, given reasonable superheat and vacuum and excluding auxiliaries. We, therefore, require at the throttle roughly 2.6 lb. of steam per lb. of copper refined, or nearly double the 1.5 lb. available from the waste heat boilers.

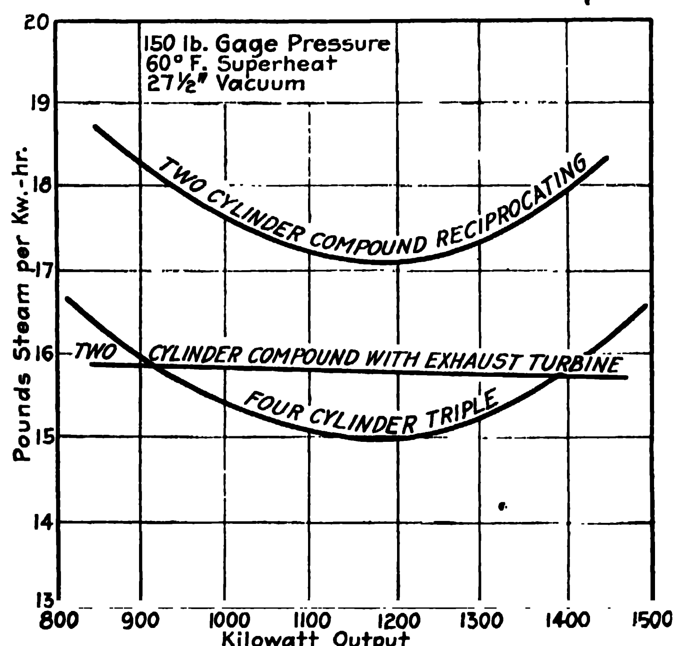


FIG. 2. WATER RATE PER KW.-HR. ON 1,200 KW. UNIT

CHOICE OF PRIME MOVER

In cases where water power is cheaper than steam at the place where a refinery has been located, generally for reasons quite apart from the cost of power, it is of course employed, and we have such a case in the refinery at Great Falls, Mont. In the same way transmitted power originating at a water power is used at Tacoma and to a certain extent at Baltimore. A very unusual instance of power transmitted from a steam generating plant is that of the electrolytic department of the leaching plant at Chuquicamata, Chile. In general a refinery is located with reference to copper freights rather than cost of power and in most locations steam power is cheaper than water power.

Gas power has also been more or less discussed, but up to the present time nowhere applied to copper-refining work as far as power generation is concerned. The great first cost of the installation and its low economy at partial loads have always been handicaps. The history of refineries has been that they are continually being added to and expanded and that even individual units are seldom operated under the conditions for which they are designed, while above all else a gas plant lacks elasticity. On a basis of thermal efficiency some very interesting figures may be worked up, but very large steam turbine units can now practically equal these.

As between steam turbines and reciprocating engines, the question is largely a question of size of unit. A turbine can expand steam down to the highest attainable vacuum without unreasonable increase in size and owing to its high rotative speed very large units can be built in small compass. In the case of a reciprocating engine the speed is limited by valve gear considerations, while cylinders larger in diameter than 54 in. are undesirable and the practical limit of size is about 72 in. diameter by 72 in. stroke. The low pressure cylinder is frequently divided into two in making a four-cylinder triple-expansion unit. These considerations bring us to about 2,000 hp. discharging into 27½ in. vacuum as a reasonable limit size of unit for a reciprocating engine and the steam economy attainable

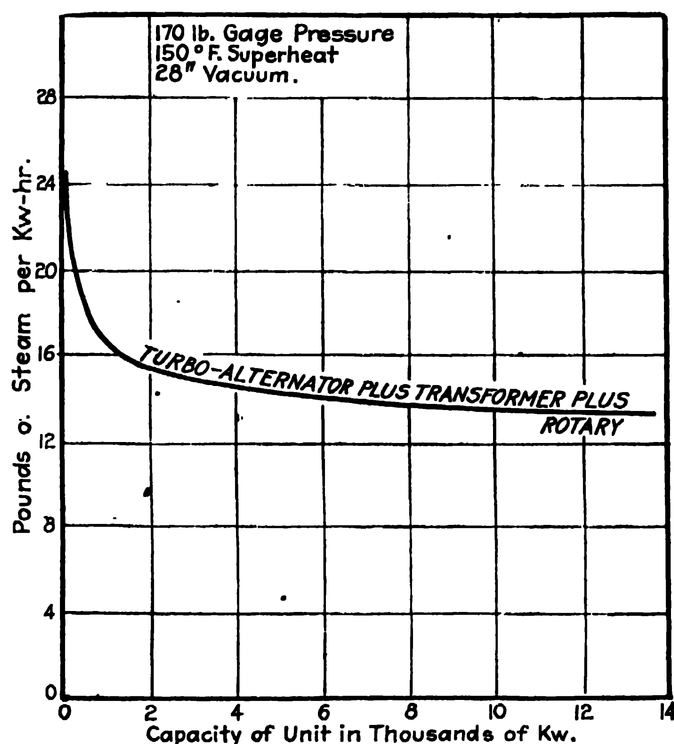


FIG. 3. APPROXIMATE STEAM TURBINE WATER RATE

is indicated in Fig. 2. A turbine of this size can hardly equal this performance even with higher vacuum and when the efficiencies of conversion from alternating to direct current are included it is under a serious handicap as far as economy of steam consumption is concerned. In larger sizes, however, the turbine reaches very high economy. Fig. 3 shows approximately what water rate may be expected with 170 lb. gage pressure, 100 deg. F. superheat, 28½ in. vacuum, after allowing 7 per cent loss of a.c.-d.c. conversion. (See Stott, quoted below.)

The advantages of a turbine are based partly upon its compactness and its ability to utilize high superheat and vacuum. One inch of vacuum or 50 deg. F. superheat will vary the water rate 5 or 6 per cent in a high pressure turbine. As to the space factor, it must be remembered that its value is considerably less at a refinery than in a city power house and regarding condensation the cost of producing high vacuum must not be lost sight of. The temperature of saturated steam drops very rapidly as vacuum increases and if cold water is not available the cost of circulating water may become very great. These conditions are illustrated by the curves in Fig. 4.

The whole question of the relative value of the several types of prime mover is reviewed by Stott, Pigott and Gorsuch in *Transactions*, A.I.E.E., vol. 33, p. 1,133. The special application to electrolytic work was discussed at a joint meeting of three of the engineering societies several years ago and may be referred to in the various transactions as follows: Newbury, *Trans.*, A.I.E.E., vol. 33, p. 1; Longwell, *Journal*, A.S.M.E., July, 1914; Addicks, *Trans.*, A.E.S., vol. 25, p. 65. In a general way it can be stated that with cheap coal the plant will be steam driven, using reciprocating engines if small and turbo-alternators distributing through rotary converters if large. With expensive coal, a fairly large plant and regular tonnage a gas plant could be made to pay. With water power close at hand it would probably displace either steam or gas.

The Electric Generator

The tank house circuits demand (*a*) direct current, (*b*) high amperage, (*c*) low voltage and (*d*) wide voltage range. The amperage used has steadily increased as the generator builders have found it possible to build larger capacity commutators and to-day runs between 10,000 and 15,000 amp. per circuit. The voltage is generally limited to 200 volts or less per circuit and the maximum unit to be considered is, therefore, 3,000 kw., while 10,000 amp. at 120 volts or 1,200 kw. would more nearly represent present practice. A 1,200-kw. generator, direct connected to a reciprocating engine, would call for 1,900 i.hp., which is about the limiting engine size.

The generator problem is almost wholly one of commutation. This subject is reviewed at length under the heading of "Physical Limitations in D.C. Commutating Machinery," by B. C. Lamme, *Transactions*, A.I.E.E., vol. 34, p. 1,739. The simplest case is that of the direct connected reciprocating engine. Here the slow engine speed, certainly not over 125 r.p.m., permits reasonable freedom in commutator design, and the volts per segment, length of bar and amperes per brush arm can all be placed at conservative figures. It must be remembered that steady duty at 100 per cent current load and occasionally at abnormally low voltages imposes commutating conditions far more severe than met with in average practice and that any roughening of the commutator surface becomes rapidly worse. Commutating pole field construction has made a great advance toward sparkless commutation in all electrolytic generators.

The efficiency of a direct connected engine type generator exclusive of bearing friction will be about 94 per cent and the e.hp. delivered by the generator should be about 88 per cent of the i.hp. of the engine. The total losses on a 750 kw. C-W. generator built in 1905 are given in Table I.

TABLE I

Voltage	Volts	125	125	100
Current	Amperes	0	6,000	9,500
Output	Kw.	0	750	950
Bearing friction	Watts	4,000	4,000	4,000
Windage	Watts	1,600	1,600	1,600
Brush friction	Watts	6,200	6,200	6,200
Core and pole losses	Watts	18,000	18,500	15,000
Field copper	Watts	6,560	7,930	4,680
Armature copper	Watts	.. .	11,750	29,400
Brush resistance losses	Watts		8,650	15,400
Total losses	Watts	36,360	58,630	76,280
Mechanical losses	per cent input	32.4	1.5	1.1
Magnetic losses	per cent input	49.4	2.3	1.5
Electrical losses	per cent input	18.2	3.5	5.0
Output (efficiency)	per cent input	0	92.7	92.4
Load	per cent rating	0	100	127

The direct current steam turbine has also given satisfaction in service, although there is a practical limit to the size of commutator which can be constructed, as it is necessary to restrict the diameter owing to the high rotative speeds required. A two-cylinder compound driving a direct connected generator and exhausting into a direct-current turbine connected electrically in parallel makes a satisfactory unit and several such pairs are in successful operation. The steam economies

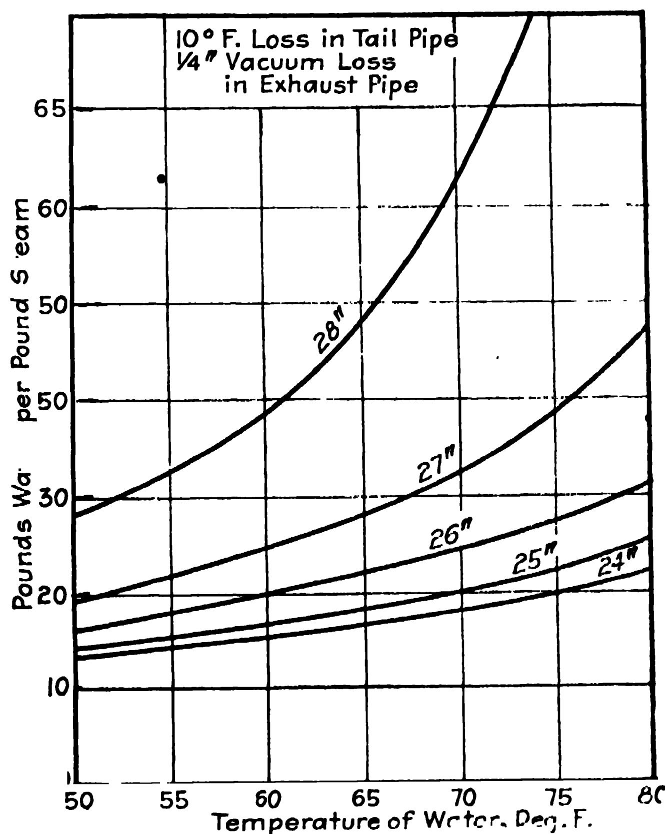


FIG. 4. WATER REQUIRED FOR CONDENSING

possible with such combinations are indicated in Fig. 2. This same field is covered by geared units, a rather high-speed generator being geared to a rather low-speed turbine. For large plants electrical rather than mechanical connection between turbine and generator, as provided by rotaries, has many advantages.

The unipolar generator which delivers direct current without a commutator and which may be driven at turbine speeds is a very pretty theoretical solution of the whole problem. Practically, while commercial units have been built (see Lamme, *Transactions*, A.I.E.E., vol. 31, p. 1,811), many special problems are involved

in the collection of the current, and this type of apparatus has not received any considerable application.

If a turbo alternator is used as the main source of current, allowance must be made for the efficiency of the distributing system, the transformers, conductors and rotary converters absorbing about 7 per cent of the a.c. output.

The voltage regulation should be made wide and is satisfactorily accomplished by hand control. In the case of reciprocating engines the speed may be altered so as to keep the engine operating at the best cut-off. This, however, means some adjustable attachment to the engine governor, which has its drawbacks. With ordinary direct current generators, either engine or motor driven, the usual hand rheostat gives satisfactory voltage control and modern commutating pole generators will operate well at surprisingly low voltages. In the case of rotary converters it is necessary to use booster control on the alternating current side, which may be supplemented by employing multi-tap transformers.

A circuit of 120 volts would probably have 360 tanks connected in series and when drawing copper two groups of, say, thirty-six tanks each might be cut out. This would call for a 20 per cent cut in the normal operating voltage during this period. On the other hand, while a tank house is supposed to be operated on a constant current basis, this is very apt to become constant wattage, the current density being temporarily increased during periods of low voltage.

Heating Electrolyte

Heating the electrolyte has already been discussed (MET. & CHEM. ENG., March 15, 1917). At what temperature it will pay to carry the liquor must be determined for each case. Eastern refineries expend about 0.75 lb. of steam per lb. of copper produced to raise this temperature, say, 30 deg. F. This means a power saving at the generator of 15 per cent taking an overall temperature coefficient of 0.5 per cent per deg. F. If we are using 3.0 lb. of steam (including auxiliaries) per lb. of copper at the engines the saving will be 0.45 lb. as against 0.75 lb. required at the heating coils and it is evident that live steam heating would not pay. If we run an electrolytic unit non-condensing it will take about 4.0 lb. of steam instead of 3.0. If we are able to run a proper proportion of the circuits non-condensing we can, therefore, furnish steam for heating the tanks and obtain an average overall steam rate of 3.2 lb. on 85 per cent of the original resistance, or 2.7 lb. per lb. of copper instead of 3.0 when running without heating.

Where the electrolytic power is hydraulic live steam heating may not pay if there is not waste heat boiler capacity in excess of other needs, but except where very high densities are employed, thereby predicating clean bullion and resulting in considerable electrical heat being generated in the tanks, it generally is desirable to heat the electrolyte from purely metallurgical considerations.

The condensate from heating coils is generally collected for use in washing the anodes and cathodes free from slimes, bluestone crystals, etc., and a small amount of heat is in this way returned to the system as well as a safeguard established against leaky heating coils withdrawing any electrolyte and sending it to the sewer.

The silver refinery and the purifying system or bluestone plant will always require a certain amount of boiling or evaporating. This varies greatly in amount in different plants. In a very general way it may be stated that there will be 2 lb. of steam condensed for every pound of water evaporated and that about 10 per cent of the total steam used will be employed in this way in the average plant.

Steam siphons used for pumping are really heaters. their efficiency as pumps running but a few hundredths of 1 per cent. The steam consumption of a siphon depends upon the original design and upon the amount of nozzle wear at the time of test, but 1 per cent dilution of the liquor is probable and 3 per cent possible.

Heating Feed Water

The steady full load conditions of the electrolytic engines call for a complete installation of economizers. Probably 10 per cent of the steam furnished by the boilers will be called for as exhaust steam for further heating of the feedwater.

Miscellaneous Demand

There is a considerable amount of pumping to be done, such as circulating electrolyte, circulating bosh water, supplying condensers, fire system, general water supply, feeding boilers and high pressure system for hydraulic cylinders. There is a more or less extensive compressed air system for operating copper hoists and pneumatic tools. There is power required for the motor drives of cranes, shop tools, ventilating fans, sampling drills and possibly an electric railway. Finally there is the lighting system.

If steam driven, non-condensing, in a large plant, these various units will consume from one-third to one-half as much steam as is called for by the electrolytic generators operated condensing. This steam may advantageously be turned into the heating systems, the requirements of which it roughly fills, turning all of the electrolytic exhaust into the condenser. Another solution is to electric drive all auxiliaries and supply the current by means of a non-condensing light and power unit. There is even the opportunity of utilizing an electrolytic spare for this service, thereby reducing the total equipment called for, the plant consisting of several electrolytic generators, one light and power unit and one spare for both services.

Summary

The total steam consumption of a copper refinery will vary within wide limits, depending upon the size of plant, the current density employed and the amount of purifying of the electrolyte required, and may be stated somewhat as in Table II.

TABLE II

		lb. steam per lb. copper.
A.	Electrolytic power, condensing	2.5 to 3.0
B.	Light, power, water, air and auxiliaries, non-condensing	1.0 to 1.5
C.	Evapozating, live steam	0 5 to 2.0
D.	Heating, exhaust steam	1.0 to 1.5
E.	Total steam demand, $A + B + C + D$	5.0 to 8.0
F.	Exhaust steam for *D* from *B*	1.0 to 1.5
G.	Contributed by waste heat boilers	1.5 to 1.5
H.	Net steam demand, $E - (F + G)$	2.5 to 5.0

China's Soap Trade

Although many small native soap factories, producing cheap and inferior soaps from local raw materials, have recently sprung up in various parts of China, for many years there has been an increase in China's import trade in this commodity as a result of the growing use of soaps by the Chinese.

Forest Products of the Northwest as Industrial Chemical Assets

By R. K. Strong

At PRESENT the great industry of the Pacific Northwest is that of lumbering. One-fifth of the standing timber of the United States is in Oregon, and consists mainly of Douglas fir. The byproducts of this industry form a large potential source of raw materials for the industrial chemist.

It is a matter of considerable expense to dispose of the waste wood and sawdust produced at the sawmills. Within the last few months one concern has put into operation a 90-foot incinerator, said to have cost $50,000 to erect. Except near the cities, most mills burn the waste in this way, to prevent its accumulation forming a nuisance. In the forest the stumps are difficult to remove on account of their immense size and the length of time required for decay. The trimmings of the trees form a considerable fire hazard.

Waste Wood Utilization

In the cities much of the waste wood is used as domestic fuel. An appreciable percentage of the sawdust and least valuable waste is utilized in this way for the production of power. Three large plants in Portland use such fuel in the generation of electricity. A large paper mill is being constructed in which much fuel will be obtained from a neighboring lumber mill, in return for which electricity is furnished the latter.

In considering the chemical uses to which waste wood may be put two lines of procedure are available—namely, those in which the material must be dried at some stage in the process, and those in which the waste is utilized by wet methods. On account of the large moisture content, which may be over half the gross weight, and the difficulty and expense involved in removing the same it would seem that processes operating without the necessity of removing the water would be more likely to succeed if other considerations were even approximately equal.

Methods Involving Volatilization of Water

As a fuel, wood waste and sawdust have inherent drawbacks, such as the high moisture content mentioned above and the low calorific value when dry. It is stated that the fuel value of a cord of wood on the dry basis is 20 per cent less than that of a ton of coal. The combustion space is necessarily larger and the flame temperature lower than with coal. In spite of these disadvantages the fuel gives satisfaction for steam generation. Plants for the production of fuel gas from wood are in operation, and it is expected that more will be installed.

Considerable work has been done on the destructive distillation of Douglas fir. As it has not yet proved successful on a large scale, probably on account of the low yield of valuable products, the problem is open.

Wet Methods

The wet methods available for treating wood waste center around the production of paper pulp and seem to offer every promise of ultimate success, if attacked with the proper scientific and financial backing. Either with or without preliminary steam distillation for the recovery of the turpentine content, the wood can be made into a satisfactory pulp for certain grades of paper by the soda or sulphate process. Experiments here have shown a high cellulose content in Douglas fir. The Forest Products Laboratory, at Madison, Wis., states the yield, in experiments made there, to be 1,170 lb. of bone dry, screened, unbleached pulp per 100 solid cubic feet of wood—the equivalent of one cord as ordinarily piled. The report states further that the fiber is of good length and the kraft pulp of good grade, with uses similar to that made of white spruce.

An approximate idea of the amount of pulp it is possible to recover from waste wood may be obtained from the statement that about 25,000 cords of waste wood, not including sawdust, are produced per month on the harbor front of Portland alone—a location which offers excellent facilities for utilization of this material both as to quantity available and transportation advantages. Even if only half of this were used, a production of 5,000 tons of paper pulp per month could be obtained.

Another wet process is that by which wood sugar is made for use in the manufacture of ethyl alcohol. Considerable importance attaches to this product in regard to its use as a fuel for internal combustion engines. Canada is attacking the problem in a large way.

Other Wood Problems

Minor problems that are worthy of study and full of promise are the extraction of tannin from the bark of the Western hemlock and the Douglas fir, and the recovery of rosin and turpentine from forest waste and stumps. Douglas fir pitch is receiving attention as a source of turpentine and rosin oil, the pitch being drawn from pockets caused by wind shakes.

Paper Pulp

The amount of paper pulp at present produced in the Pacific Coast region is relatively small, although the mills already established are intelligently operated and of good size. From the latest statistics of the Forest Service, for the year 1918, the following figures are cited to compare and contrast the production of paper pulp in the Eastern and Western states:

EASTERN STATES

State	Cords Pulp Wood Consumed	Per Cent of Total in U. S.
Maine	1,235,000	23.5
New York	1,004,000	19.1
Wisconsin	861,000	16.4
Pennsylvania	384,000	7.3
New Hampshire	345,000	6.6
		72 9

WESTERN STATES

State	Cords Pulp Wood Consumed	Per Cent of Total in U. S.
Oregon, Washington, California	240,000	4.6
		4 6

Total consumed in the United States, 5,251,000 cords.

The output of the Pacific Northwest should be greatly increased and the percentage raised to an appreciably large fraction of the production of the country. This could be done with more benefit to the country and at less expense than the proposed utilization of the Alaskan forests for this purpose. Not that the latter is undesirable, but that the former can be more easily and quickly accomplished.

Research and development would make possible the use of other woods of the region besides those at present made into pulp. With 46 per cent of the standing timber of the United States in the Pacific Northwest and an abundant supply of water for power and pulp treatment, there should be a paper-producing industry in this region ranking with that in any other part of the country. Research and capital can accomplish this in a reasonable time.

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Zones of Weakness in Solidified Ingots

By Leslie Aitchison, D.Met.

In the course of a considerable experience of the defects which are met by engineers in bars, forgings and castings made of steel and other metals I have been convinced that a very considerable proportion of these defects can be traced back to the earliest history of the metal; namely, to the form which it assumes immediately after it has been melted and poured from the melting furnace. In other words, it can be said quite definitely that a very large number of the engineer's problems are created for him in the steel or brass ingot which provides the metal which he finally uses. This being so, it seems desirable to give a brief account, as far as possible, of some phenomena associated with the production of metal ingots.

Columnar crystals will fill up the whole of an ingot if the supply of fluid metal does not fail or if the growing crystals do not meet any solid obstruction. The first requisite means that the metal in the ingot must remain liquid for a comparatively long time. In practice it may happen in relatively small ingots that the steel in the center of the ingot remains fluid to the end, but in large ingots this very rarely occurs, and the center of the ingot is cooled down to the freezing point before the columnar crystals have grown right across the ingot. The solidification of the remaining metal takes place from a large number of independent centers, the result being that the center of the ingot is filled up with numerous small crystals of no special shape and whose axes do not lie in any definite direction in relation to the walls of the ingot mold. These may be termed "free" crystals. The main variation among the different steel ingots is the proportion of the columnar and "free" crystals found therein. From what has been said above one important factor which determines the proportion of these crystals is evidently the temperature from which the metal was cast, as this will fix the time during which the steel will remain fluid after casting.

Sets of Crystals Distinct and Separate

The structure of the cross-section of an ingot shows the way in which two sets of columnar crystals growing from adjacent sides of the ingot mold interfere along a plane of junction. It is quite clear that the two sets of crystals are quite distinct and separate and that even where they touch they do not join or coalesce. If the junction has been suitably magnified for examination the nature of the junction is made much more plain and it is evident that really there is no junction at all, there being rather a complete discontinuity or hiatus between the two sets of crystals. If this is so it may be expected that between the individual columnar crystals (which after all have formed their junctions in exactly the same way in which the junction of the sets of columnar crystals has been formed) there will be no real coalescence. Similarly there will be a zone in which the columnar crystals of the outside of the ingot join onto the free crystals of the core, and here again there will be distinct discontinuity or lack of cohesion between the two constituent types of crystal.

It must be stated that in the majority of cases the crystal boundaries, particularly those of the columnar crystals, are defined by a layer of non-metallic impurities—slag or sulphides or the like. Conversely it may be put that if there is a layer or a pocket of non-metallic material in the ingot it will result in a greater or less degree of discontinuity between the crystals around which it is formed.

Position of Non-Metallic Impurities Preordained

In the middle of the ingot—i.e., in the free crystals of the core—there are found a certain number of places at which there are inclusions of non-metallic impurities. It can easily be understood that these inclusions will occur somewhere, and a little thought will show that the positions in which they are found are more or less preordained. As the steel rises in the mold the steel in contact with the sides and bottom freezes first and the succeeding layers of steel to solidify will be more or less cup shaped. Owing to fluid contraction and to the contraction which occurs during the plastic state of the metal in the core of the ingot there is a tendency for the steel of any particular layer to sink in the middle to a level rather lower than that at the sides, so that a layer which was originally horizontal becomes at a later stage more or less sharply depressed in the middle. The result is that the successive layers of steel as they solidify are distorted downward. The non-metallic inclusions will follow the same path, so that the region filled with free crystals—i.e., the part of the steel which was fluid longest—contains these inclusions arranged symmetrically pointing downward and inward toward the central axis of the ingot. Since the inclusions are there it is safe to assume that there is some discontinuity between the crystals at these points.

Summary

Summing up, it is evident that in the solidified ingot there are certain definite zones in which there is only very moderate cohesion between the crystals of the steel, and consequently that these positions in the ingot are zones of weakness. The zones in particular are: (1) the junction of each columnar crystal with its neighbors. (2) The junction of each set of columnar crystals. (3) The junctions of the columnar and the free crystals. (4) The symmetrically placed "herringbone" arrangement of planes of non-metallic impurities lying on either side of the axis of the ingot. These four places, since they represent the weakest zones of the ingot, are the positions at which contraction is likely to take effect. The result of the contraction will be the pulling apart of the hotter crystals within the ingot from each other and from the cooler, more rigid and stable shell, thus producing contraction or cavities in the metal. The pulling apart of the columnar crystals either individually or in sets may easily occur in the early stages of the contraction—i.e., during the later stages of solidification—while the later contraction will become evident in the junction of the columnar and free crystals and in the "herringbone" cavities within the free crystals.

Unfavorable Outlook for German Potash Industry

The issue of *Deutsche Allgemeine Zeitung* for June 16, 1920, says that at the general meeting of the Bergbau-Aktien-Gesellschaft Justus in Volpriehausen the chairman remarked that domestic sales had come to a complete standstill. No exports are being made to the United States at present. Negotiations with the Americans are still pending, but the Potash Syndicate expects to come to a satisfactory settlement and to resume deliveries in the near future.

Studies in Evaporator Design*—II

The Effect of Temperature Drop and Temperature Level on Heat Transmission in Vertical Tube Evaporators—Corrections for Hydrostatic Head—Boiling Points, Heat Drops and Steam Temperatures as Factors†

BY W. L. BADGER AND P. W. SHEPARD

DETAILS of the methods used in conducting the tests and making the measurements have been given in Part I.

Pressures were measured in mm., temperatures in deg. C., and heat in kilogram calories. Where condensed water was weighed, it was weighed in pounds. When measured, it was calculated directly in kilograms. Heating surface was calculated on the basis of the wet surfaces. Both top and bottom tube sheets were included. The heating surface in tubes was 65.4 per cent of the total, the rest being in the basket shell.

Heat input was taken as the sum of the latent heat at the temperature calculated from the pressure of the steam basket, and the sensible heat recovered between this temperature and the temperature of the condensate. All calculations from the simplest up were made independently by two persons and checked back. All figures in the calculations were carried to 0.01 deg. for temperatures, 0.1 mm. for pressures, 0.1 kg. for weights and 0.1 cal. for heat. The final results were rounded off to the nearest even digit for *K*.

RESULTS

The essential data for the three series of experiments are given in Tables II, III and IV and in Fig. 3. It will be noted in the tables that the results are averaged in groups. In Fig. 3 the average of each group is indicated by a large circle. These circles have their centers at the exact points indicated in the averages and their radius is fifty units on the scale for *K*. This is an arbitrary choice, but is thought that it represents approximately the accuracy of the averages. At any rate there are few cases where it is possible to suppose that the average has a greater accuracy than this.

The principal thing which the curves indicate at once is the decided effect of both temperature level and temperature drop. The curves cannot be represented by a simple equation and it has not been thought worth while to try to derive any expression for them, in view of the limited significance of the absolute numerical values.

The large number of determinations on the 25 deg. point on the 75 deg. curve is due to the fact that this point is common to several sets of investigations now under way. The theoretical work of the station has been interrupted at numerous times. After each interruption this point was redetermined in order to be certain that the evaporator was in a condition similar to that under which the other runs had been made. No definite explanation can be made now for the fact that the 20 deg. point on the 75 deg. curve is low.

In order to get a basis for more general comparisons, these figures were all corrected for hydrostatic head. The points corrected were not the averages actually determined, but were read off the smooth curves. The method of recalculation is illustrated by the following example:

Let t_s = temperature of steam (calculated from pressure).

t_w = temperature of boiling liquid at the surface (calculated from vacuum).

t_b = temperature of boiling liquid at the bottom tube sheet.

$\theta_1 = t_s - t_w$ = temperature difference at surface = "apparent" temperature drop.

$\theta_2 = t_s - t_b$ = temperature difference at bottom.

$$\theta_{mh} = \frac{\theta_1 + \theta_2}{2}$$ = mean temperature difference corrected for hydrostatic head.

P_v = absolute pressure in vapor space.

P_h = head of liquid on bottom tube sheet in mm. mercury.

$P_b = P_v + P_h$ = total pressure at bottom tube sheet.

For example, take the 25 deg. point on the 75 deg. curve.

P_v = 287.6 mm. t_w = 74.89 deg.

$t_s = t_w$ + 25.00 deg. = 99.89 deg.

θ_1 = 25.00 deg.

The hydrostatic head is 48 in. of water at a temperature of about 75 deg. (sp.gr. of water at 75 deg. = 0.9749).

$$P_h = \frac{48 \times 25.4}{13.6} \times 0.9749 = 87.4 \text{ mm.}$$

P_b = 287.6 + 87.4 = 375.0 mm., t_b = 81.37 deg

θ_2 = 99.89 — 81.37 = 18.52 deg.

$$\theta_{mh} = \frac{18.52 + 25.00}{2} = 21.76 \text{ deg.}$$

Now from the curve we read the apparent K at θ_1 = 25.00 deg. as 2,240.

Then the corrected K is $2{,}240 \times \frac{25.00}{21.76} = 2{,}573$ cal.

The complete data from such calculations are given in Tables V, VI and VII and are plotted in Fig. 4, to which the curves for apparent *K* are added for comparison.

NOTES ON CALCULATIONS

This method of calculation calls for boiling points higher than steam temperature for the 5 deg. and 10 deg. points on the 60 deg. curve and for the 5 deg. point on the 75 deg. curve. These cases were handled as follows: The point on the basket where the boiling point of the liquid should become equal to the temperature of the steam was determined. At this point, then the true temperature difference should be zero so far as any boiling is concerned. The mean temperature difference over the part of the heating surface used for boiling was taken as the arithmetical mean of zero and the temperature difference at the top. Assuming that the heating surface below this point was totally inactive, the apparent values for *K* were recalculated on the basis of the new temperature drop and the diminished heating surface. For the sake of comparison this correction was also made on the basis of temperature drop only, neglecting any consideration of decreased heating surface. Both values so obtained are plotted for each of the three points in question.

It will be seen that neither assumption was correct, but that the truth lies somewhere between the two. The values calculated on the basis of no action in the lower part of the heating surface are too high, thus

*Read before the American Institute of Chemical Engineers, Montreal, June 27, 1920.

†For Part I, see CHEM. & MET. ENG., vol. 23, Nos. 6, Aug. 11, 1920, p. 237.

TABLE II. DATA OF INDIVIDUAL RUNS

60 Deg. Temperature Level

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
		Absolute Body Pressure, P_s	Corres. Body Temp. t_s	Absolute Steam Pressure	Corres. Steam Temp. t_s	Condensate Temp.	Condensate	Apparent Temp. Difference θ_1		
Run No.	Time Min.	Mm. Hg	Deg. C.	Mm. Hg	Deg. C.	Deg C.	Lb.	Deg. C.	K	U
183	60.0	145 9	59 56	186 2	64 87	64 39	68	5 31	516	104
44A	60.0	145.8	59.55	193 2	65.68	65 05	87	6 13	570	117
179-II	60 0	134 8	57.88	186 8	64 93	64 75	125	7 05	713	153
181-II	50.2	143 7	59 24	192 9	65.65	65.22	101	6 40	760	155
178-II	15.25	136 1	58.08	216 5	68 26	67 02	164	10 18	773	158
178-III	40 25	137 1	58 24	214 9	68 09	66 84	116	9 85	709	145
184	50.0	138 5	58 45	208 3	67 38	66 36	138	8 93	743	161
185	50.2	138 9	58 51	208 9	67 44	66 43	162	8 93	872	179
186	50.0	139 9	58 66	210 6	67 62	66 50	124	8 96	670	137
61B-I	42.5	138 6	58 47	217 2	68 34	65 81	157	9 87	899	183
61B-II	30 0	140 3	58 73	219 8	68 61	66.37	122	9 88	998	204
61B-III	30.0	140 2	58 71	216.7	68 28	65 28	110	9 57	922	189
50B-I	31 5	141 2	58 86	276 5	73 79	71 93	264	15 09	1,334	273
50B-II	31 0	141 2	58 86	277.3	74 01	72 36	278	15 15	1,417	290
177-I	30.8	137 7	58 33	272 5	73 60	71 61	246	15 27	1,254	257
177-II	30 67	137 5	58 30	271 0	73 47	71 71	244	15 17	1,260	258
177-III	30 08	139 1	58 55	273 7	73 70	71 71	230	15 15	1,208	248
51B-I	30 0	145 5	59 51	347 1	79 43	76 51	401	19 92	1,603	328
51B-II	30 0	145 5	59 51	345 9	79 35	75 91	386	19 84	1,551	318
51B-III	19.5	145 4	59 51	347.3	79.45	76 35	246	19 94	1,514	310
52B-I	23 5	142 8	59 11	412 8	83 76	80 66	383	24 65	1,573	322
52B-II	34 5	142 8	59 11	415.3	83.91	80 42	569	24 80	1,583	324
52B-III	23.0	143.3	59 18	414.5	83 86	80.47	406	24 68	1,701	348
175	23 75	139 5	58 45	488.2	88 05	84.10	506	29 60	1,706	350
174	22 5	140 7	58 79	482 6	87.76	84 33	454	28 97	1,650	333
53B-I	21.25	146 8	59 70	487.4	88 02	84.46	264	28 32	1,736	356
176-I	20 5	138 8	58 50	591 2	93 11	89 44	556	34 61	1,847	378
176-II	21.25	140 9	58.82	588 0	92 97	89 99	596	34 15	1,847	378
176-III	20.75	138.3	58 42	585.8	92 87	89 50	560	34 45	1,847	378
Av. of all runs,		140.68	58.79							

Averages by Groups

Steam Pressure mm. Hg	Steam Temp [1] Deg. C.	Steam Temp [2] Deg. C.	θ Deg. C.	K	U
189.7	65 27	64 51	5 72	543	110
189.8	65 32	65 31	6 72	736	154
214.1	68 00	68 31	9 52	823	170
274.2	73 75	73 96	15 17	1,295	265
346 8	79.41	78 69	19 90	1,556	319
414.2	83.88	83.50	24 71	1,619	331
486.0	87.94	87 75	28 96	1,697	346
588.3	92 98	93 19	34 40	1,847	378

[1] Average from data of column VI.
[2] Average of column IV + average from data of column IX

showing that there is some heat transmitted below the point where theoretically there is no temperature difference between boiling liquid and steam. On the other hand, heat transmission in this area cannot be as high as during boiling, for the values calculated on the basis of the whole heating surface are far too low. Evidently, then, there is some action in the lower part of the basket in heating liquid from the temperature in the down-take (which is that corresponding to the vacuum, or a little below because of radiation and incoming feed) to temperatures approaching steam temperature. Since heat transmission from steam to non-boiling water is known to be at a far lower rate than heat transmission from steam to boiling water, this furnishes a qualitative explanation for the difference in results from the two assumptions. It has not been considered worth while to try to draw any quantitative results from these considerations.

It should be noted that the corrected coefficients change very little with change in temperature drop. What slope these lines have is undoubtedly due to the factor of increased circulation pointed out by Claassen (see above). It will also be noted that these corrected curves differ from each other nearly as much with changes in boiling point as do the apparent values for *K*. Many reasons for this will suggest themselves such as increased density of steam, decreased viscosity of boiling liquid, decreased viscosity (and consequently better drainage) of condensed water, better thermal conductivity of condensed water, etc. The authors at present have no definite explanation to offer as to the cause of this increase in heat transmission with increase in boiling point.

TABLE III. DATA OF INDIVIDUAL RUNS

75 Deg. Temperature Level

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
		Absolute Body Pressure, p^s	Corres. Body Temperature, t_s	Absolute Steam Pressure	Corres. Steam Temperature, t_s	Condensate Temperature	Condensate	Apparent Temp. Difference, θ_1		
Run No.	Time Min.	Mm. Hg	Deg. C.	Mm. Hg	Deg. C.	Deg. C.	Lb.	Deg. C.	K	U
46B-I	54.0	288 6	74.97	338 1	78.79	77.78	69	3.82	797	163
46B-II	54.0	287.8	74.90	340.7	78 98	78.14	85	4.08	919	188
172	61.0	286 6	74 80	386 0	82.07	80.89	256	7.27	1,374	281
173-II	60 0	290.0	75 08	387.2	82.15	81.09	222	7.67	1,333	254
38A-I	29 0	283.7	74.55	427 0	84.61	82.38	184	10.06	1,497	306
38A-II	29.75	289 8	75.06	427.6	84.67	83.11	184	9.61	1,525	412
47B-I	29.75	285.6	74 72	508 2	89.11	86.05	336	14 39	1,856	380
47B-II	30 5	290 8	75 15	510 4	89 22	86.26	330	14.07	1,820	373
48B-I	32.75	289 2	75.02	519.2	89.67	87.27	371	14 65	1,824	374
48B-II	31.05	289.6	75.06	523.8	89.90	86.74	343	14.84	1,733	355
193-I	27 0	283 9	74.60	632.0	94.93	93.96	440	20 33	1,877	384
193-II	40 0	282.9	74 51	632 8	94.96	94.09	640	20 45	1,829	374
195-I	30 0	286 6	74 82	651 6	95.74	95.79	514	20.92	1,911	392
198-I	30 0	283.4	74.55	634 2	95.02	91.65	512	20.47	1,958	401
198-II	30 0	285 4	74 72	633.6	95.0	91.43	489	20 28	1,890	387
205-I	24 5	288 6	74.96	631 0	94.86	92.04	402	19 90	1,938	397
205-II	24 0	288 8	75 0	636 0	95.10	92.0	395	20.10	1,920	393
208-III	26.5	289 6	75.07	625 7	94.66	92.63	427	19 59	1,930	395
208-IV	24 5	289 4	75 05	626 4	94.69	92 34	386	19.65	1,884	386
208-V	24 5	291.2	75 20	631.4	94.90	92.43	389	19 72	1,891	387
39A-I	33 0	285 3	74 69	618.7	94.34	91.64	524	19.65	1,898	345
39A-II	33 5	290 0	75 11	621 2	94 45	91 29	532	19.34	1,930	395
39A-III	30 0	291 6	75 24	621.0	94.44	91.15	443	19 20	1,808	370
39A-IV	33.5	292 3	75 27	623.0	94 52	91.43	512	19 25	1,864	382
208-I	23.0	292.4	75.30	765.5	100.20	98.56	552	24 90	2,245	460
208-II	24.5	292 3	75.29	761.1	100.04	98 03	558	24 75	2,145	439
207-I	31 0	286.5	74.81	762.9	100.11	98.05	754	25 30	2,242	458
207-II	25 0	288.0	74.94	761.6	100 06	97.84	590	25 12	2,189	448
207-III	25.5	284.3	74.63	767.4	100.27	97.94	607	25.64	2,166	444
209-II	30.0	277.6	74.06	767.4	100.27	97.85	734	26.21	2,175	446
209 III	23 0	281.8	74.42	776.5	100.60	98.59	573	26 18	2,218	454
41B-II	28.5	297.9	75.72	756 7	99.90	97.00	664	24.18	2,249	446
41B-III	23 9	286.7	74.79	760 2	100 01	96.80	583	25.23	2,257	465
41B-IV	26.25	287.0	74.82	760.4	100.02	97.10	661	25 19	2,335	476
60B-I	19 5	293.2	75 35	781.8	100 79	96.67	484	25.44	2,278	466
60B-II	20.2	290.0	75.09	767 8	100 28	96 28	480	25 19	2,207	452
60B-III	19.5	290 0	75 09	733.2	100.48	96 87	479	25 39	2,260	463
187	25.0	280 7	74 33	766 9	100 25	98.54	651	25 92	2,339	479
188	27 0	283 4	74 55	762.8	100.10	97.58	664	25.55	2,243	459
190-II	26 5	284 8	74 67	760 9	100 03	98.67	672	25 36	2,325	477
190-III	22 0	286 1	74.78	761.4	100 05	98.84	552	25.27	2,310	473
190-IV	28 0	285 9	74 76	762.2	100.08	99.10	724	25 32	2,375	486
197-I	29.5	286.6	74 82	763.7	100 13	96.94	708	25.31	2,213	453
197-II	30 0	287.1	74 87	759.2	99.97	96.70	731	25.10	2,268	464
201-I	24.0	293.3	75.35	916.4	105.32	102.50	729	29.97	2,340	479
201-II	24.0	292.5	75 31	916.0	105.31	102.33	734	30.00	2,364	484
192-I	16.0	283.9	74.60	906.7	105.02	104.26	502	30.42	2,384	488
192-II	23.0	284.7	74.66	906.6	105.02	104.85	720	30.36	2,379	487
192-III	22.0	283.8	74.59	905.7	104.99	104.41	676	30.40	2,338	479
49B-I	26.25	282 5	74.45	889.2	104.45	100.51	752	30.00	2,222	455
49B-II	26.25	283.5	74.54	889.6	104.46	101.22	744	29.92	2,290	469
49B-III	26.0	283.2	74.51	890.6	104 50	100.98	762	29.99	2,273	466
49B-IV	26.0	287.9	74.91	892.8	104.57	101.30	760	29.66	2,291	469
204-I	20.0	289.3	75.04	1065.8	109.76	106.80	759	34.72	2,521	516
204-II	19.0	290.4	75.14	1074.0	109.99	107.30	736	34.85	2,564	525
Av. of all runs,		287.6	74.89							

Averages by Groups

Absolute Steam Pressure mm. Hg	Steam Temp. [1] Deg. C.	Steam Temp. [2] Deg. C.	θ Deg. C.	K	U
339.4	78.88	78.84	3.95	858	176
386.6	82.11	82.06	7.17	1,354	277
427.3	84.64	84.73	9.84	1,511	309
515.4	89.48	89.38	14.49	1,808	370
629.9	94.83	94.81	19.92	1,895	388
763.0	100.18	100.22	25.33	2,252	468
901.5	104.85	104.97	30.08	2,302	475
1,069.9	109.88	109.67	34.78	2,542	520

[1] Average from data of column VI.
[2] Average of column IV + average from data of column IX.

Another interesting fact is that at higher temperature levels both the apparent and the corrected curves are becoming parallel.

The hydrostatic head corrections furnish a ready explanation for the fact that the apparent values for K approach zero as the temperature drop approaches zero.

As the apparent temperature drop (θ_1) approaches zero, this means that t_w approaches t_s. As t_w approaches t_s, the distance below the top tube sheet where $t_b = t_s$ approaches zero. Hence the inactive part of the heating surface approaches the whole heating surface, and the total heat transmitted approaches zero. But since in calculating the apparent heat transmission coefficient the whole heating surface is used, it is evident that the coefficient must therefore also approach zero as the heat transmitted decreases.

Relation of Steam Temperature to Heat Transmission

If a section is taken across the curves of Fig. 3 at right angles to the X-axis, one obtains a curve showing the combined effect of increased steam temperature and increased boiling point for the same temperature drop. Such sections taken for temperature drops in multiples of 5 deg. are plotted in Fig. 5. These curves are obviously developing a fairly definite limiting curve to the left, but will extend out to fill the whole space to the right. Fig. 5 furnishes an excellent explanation for the very wide variations in Kerr's results both experimental (Bull. 149, La. Agr. Exp. Sta., p. 33) and on the commercial scale. (*Trans.*, A. I. M. E., vol. 30, p. 67.) Kerr plots K against steam temperature without any regard to temperature drop and then attempts to derive a single equation to cover all these points. Our results show how completely false it is to assume such an expression.

On the basis of his experimental results, Kerr develops an equation, $U = 225 + 17{,}500D$, where D = steam density in lb. per cu.ft.

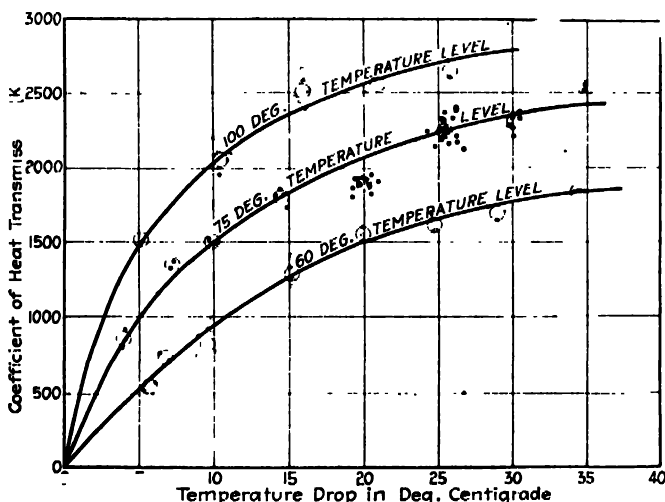


FIG. 3. RELATION BETWEEN APPARENT HEAT TRANSMISSION COEFFICIENT AND TEMPERATURE DROP FOR DIFFERENT BOILING POINTS

In attempting to plot this equation, it was found that the equation called for such high values of K that they came entirely off our chart. To make Kerr's figure for steam at 130 deg. check with our figure for steam at 130 deg. and the 30 deg. temperature drop, his results, as calculated and converted to metric units, are multiplied by 0.302. The resulting values are plotted in Fig. 5.

Parr (*Engineering*, vol. 121, p. 146) has suggested for multiple effect evaporators, $U = 300\sqrt{PD}$, where P is the absolute pressure of the heating steam in lb. per sq.in. and D is the density of steam in lb. per cu.ft. Parr's equation is derived from theoretical considerations and not from experimental data. Values calculated from this expression and converted to metric units are also plotted in Fig. 5. These results and those of

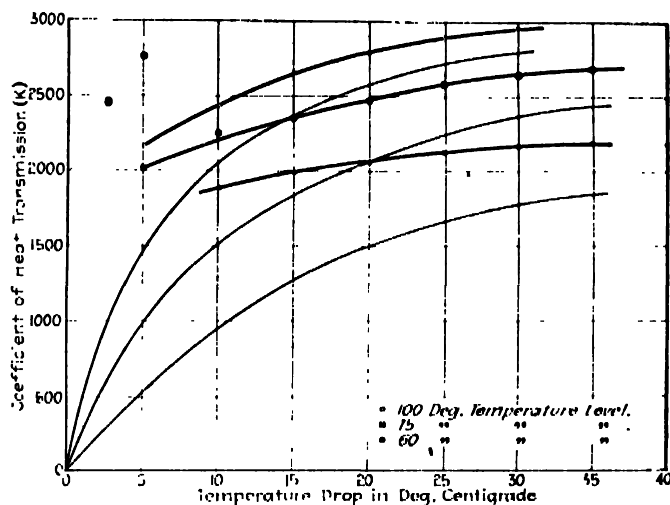


FIG. 4. DATA OF FIG. 3 CORRECTED FOR HYDROSTATIC HEAD

TABLE IV DATA FOR INDIVIDUAL RUNS
100 Deg. Temperature Level

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Run No.	Time	Absolute Body Pressure, t_e	Corres. Body Temperature, t_g	Absolute Steam Pressure	Corres. Steam Temperature, t_s	Condensate Temperature	Condensate	Apparent Temp. Difference, θ_1		
	Min.	Mm. Hg	Deg. C.	Mm. Hg	Deg. C.	Deg. C.	Lb.		K	U
63B-I	30 0	738 4	99 19	881 9	104 22	102 17	97	5 03	1,491	305
63B-II	30 0	738 4	99 19	881 7	104 21	102 41	100	5 02	1,547	317
65B I	20 0	735 3	99 08	1,049 8	109 31	106 04	177	10 23	1,998	419
65B II	21 75	735.3	99 08	1,049 9	109 31	106 88	204	10 23	2,110	432
65B-III	19 0	735.3	99 08	1,042 2	109 10	105 72	172	10 02	2,088	428
212-III	18 0	736.7	99 14	1,039 4	109 02	107 41	170	9 88	2,203	451
215-I	16 0	731.3	98 93	1,072 5	109 95	107 69	160	11 02	2,097	429
215-III	16 0	731.3	98 93	1,064 9	109 73	107 53	154	10 80	2,052	420
45A-I	30 0	733.3	99 00	1,048 3	109 26	105 95	200	10 26	1,955	399
45A-II	29 25	733.3	99 00	1,051 9	109 37	106 30	256	10 36	1,954	398
210-I	29 50	745 9	99 48	1,288 2	115 48	113 72	533	16 01	2,590	530
210-II	29 0	745 9	99 48	1,280 2	115 29	113 79	536	15 81	2,660	545
210-III	29 0	745 9	99 48	1,282 0	115 34	113 56	522	15 86	2,588	530
211-I	24 0	738 2	99 19	1,285 0	115 41	113 59	428	16 22	2,512	514
213-I	21 0	731 1	98 92	1,254 6	114 67	112 20	370	15 73	2,568	526
213-II	28 0	731 1	98 92	1,238 3	114 27	112 43	465	15 35	2,477	507
216-I	16 0	733 2	99 00	1,268.0	115 00	112 91	267	16 00	2,384	488
216-II	17 5	733 2	99 00	1,270 3	115 06	112 90	295	16 06	2,404	492
216-III	16 0	733 2	99 00	1,253 0	114 66	112 31	267	15 66	2,444	500
64B-II	20 0	738 4	99 19	1,458.1	119 34	115.77	445	20 15	2,520	516
214-I	26 0	729 3	98 85	1,489 6	120 17	117 74	616	21 32	2,526	518
214-II	25 0	729 3	98 85	1,481 9	119 83	117 90	532	20 98	2,634	538
191-I	18 0	744 4	99 42	1,741.7	125 02	124 04	557	25 60	2,726	558
191-II	22 0	744.9	99 44	1,743 5	125 06	124 09	656	25 62	2,621	537
191-III	25 0	745 9	99 46	1,749.3	125.16	124 39	745	25 70	2,613	535
Average of all runs,		736 7	99 13							

Averages by Groups

Absolute Steam Pressure mm. Hg	Steam Temp.[1] Deg. C.	Steam Temp[2] Deg. C.	θ Deg. C.	K	U
881.8	104.21	104 13	5.02	1,519	311
1,052.4	109.38	109.46	10 35	2,057	422
1,268.8	115.02	114.97	15.86	2,514	515
1,476.5	119 78	119.93	20 82	2,560	524
1,744.8	125.08	124.75	25 64	2,653	543

[1] Average from data of column VI.
[2] Average of column IV + average from data of column IX.

TABLE V.

Mean values at intervals of 5 deg. temperature drops, corrected for hydrostatic head; 60 deg. temperature level series

Average body temperature at top tube sheet for whole series, 58.79 deg. C.
Average body temperature at bottom tube sheet for whole series, 69.59 deg. C.

θ_1	t_s	--	θ_{mh}	Apparent K	Corrected K
5	63.79	0.0	2 50	525	1,050
10	68.79	0 0	5.00	940	1,880
15	73.79	4.20	9.60	1,270	1,984
20	78.79	9 20	14 60	1,500	2,054
25	83 79	14 20	19 60	1,660	2,117
30	88 79	19.20	24 60	1,770	2,159
35	93 79	24 20	29.60	1,850	2,188

Where θ_1 = 5.0 deg., K corrected for both hydrostatic head and inact heating surface = 2,563.

Where θ_1 = 10.0 deg., K corrected for both hydrostatic head and inactive heating surface = 2,134.

TABLE VI.

Mean values at intervals of 5 deg. temperature drops, corrected for hydrostatic head; 75 deg. temperature level series.

Average body temperature at top tube sheet for whole series, 74 89 deg. C.
Average body temperature at bottom tube sheet for whole series, 81 37 deg. C

θ_1	t_s	θ_2	θ_{mh}	Apparent K	Corrected K
5	79 89	0 0	2 50	1,005	2,010
10	84 89	3 52	6 76	1,515	2,246
15	89 89	8 52	11 76	1,840	2,346
20	94 89	13 52	16 76	2,070	2,470
25	99 89	18 52	21 76	2,240	2,573
30	104.89	23 52	26 76	2,365	2,640
35	109 89	28 52	31 76	2,435	2,684

Where θ_1 = 5.0 deg., K corrected for both hydrostatic head and inactive heating surface = 2,750.

TABLE VII.

Mean values at intervals of 5 deg. temperature drop, corrected for hydrostatic head; 100 deg. temperature level series.

Average body temperature at top tube sheet for whole series, 99.13 deg. C
Average body temperature at bottom tube sheet for whole series, 102 23 deg C

θ_1	t_s	θ_2	θ_{mh}	Apparent K	Corrected K
5	104 13	1 90	3 45	1,490	2,160
10	109 13	6 90	8 45	2,050	2,426
15	114 13	11 90	13 45	2,370	2,643
20	119 13	16 90	18 45	2,570	2,786
25	124 13	21 90	23 45	2,710	2,890
30	129 13	26 90	28 45	2,800	2,952

Kerr are reproduced here merely to illustrate how impossible it is to represent heat transmission over a range of values for either boiling point, steam temperature or temperature drop by any expression which does not involve at least two of these three factors.

It will be seen by a comparison of the corrected values for K and the apparent values for K that one part of the cause for low coefficients in the latter bodies of multiple effect evaporators is accounted for by the effect of hydrostatic head. Of the many factors which affect heat transmission coefficients, hydrostatic head is the one which is susceptible of calculation. The authors believe that if values reported in the literature for heat transmission coefficients had been uniformly corrected for hydrostatic head, the results would be found much more concurrent and systematic than they have been thought to be. As work progresses in the evaporator experiment station and more data are accumulated on both apparent and corrected heat transmission coefficients over a wider range of conditions, it seems not unreasonable to expect that the choice of the coefficient for the different bodies of the multiple effect may not be such a difficult matter in the end. Removing the factor of hydrostatic head may remove much of the uncertainty regarding heat transmission coefficients at low boiling temperatures or low temperature drops.

CONCLUSIONS

The following conclusions for the present must be taken as indicating tendencies only and must be applied with caution to evaporators which differ very much in design from the evaporator in which they were determined:

1. The apparent coefficient of heat transmission in vertical tube evaporators decreases in temperature drop and approaches zero for zero temperature drop.

2. The apparent coefficient of heat transmission increases with boiling point for a given temperature drop (which also means increasing steam temperature).

3. Correcting the apparent heat transmission coefficients for hydrostatic head gives figures which change but little with temperature drop. This remaining

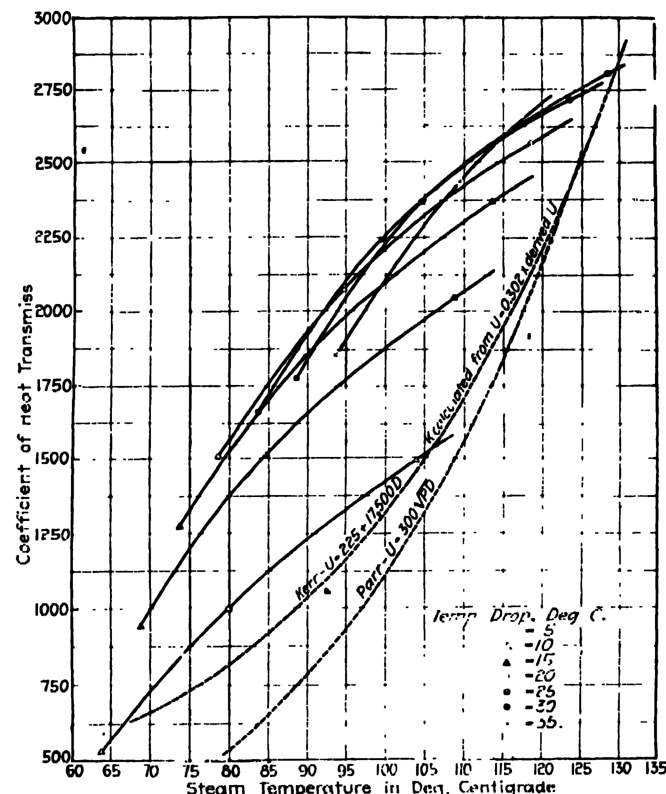


FIG. 5. VARIATIONS IN HEAT TRANSMISSION WITH STEAM TEMPERATURE, FOR VARIOUS TEMPERATURE DROPS

change is probably due to increased circulation at increased rates of boiling.

4. The corrected heat transmission coefficients used show considerable differences as the boiling point is increased and the temperature drop held constant.

5. It is impossible to represent heat transmission coefficients for different boiling points, different temperature drops and different steam temperatures by any expression which does not consider at least two of these three factors.

ACKNOWLEDGMENTS

All of the work of this paper was done with funds supplied by the Swenson Evaporator Co., to which the authors wish to express their appreciation for permission to publish the results. Acknowledgment is also made of the assistance of E. M. Baker, of the chemical engineering department of the University of Michigan.

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New Zealand Prohibits Exportation of Adulterated Kauri Gum

The New Zealand Government published in the *New Zealand Gazette* of May 27, 1920, an order in council prohibiting the exportation of kauri gum which has been in any manner adulterated or mixed with other gum.

Legal Notes

BY WELLINGTON GUSTIN

Decree Against Continental Sugar Co. Modified—Byproduct Plant Is Abandoned

In a recent decision of the Supreme Court of Michigan the Continental Sugar Co. and the United Engineering Co. were defendants. The sugar company operates a plant at Blissfield, Lenawee County, Mich., for the manufacture of beet sugar. Among its waste products was a liquid known as Steffens water, which developed an offensive odor and could not be run into the river there, and this it was compelled to store at some expense. The United Engineering Co. believed that by a process of evaporation this waste product could be converted into a valuable byproduct, and entered into an agreement with the sugar company, whereby the engineering company agreed to install a plant for such purpose at its own expense on a part of the sugar company's premises, the net profits to be divided between them. This contract was to cover a period of ten years from October, 1917. The sugar company had the option to purchase at any time after three years.

The engineering company let the job of constructing and installing the plant to J. C. Carland & Co. The plant was completed and operated for a few months, but was then closed because its operation was not profitable. Payment for its services having been made by the engineering company, Carland & Co. sought to foreclose its lien upon the plant against the two companies. The trial court gave a decree against the companies and found the amount due to be a "lien upon said refining or potash plant, equipment and appurtenances and leasehold rights."

The Supreme Court upheld this decree except it provides that should the purchaser, at a sale of the property, remove the buildings, the premises should be restored to substantially the same condition as before the construction of the plant. This modification of the decree was obtained upon the appeal of the Continental Sugar Co., one of the defendants.

How a Loosely-Drawn Contract Caused Loss to Glue Manufacturer

Interesting facts on how loosely business is sometimes conducted are brought out in the action of the Oscar Schlegel Manufacturing Co. against Peter Cooper's Glue Factory; so also is the law applying to a sales contract to furnish one with chemical requirements covering a period.

The plaintiff was a jobber exclusively, handling glues, wax, paints and chemicals. It bought only for retailing to the trade and did not manufacture or use any of these articles in its own business. The defendant glue factory wrote plaintiff, stating that it had been instructed by one of its officers to enter contract of said jobber "for your requirements of special BB glue for the year 1916, price to be 9c. per pound. . . . delivery to be made to you as per your orders during the year." This writing, together with the jobbers' written acceptance thereof, was held by the court to show that there existed a valid contract between the parties. The parties admitted these writings constituted the only agreement between them, but defendant claimed that it lacked mutual promises and therefore was unenforceable when it sought to avoid deliveries.

DEFENDANT REFUSES DELIVERY

It appears that the parties entered upon performance of the agreement and deliveries were made from time to time amounting to 169,800 lb. Between October and December, 1916, the jobber ordered 79,891 lb. of glue, to meet its requirements, but defendant refused to deliver the same. The jobber in anticipation of the performance of this contract on the manufacturer's part had sold 42,000 lb. of this glue, and as it could no longer be bought in the open market it lost its profits on such sales. Other damages sustained by refusal to perform on part of defendant brought plaintiff jobber's damages up to $6,431.28, for which it recovered a judgment.

The jobber filled the orders of its customers as it received them by calling upon the factory to deliver the goods under the contract. Therefore the jobber's requirements for the year 1916, in special BB glue, were the amounts of orders received therefor from its customers to whom its salesmen had sold such goods.

SYSTEM WAS THE USUAL ONE

This method of doing business, and the meaning of the term "requirements" as used in the contract, were concededly well known to the manufacturer, which had done business with the jobber under the same system as far back as 1910. The contract for 1915 was also for the jobber's "requirements" of special bookbinder's glue, for the balance of the year from March 3, 1915, at a fixed price quoted. No question arose as to the meaning of this contract, nor, said the court, did any question arise as to the meaning or validity of the contract for the year 1916, until the price for this special glue rose so high that the contract became very valuable to the jobber, and entailed a corresponding loss of profit to the manufacturer which it could have made by selling elsewhere. The contract price was 9c. per pound, and, by December, 1916, prices were quoted as high as 25c.

Under these conditions the jobber sought to reap a legitimate advantage from its contract, and by soliciting the trade received orders for the last three months of 1916 aggregating 126,100 lb. Instead of repudiating the contract, the manufacturer undertook to place an arbitrary limitation upon the same, by saying it would give the jobber 10 per cent more than it had purchased in 1915, or about 40,000 lb. But despite this the manufacturer never notified the jobber to cease taking orders from its customers for delivery of this glue, nor did it ever notify the jobber that it would not live up to its contract.

MANUFACTURER COULD HAVE PROTECTED HIMSELF

The manufacturer had not protected himself against any abnormal variation in price during the year, nor had he limited the amount to be furnished. The only proviso in the contract which he cared to insert was that the contract was contingent upon fires, strikes, accidents and other causes beyond the control of the parties. A rising market, says the court, could have been guarded against by the factory, by inserting in the contract a clause fixing the maximum amount which

the plaintiff might be entitled to receive thereunder, but instead the manufacturer made an absolute contract at a fixed price for the entire year to deliver as much glue as the jobber might be able to sell.

Contract Was Mutual, Says Court

As for the contract not being mutual, the facts are that if the jobber had taken orders for this quality of glue, and had failed to buy the amount to fill such orders from the defendant, the latter could have held the jobber under the contract and recovered the damages which it sustained by reason of the jobber's failure to order such glue from the defendant. This it could have done, no matter how low the market price might have fallen during the year. The parties entered upon this contract with their eyes open to all the conditions then existing or which might possibly arise, said the court, and with the intention of being mutually bound thereby. The mere uncertainty as to the amount of glue which might be required to be furnished under the contract is no reason why it was not a mutual one, nor does it make the contract unenforceable.

Jobber Had Right to Solicit Orders

The customers' orders were received by the jobber and transmitted to defendant under the contract. The jobber's good faith in soliciting the orders, and their validity, were not successfully attacked. In the absence of any notification from the manufacturer that it would not or could not fill all its orders, the jobber had a right to proceed legitimately and in good faith to solicit orders from the trade and expect the filling of these orders by the manufacturer. The manufacturer had no right to limit arbitrarily the amount which the jobber should receive under the contract, and it was therefore liable for the damages which the jobber sustained. Thus the Appellate Division of the New York Supreme Court affirmed judgment against the Peter Cooper Glue Factory.

Same Situation in Another Case

In another case the same situation was presented to the New York Court of Appeals. There also the parties had left the contract open and indefinite as to the quantity of the goods the purchaser might order from time to time. The seller had there sought to have the contract reformed, so as to call for only the usual amount of goods sold in the preceding year, as an answer to the buyer's suit for damages sustained by reason of the seller's refusal to furnish the goods called for under its orders for the second year. Here the court said:

"It is quite probable that this controversy originated in a circumstance which the defendant, at least, had not anticipated or provided for. After the execution of the contract there was a large advance in the market price of iron and the manufactured products of iron, and consequently the value and selling price of the goods covered by this contract advanced in the same or possibly in a greater proportion.

"The needs of the plaintiff could be indefinitely enlarged, when the market was in such a condition as to enable it to undersell its competitors in the same business, in consequence of a favorable contract with the manufacturer of the goods. If a party contracts for goods upon a rising market, he is ordinarily entitled to such profits as may accrue to him by reason of a prudent or favorable contract."

Determination of Naphthalene in Crude Naphthalene and Tar

By John C. Pastre*

The following rapid and accurate method for determining naphthalene in crude naphthalene and tar was worked out by R. C. Downing, chief chemist, and the author, while endeavoring to determine the yield of naphthalene from our products at the new plant of the Steel & Tube Co. at Indiana Harbor, Ind.

Distil 1,000 g. of tar into two receivers, collecting in the first receiver all the distillate up to 270 deg. C., and in the second receiver the fraction obtained between 270 deg. C. and 300 deg. C. It is necessary to use an air-cooled condenser when the naphthalene begins to come over and to gently heat the condenser with a flame to prevent freezing.

The first fraction is then freed from water by means of a pipette and the fractions combined and refractioned. The water is again removed as before and the crude naphthalene allowed to solidify. This is weighed as crude naphthalene.

Ten grams of the crude naphthalene is then weighed on a balance and dissolved in 100 to 200 c.c. of naphthalene-free benzol. When solution is complete make the volume up to 250 c.c., with benzol. Pipette off 5 c.c. of this solution and place in a dry 100 c.c. flask containing 0.7 g. of picric acid and allow the picric acid to dissolve.

When solution is complete place the flask in a water bath at 60 deg. C. and pass air over the solution. Precaution must be taken to keep the liquid level in the flask above the water level. When the benzol is entirely evaporated and the odor of benzol is no longer detected, dissolve the residue in the flask in 10 c.c. of alcohol. Make the volume up to 100 c.c. and cool in an ice bath. Filter off 50 c.c. and titrate with N/10 sodium hydroxide, using methyl red as an indicator. Run a blank determination with 0.7 g. of picric acid and subtract the first titration (times 2) from the blank. This gives the difference due to the formation of naphthalene picrate, and when multiplied by 2.56 gives the grams per liter of naphthalene.

Since a theoretical solution of 40 g. per liter was made, the per cent of naphthalene in the crude naphthalene is calculated by dividing the grams per liter found by 40 and multiplying this result by 100.

It is best, however, to determine a factor on the solution used by running a sample of pure naphthalene in conjunction with the test.

The results on the crude naphthalene are then calculated back to the original weight of tar.

Hydro-electric Development in Ceylon

The Public Works Department, Ceylon, has taken up the work of investigating the island's hydro-electric resources, which work was delayed by the war, and it is expected arrangements will proceed rapidly for the early initiation of the proposed electrification of the island's industries and the partial transformation of the transportation systems for steam to electricity, including the extension and development of the use of electricity for domestic purposes in Colombo and other centers of population. Although the standard American frequency of sixty cycles has been prevalently employed in Eastern countries during recent years the adoption of the British standard of fifty cycles is now recommended.

*Laboratory Manager, Steel & Tube Co., Indiana Harbor, Ind.

Bituminous Acid-Proof Coatings for Acid-Proofing Concrete Surfaces*

A Condensed Form of the Recommendations of the Bureau of Standards as to the Coating of Concrete Floors, Vats and Tanks Exposed to Acids, Oils and Similar Substances

THREE methods of treatment have been used for the protection of concrete floors, vats and tanks against mineral acids and acid salts, the method selected depending upon the character of surface to be covered, the concentration and temperature of the acid and whether the coating was required to resist abrasion. The materials are bituminous compositions of various kinds.

BITUMINOUS PAINTS

The bituminous paints are used primarily on account of their cheapness and ease of application and give fair service on tanks or other vessels with rather smooth walls, such as is obtained with a plaster or grout coat, and when exposed to mineral acids of low concentration. Two kinds are marketed—those made with an asphalt and those with a coal-tar pitch base, thinned to the desired brushing consistency with suitable solvents. For acids of the lower concentration, the kind of base selected is immaterial. The efficiency of the coating depends upon its thickness and continuity. This can best be obtained by using a thin priming coat to insure a bond with the concrete surface, and when this is thoroughly dry, carefully applying a thicker coat of similar material. It is important that the concrete surface be fairly dry and dust-free. Special care should be taken to touch up all dull, brown, porous and uncoated spots. At least one week should elapse after the application of the last coat before filling the tank with acid.

Satisfactory material has been obtained on the following specification:

Acid-Proof Black. This material shall be composed of a high grade of bitumen thinned with suitable volatile solvents to furnish a smooth, black product which shall dry in twenty-four hours and be unaffected by mineral acids of specified concentration.

It must contain at least 40 per cent of non-volatile, shall not settle, liver or thicken in the container, and shall conform to the following requirements:

(*a*) When flowed on a piece of clean sheet iron approximately 4 x 6 in. and 0.016 in. thick and allowed to dry for one week at room temperature, the film must withstand bending double quickly over a rod 5 mm. in diameter without cracking or flaking.

(*b*) A test piece prepared as above and dried for one week at room temperature shall be laid flat and in different places several drops each of sulphuric acid, specific gravity 1.3, nitric acid, specific gravity 1.23, and hydrochloric acid, specific gravity, 1.09, shall be allowed to remain on the surface of the film for six hours. On examination the film shall show only slight dulling and the metal beneath shall show no corrosion.

BITUMINOUS ENAMELS

The bituminous enamels are used where protection for an indefinite period against relatively strong acids is desired and when the cost of the structure justifies the extra expense of application. They can be employed both on smooth and rough walls and surfaces, and on account of its thickness, continuity of the coating is more easily obtained. They will not resist abrasion at elevated temperatures.

The bituminous enamel consists of two materials—the priming solution and the enamel proper. The priming solution consists usually of a relatively high-melting-point bitumen, of low susceptibility to temperature changes, dissolved in sufficient volatile solvent to give a paint of thin brushing consistency. The enamel proper consists of a bitumen similar to that used in the primer with or without a finely powdered siliceous mineral filler. Some mineral filler is desirable, as it increases the resistance of the enamel to flowing and sagging at elevated temperatures and to abrasion. The enamel is applied hot over the properly dried priming coat.

The following specification should obtain material suitable for tanks exposed to relatively high and wide variation in temperature:

This material shall consist of a bituminous primer and a bituminous enamel which when applied to concrete surfaces will give a coating which will possess good adhesive qualities, will not flow or sag from a vertical surface at the highest prevailing temperature, will not become brittle at 32 deg. F., and will resist mineral acids of specified concentrations for long periods.

Bituminous Enamel. The enamel shall consist of a homogeneous mixture of a bitumen of relatively high melting point and finely powdered siliceous mineral filler. The total amount of mineral filler, as determined from the ash, shall not exceed 40 per cent nor be less than 15 per cent by weight. Within the above limits the satisfactory working qualities of the enamel shall control the quantity of mineral filler to be used. The mineral filler must be resistant to hydrochloric, sulphuric and nitric acids, and must pass a sieve the openings of which are not greater than 0.14 mm. (0.0055 in.). (This corresponds to about 100-mesh sieve.)

Bituminous Primer. The primer shall consist of a like bituminous material, containing no added mineral matter, thinned with a solvent to a satisfactory brushing consistency. It shall dry to a tacky state in thirty minutes and shall not flash below 30 deg. C. by the Abel closed tester. The solvent used shall have a minimum toxic effect upon workmen applying the primer within an enclosed space.

These materials shall conform to the following requirements:

(*a*) *Workability.* The enamel and primer shall be applied to dry, clean, dust-free concrete slabs in the following manner: The slabs shall be coated with the primer and when this has dried to the tacky state, the enamel shall be mopped on until a coating 3 to 5 mm. (⅛ to $\frac{3}{16}$ in.) thick is obtained. The temperature of application shall not exceed 350 deg. F., at which the enamel shall brush and spread out to a fairly smooth coating.

(*b*) *Brittleness Test.* The brittleness is best determined by testing the material applied to a steel plate. A steel plate 30 cm. x 30 cm. x 1.6 mm. (12 x 12 x $\frac{1}{16}$ in.) shall be primed and coated to a thickness of 3 to

*A report prepared by the Bituminous Materials and Cement Sections of the Bureau of Standards.

5 mm. (⅛ to 3/16 in.) with the enamel, and after cooling for twenty-four hours shall be subjected to the following test: A 750-g. (1.65-lb.) steel ball shall be dropped from a height of 244 cm. (8 ft.) on the coating at a point at least 10 cm. (4 in.) from the edge of the plate. The plate is to be supported in this test by a block or the floor in such a manner that there shall be support beneath the point of impact. In this test none of the coating shall have shattered from the plate nor shall radial cracks develop longer than 4 cm. (1.0 in.) from the center of the point of impact. The coated steel plate shall then be laid coating downward, on a board through which a hole about 8.9 cm. (3.5 in.) in diameter has been cut. The same steel ball shall be dropped from a height of 244 cm. (8 ft.) and shall strike the steel plate over the center of the hole in the board supporting the plate. The coating must not shatter from the plate by this test nor shall cracks develop in the coating further from the center of the point of impact than the boundaries of the hole in the board.

(c) Acid Test. The test piece made in the workability test may be used for this test. The coating shall be unaffected except for a slight dulling when exposed in different places to the action of sulphuric acid, specific gravity 1.3 (about 40 per cent), nitric acid, specific gravity 1.22 (about 35 per cent), and hydrochloric acid, specific gravity 1.09 (about 18 per cent), for twenty-four hours.

Covering Power. The materials shall have the following covering power:

Bituminous primer, 1 gal. to cover not less than 100 sq.ft.

Bituminous enamel, 1 lb. to cover not less than 2 sq.ft., 1/16 to ⅛ in. thick.

Application. Extreme care should be taken in the application of these materials so as to obtain a continuous coat free from blisters and pinholes, and bonding well to the concrete surface. The concrete surface should be as dry as possible, and free from oil and grease and all loose particles and dust. The latter can be removed by brushing the surface first with a wire brush and then removing the very fine dust with a soft bristle brush. The primer then should be applied and should be worked thoroughly into all hollows and pores. The bond between the concrete surface and the enamel coat depends to a great extent upon the proper application of the primer. Before the application of the enamel, the primed surface should be thoroughly inspected and all brown, dull or uncoated spots should be touched up. When the primer has dried to a slightly tacky state, it is ready for the enamel.

The enamel should be melted and carefully heated until it is sufficiently fluid for brushing, avoiding decomposition and carbonization. The temperature of the material in the kettle should not exceed 375 deg. F. When fluid it should be mopped on quickly, as it sets and hardens very rapidly.

For tanks below ground or those in which the temperature never exceeds 100 deg. F., material with a lower melting point made from a softer bitumen may be used on account of its greater ease of application.

For tanks in which the temperature range does not exceed 30 deg. F., a slightly more brittle material might be used which although shattering under the impact of a 750-g. (1.65-lb.) ball from a height of 244 cm. (8 ft.) withstands its impact from a height of 183 cm. (6 ft.)

Bituminous Mastics

The bituminous mastics are used almost exclusively for floors on account of the thickness of the layer which must be applied, but they can be used for tanks or vats if proper care is taken in the application. They are easily applied, bond well to concrete surfaces and resist moderate abrasion and fairly strong mineral acids. They are of two kinds, depending upon whether they are applied hot or cold.

Where a thin surfacing for concrete floors is desired, cold mastic is ordinarily used. This consists of two compositions—the priming solution and the body coat or mastic. The primer consists of a hard asphalt dissolved in a volatile solvent to a fairly thin brushing consistency. The mastic consists of the primer into which sufficient abestos and finely powdered siliceous mineral fillers are ground so as to obtain a very thick pasty fibrous mass. Occasionally, a finishing coat is applied where a color other than black is desired. In that case pigments are added to the last coat of the mastic. The method of application is as follows: The smooth concrete surface is thoroughly dried and cleaned of all grease and dust. The priming coat is then applied, and when it has dried to the tacky state a thin layer (about 1/32 in.) of the mastic is trowelled on. When this has dried, successive 1/32-in. coats of the mastic are applied until the required thickness is obtained.

The hot mastics are somewhat similar to the mixtures used in laying sheet asphalt pavements. However, they contain a little more asphaltic binder, so that when they are heated to the temperature where the asphalt is fluid they can be poured and trowelled into place. They are satisfactory only when applied in layers 1 in. or more in thickness. When mixed and ready for laying they consist of about 15 per cent of asphaltic binder, about 20 per cent of finely powdered siliceous mineral filler, and the remainder properly graded sand or other aggregate, containing no particles larger than those passing ¼-in. sieve. The proper grading of the aggregate so as to get a composition having a maximum density is very important, as upon it the stability and efficiency of the finished floor largely depends. The thoroughness with which the materials are mixed and the care with which they are laid also contribute to the life of the finished surface.

Hot mastics have given very satisfactory service in a wide variety of chemical and dye manufacturing plants, plating, acid tank and storage battery rooms, the pulp rooms of paper mills, and in the leaching tanks of copper and gold refineries.

For convenience in shipping and handling on the job, the asphalt cement and the powdered mineral filler are usually mixed by the manufacturer and cast into blocks weighing from 50 to 75 lb. each, which are marketed as "rock asphalt mastic." For use these blocks are broken up, melted and fluxed with additional asphalt and mixed with the sand or other aggregate. However, the practice of mixing all of the raw materials on the job in suitable mastic machines is becoming more common, as it is more economical, gives a more homogeneous mixture, and danger of overheating and charring of the asphalt is minimized.

Satisfactory materials have been obtained on the following specification:

Bituminous Acid Proof Mastic. The bituminous mastic shall be composed of asphalt cement, clean, sharp grained sand, and fine absorbent siliceous dust. These materials shall be mixed in the proper proportions and shall be applied hot to the concrete surface, which shall be dry and free from dust and shall have been previously coated with a priming or bonding solution which has just reached the tacky state.

Asphalt Cement. The asphalt cement must be of refined asphalt, and shall be homogeneous and free from water.

It shall meet the following requirements:

Melting point (ring and ball), 150 to 180 deg. F.

Penetration at 25 deg. C., 100 g., 5 sec., 15 to 40.

Total bitumen soluble in carbon bi-sulphide, not less than 90 per cent.

Sand. The sand shall be clean, hard grained and moderately sharp, and shall be free from clay, silt and organic matter.

It shall be well graded from coarse to fine, and when tested by means of the laboratory sieves shall meet the following requirements:

	Per Cent
Passing 4-mesh sieve	100
Total passing 20-mesh sieve	50 to 80
Total passing 50-mesh sieve	not more than 30
Passing 100-mesh sieve	not more than 5

Mineral Filler. The mineral filler shall be any finely powdered acid-resistant siliceous material, 85 per cent of which shall pass a 100-mesh screen.

Priming Solution. The priming solution shall consist of an asphaltic base similar to the asphalt cement and shall be thinned to a good brushing consistency with a suitable volatile solvent.

Mixing. The sand or the mixture of the sand and mineral filler and the asphalt cement shall be heated separately to about 300 deg. F. When the asphalt cement is completely fluid, the hot dry aggregate is stirred in and thoroughly mixed until the mass is homogeneous and sufficiently fluid for pouring. The temperature of pouring should be between 350 and 400 deg. F. The aggregate if dry may be stirred in without previous heating, but in that case a longer period of heating and stirring will be required.

Laying. The concrete surface shall be primed and allowed to dry to the tacky state. The hot mixture, prepared as above, shall then be poured, spread on, smoothed out and worked into place with suitable tools. After the surface has begun to set, it shall be sprinkled with hard-grained sand and a little mineral dust and rubbed down until it is smooth. The finished layer should be at least 1 in. thick.

Approximate Formula. The composition varies within narrow limits according to the service required of the material, and when ready for laying should be as follows:

	Per Cent
Asphalt cement	12 to 15
Mineral filler	20 to 25
Sand or other aggregate	60 to 70

Names of manufacturers who can probably furnish materials conforming to the foregoing specifications are given in the following list:

Bituminous Paints:
- Barber Asphalt Paving Co., Philadelphia, Pa.
- Standard Paint Co., Woolworth Bldg., New York City.
- The Barrett Co., 17 Battery Pl., New York City.
- The Biturine Co., 24 California St., San Francisco, Cal.
- The Paraffine Paint Co., San Francisco, Cal.
- Certainteed Products Corp., St. Louis, Mo.

Bituminous Enamels:
- American Bitumastic Enamels Co., 17 Battery Pl., New York City.
- Barber Asphalt Paving Co., Philadelphia, Pa.
- Johns-Manville Co., New York City.
- Briggs Bituminous Composition Co., 17 Battery Pl., New York City.
- Standard Paint Co., Woolworth Bldg., New York City.
- The Biturine Co., 24 California St., San Francisco, Cal.

Bituminous Mastic (Cold):
- Thomas Moulding Brick Co., Chicago, Ill.
- Insulite Mastic Flooring Co., Aurora, Ill.

Bituminous Mastic (Hot):
- Barber Asphalt Paving Co., Philadelphia, Pa.
- Warren Chemical & Mfg. Co., 17 Battery Pl., New York.
- Johns-Manville Co., New York City.
- Standard Paint Co., Woolworth Bldg., New York.
- The Biturine Co., 24 California St., San Francisco, Cal.
- Paraffine Paint Co., San Francisco, Cal.

Newly Discovered Australian Pigment Deposits

The discovery of an extensive deposit of ocher and sienna at no great distance from the surface and within thirty miles of Adelaide, South Australia, has attracted much local interest, particularly in view of the abnormally high price of imported paint pigments.

Though regarded primarily as a mining proposition the discovery is important in a manufacturing sense. During the years of war several new paint works were established in Australia, but the promoters were handicapped to some extent by the necessity of importing most of the requisite raw materials. This new find of ocher and sienna, therefore, extends the possibilities of the paint industry and should render it largely independent of overseas supplies of the basic pigments.

Oil Shales and Their Economic Importance*

By Martin J. Gavin†

The twentieth century has often been spoken of as the age of petroleum, and from many viewpoints it can justly be considered so. Certainly the petroleum industry is one of enormous importance to this country, industrially, financially and economically. The United States, however, at present producing over 60 per cent of the world's total output of petroleum, is not producing petroleum at a sufficient rate to provide for its own domestic consumption. For several years this country has been importing increasing quantities of crude and partly refined oils from Mexico, and has been drawing heavily on domestic stocks of petroleum. Production in the United States is increasing, but it is not increasing at the same average rate as domestic consumption, nor is it probable that in the future domestic production will increase sufficiently to satisfy the demands of domestic consumption, but on the contrary, in the opinion of those best qualified to know, the peak in the curve of domestic production of crude petroleum will be reached in a comparatively few years, whereas the consumption of petroleum and its products will increase at a continually growing rate. This country, then, must turn, and, as the increasing imports from Mexico indicate, is turning, to other sources than the crude petroleum produced in this country to make up the deficit between domestic production and domestic consumption of petroleum and its products.

Industrial Products Derived From Petroleum

The chief products of petroleum are motor fuels, kerosene, fuel oils and lubricating oils. Of these, the increasing demand for motor fuels or gasoline is perhaps the greatest, and that of fuel oils probably next greatest. The ever-growing use of the internal combustion motor, especially in automobiles and trucks, accounts for the first, and the increasing use of fuel oil, chiefly for steam-raising purposes, accounts largely for the second. Lubricating oils are, of course, of prime importance, as machinery must be lubricated if it is to operate.

Growing Need for Petroleum Products Substitutes

To help make up the deficit in our supply of petroleum we can expect to draw on the enormous potential petroleum supplies of Mexico at an increasing rate, and by the use of new and improved processes of manufacture a greater percentage of the petroleum products for which there is the greatest demand will undoubtedly be obtained from petroleum. The more efficient utilization of these products, as for example through the development and use of the Diesel engine and the gradual change in the design of our present internal-combustion motors, enabling them to use lower-grade fuels, will perhaps tend to relieve the growing shortage. Hydro-electric power, or electricity otherwise produced, can be expected to take the place, to a certain extent at least, of fuel-oil installations on land. However, all these expedients have their practical limitations, and it is to be expected therefore that in the comparatively near future new sources of products similar to those now

*U. S. Bureau of Mines, reports of investigations. A paper presented by permission of the Director, U. S. Bureau of Mines, before the thirteenth convention of the Utah Academy of Science, April 3, 1920.

†Refinery engineer, Bureau of Mines.

being derived from oil-well petroleum will have to be developed. As a matter of fact, some are already being developed.

Source of Petroleum Products Substitutes

There are possibilities of importance in the development of the production and use of benzol as a motor fuel and other coal-tar products as Diesel engine fuels and as substitutes for other petroleum products. There are also important possibilities in the commercial production of alcohol as a motor fuel. In fact, blends of alcohol, benzol and petroleum distillates are being marketed in the East at the present time as motor fuels and are giving satisfaction in use.

Taking all these considerations into account, however, it is the opinion of many that the oil shales of Utah, Colorado, Wyoming, Nevada and possibly other states are extremely important as new sources of products similar to those now obtained from oil-well petroleum. These states contain enormous deposits of oil shales which by proper treatment yield gas, oil and also, if desired, ammonia, of value as a fertilizer. The oil in many respects is similar to oil-well petroleum and yields products similar to those of petroleum.

Oil shales have been worked in Scotland and France for upward of sixty years. In the former country the industry has been successful from a financial standpoint, especially of late years, although it is passing through a difficult period at present. The industry in France has not been nearly so successful as that in Scotland. The success of the Scotch shale industry has been brought about partly by the development of cheap processes for treating the shales and the oils produced from them, but mostly by local conditions, such as competition only with high-priced petroleum products, low labor costs and the fact that the industry grew up in a densely populated region where a ready market for oil and ammonium products was available.

Products Obtained From Oil-Shale Distillation

Oil shale contains little or no oil as such, but it contains substances which when the shale is subjected to destructive distillation yield gas, crude oil and nitrogen-containing compounds, notably ammonia, as well as other products in small and probably of unimportant value for the most part. Oil shale as a rule must be mined much as coal is mined, crushed, and heated to a relatively high temperature in closed retorts which may operate continuously or intermittently. These steps are necessary to produce the gas, crude oil and ammonia, the latter in solution in the water obtained along with the oil.

The ammonia water is then distilled and the released ammonia passed into sulphuric acid, producing ammonium sulphate. The crude oil must be refined, much as petroleum is refined, to produce the various commercial products. The refining of shale oil is more complex and in all probability more costly than the equivalent refining of petroleum. Undoubtedly, however, the shale oils can be refined and made to yield many products similar to those produced when petroleum is refined. The oils produced from the oil shales of this country will yield gasoline, burning oils and paraffine wax, all of which when properly treated will be satisfactory commercial products. Whether the more viscous grades of lubricating oils, such as lubricants for internal-combustion motors, can be produced from shale oils is doubtful, but it may be possible. Little is known in this country as to the refining of shale oils, and this statement can be applied generally to the possibilities and technique of oil-shale operations in the United States.

Economic Requirements for the Development of an Oil-Shale Industry

The development of an oil-shale industry to one of considerable importance in this country will require the expenditure of many millions of dollars and take a period of many years. Such development will require much research and technical study, and will require the services of trained executives and experienced technicians. Nevertheless, when economic conditions become favorable, it is reasonable to believe that our oil shales will be of great value as a source of oils similar to those now derived from petroleum. An idea of what large-scale development of the oil-shale industry involves may be gained from the consideration that to produce one barrel of crude oil from shale, on the average at least one ton of a tough rock must be mined, crushed, heated to a relatively high temperature, and finally the residue, amounting to about 75 per cent of the original weight of the raw shale, must be disposed of as valueless. The United States now produces over one million barrels of crude petroleum per day.

Our immense oil-shale deposits practically assure us that, come what may, this country will still have its own sources of petroleum products. We should never have to be wholly dependent on foreign countries in this respect. From another standpoint the shales are also of great economic importance. The oil shales, especially of the Rocky Mountain country, occur in sparsely settled regions. Their development on a large scale means the bringing into these regions of a great number of miners and other laborers, often with their families, who will earn their living in the shale fields and spend their money in the same locality. Millions of dollars must be spent in erecting plants, developing mines and the like, much of which will be spent in the states where the oil shales occur. The shale-oil refineries will require sulphuric acid and other chemicals and supplies, which logically will be produced as near to the shale fields as possible, thus bringing in more capital and labor. Transportation facilities will be extended to meet the requirements of the shale operators, thus benefiting the regions now inadequately supplied in this regard. Prices of petroleum products in the regions contiguous to the shale operations can be expected to be relatively lower than they would be if similar petroleum products had to be shipped in.

Conclusion

It should again be emphasized, however, that development of an oil-shale industry to a scale sufficient to be of so much economic importance will require much study, time and money. The oil-shale industry is no business for the man of little experience and small capital. It may be compared with the development of the low-grade copper ores of the West, in that it is a large, low-grade, chemical manufacturing enterprise, requiring capital, time and trained men. The investor in oil-shale operations should know that he will probably have to wait for a long time for a return on his investment and that returns in all probability will be conservative. In spite of this, the day of the oil-shale industry is coming. When, it is difficult to predict, but some day it will undoubtedly be one of great importance.

Mid-Continent Gasoline*

By C. K. Francis†

THE gasoline of the Mid-Continent district, which includes the states of Kansas, Oklahoma, Texas and Louisiana, is a product derived from petroleum and natural gas, having a Baumé gravity between 55 and 72; initial boiling point, 90 to 140 deg. F.; a dry point between 370 and 460 deg. F., and is suitable for use in an automobile engine.

There are three methods for producing this gasoline: (1) Direct distillation of petroleum. (2) Cracking, under pressure, certain petroleum products, such as gas oil. (3) Extraction from natural gas by means of compression, absorption and refrigeration. Contrary to the somewhat general opinion, gasoline identical with some refinery gasoline may be obtained from natural gas by the absorption process.

The ordinary refinery equipment will not permit the recovery from petroleum of that very volatile product identical with compression natural gas gasoline. However, by means of suitable towers, condensing and other apparatus, it is possible to condense the petroleum vapors so as to obtain products identical with those obtained from natural gas.

During 1919 the Mid-Continent field produced over 217,000 000 bbl. of petroleum, from which there was extracted over 50,000,000 bbl. of gasoline, and while exact figures are not available, it would probably be safe to venture the opinion that 12,000,000 bbl. more of gasoline was made by special processes in pressure stills. The quantity of gasoline extracted from natural gas in this district was about 37,000,000 bbl. Then approximately 100,000,000 bbl. of gasoline was obtained last year from petroleum and natural gas out of the Mid-Continent district and placed on the market.

It is the object of this paper to outline and briefly describe some of the tests used for determining the prominent characteristics of gasoline.

The greater proportion of the gasoline marketed is obtained by the distillation of petroleum and consists of the first fraction, or cut, condensed. This product is for convenience called crude benzine.

Treatment of Crude Benzine

The crude benzine is transferred from the receiving tank, commonly known as a run-down tank, to a specially constructed vessel called an agitator. Most agitators in the Mid-Continent field have a capacity of from 1,000 to 2,000 bbl. When these are used singly or in pairs they are known as batch agitators because the charge of the product to be treated is a known quantity. Sometimes agitators are erected and connected in series; usually the system consists of from six to ten tanks through which the liquid passes while being treated, each unit or agitator containing the proper chemical or liquid for treating the crude benzine. Such units are known as continuous agitators. It is now the common practice to mix or agitate the crude benzine and the purifying agents by means of compressed air.

While the charge is being agitated, strong sulphuric acid is added. The quantity of acid used may vary from 1 to 15 lb. per bbl. of product treated according to its condition and the specific results desired. The next step is to wash the benzine free from acid by showering water through it. Then, in order to be very certain that no acid remains and to remove sulphur compounds, it is washed with dilute caustic soda which is saturated with litharge. Free sulphur is added to aid in the precipitation of the lead sulphur substances. The charge is finally washed with water.

*Paper read at the May 29, 1920, meeting of the American Chemical Society and Society of Mechanical Engineers, Tulsa, Okla.

†Technical superintendent and chief chemist, Cosden & Co., Tulsa, Okla.

Distilling Treated Benzine

The treated benzine is pumped to a steam still and redistilled. The vapors from this may be led through special towers which serve to divide them while slightly cooling and the resulting streams may be further separated in the receiving house. In this manner a series of streams are divided from one tank to another and a number of finished gasolines produced.

Cushing, Inola and Bixby crudes (Fig. 1), which are representative of the best crudes of Oklahoma, begin to decompose or crack when approximately 60 per cent of the total volume has been distilled.

Up to this point the products extracted from the crude oil are separated by direct distillation on a basis of their boiling points. Between 550 and 700 deg., chemical decomposition takes place, with the result that the boiling point is materially lowered owing to the formation of cracked products from the wax or lubricating oil portion of the crude. This illustrates the difficulty of using crude petroleum in the ordinary motor. The decomposition of the oil and resulting deposition of carbon and heavy substances, including coke, brings out clearly the fact that refining is necessary for the production of an ideal motor fuel.

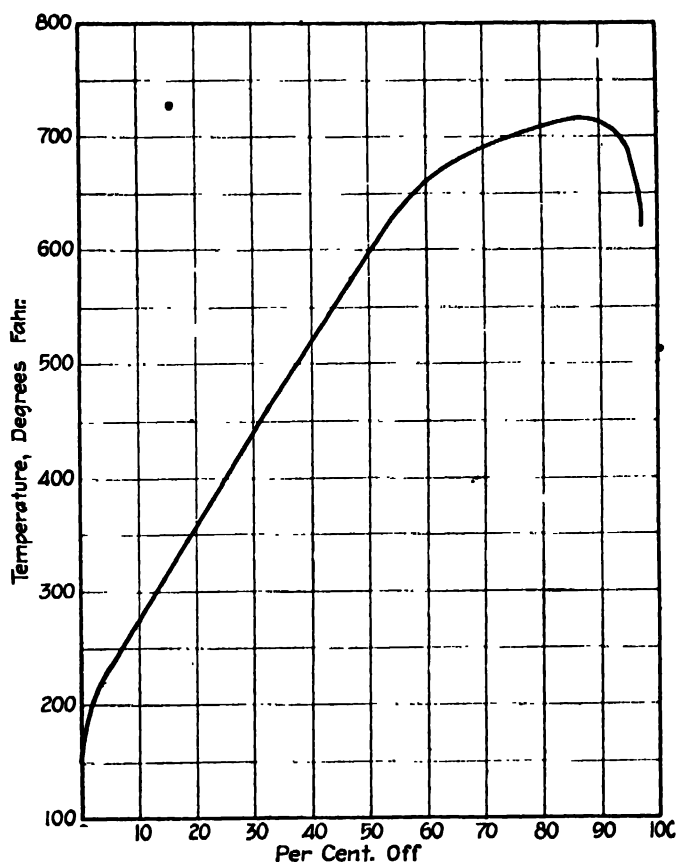


FIG. 1. DISTILLATION CURVE OF BIXBY CRUDE OF 34.6 DEG. GRAVITY

Probably the most apparent property of gasoline to the owner of his first car is that of color, and he with

his fellows soon learn to demand, without knowing why, a product which must be as clear as a crystal. Gasoline, being the lightest of the common liquids obtained from the distillation of petroleum or from natural gas, should be free from the heavy oils and asphaltic substances which would produce a yellow to brown color. A very light yellowish tinge may be caused by a dirty tank, contamination with coloring matters contained in packing of the seams of the tank, faulty refining and occasionally as a result of the addition of an inferior or heavy petroleum product. The common cause of the yellowish tint found in many gasolines is faulty refining. A very large part of the gasoline on the market is the product of cracking processes. The cracking process causes the formation of unsaturated compounds and these in turn are the cause of many gasolines going off color. The unsaturated compounds are removed to a great extent by washing the unfinished gasolines with sulphuric acid.

Gasoline Distillation Test

All gasolines used for motor fuel are subjected to the distillation test, which includes:

(*a*) The determination of the temperature at which the gasoline boils, or more accurately when the first drop falls from the end of the condenser tube; this is known as the initial boiling point.

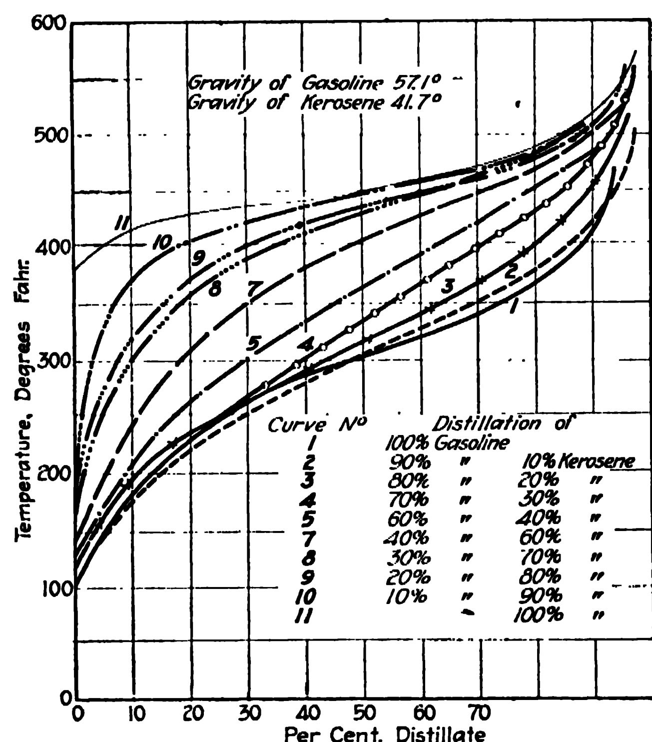


FIG. 2. EFFECT OF BLENDING OF GASOLINE WITH KEROSENE ON THE DRY POINT DISTILLATION

(*b*) The rate of distillation, which is determined by observing the temperature for each 10 per cent of the distillation.

(*c*) The dry point, or the temperature when there is no liquid remaining in the bottom of the flask, commonly known as the end point.

(*d*) The maximum temperature, or the highest temperature recorded at the end of the distillation.

It is unfortunate that the terms end point and maximum temperature are often confused. The dry point is probably more often considered to be the end point than the maximum temperature, because the dry point is the temperature registered at the end of the distillation or, specifically, when no liquid remains in the flask and the observation is usually aided by the fact that there is a slight puff of smoke formed when the last particle of liquid is vaporized. The maximum temperature, on the other hand, is the highest temperature recorded during the operation of heating and may be the dry point. The maximum temperature is a point not so easily checked as the dry point and the higher temperature may be due to superheating and not actually be a physical characteristic of the gasoline.

A convenient method for illustrating the results of distillation tests is by means of a temperature per cent curve, the ideal gasoline being one that produces a distillation curve which may be represented by a straight line inclined upward at an angle of about 30 deg., having a downward turn at the left end and an upward turn at the right end. The beginning of the curve shows the starting quality; the long straight line, the even distribution of the energy; and the upward turn at the end indicates the proportion and character of the heavier liquids present.

PHYSICAL AND CHEMICAL PROPERTIES OF MID-CONTINENT GASOLINE

Properties	Standard Motor and Navy Gasoline	Pressure Gasoline
Gravity, Bé	58 0 61 0	54 -60
Gravity, specific	0 7447 0 7330	0 7609 –0 7368
Initial boiling point, deg. F	95—140	100—140
Dry (end point), deg. F	437	436—460
Flash	Below zero	Below zero
Color	Plus 25 (Saybolt)	Yellow
Color	W. W. (Lovibond)	...
Odor	Sweet	"Cracked"
Doctor	Sweet	Sour
Sulphur, per cent	0 01—0 05	0 02- -0.08
Copper	Good	Good
Refractive index	1 4153 -1 4235 at 20 deg. C.	1.4430 - 1.4442 at 20 deg. C.
Evaporation, minutes	2 to 8	2
Iodine number	2 0 4 0	40 0 -55 0
Olefines, per cent	3 0 —10 0	6 0-–15 0
Aromatics, per cent	2 0 - 4 0	5 0 –12 0
Naphthenes, per cent	2 0-–15 0	5.0—10 0
B.t.u	20,000 21,000	20,000
Vapor pressure at 100 deg. F., lb.	3	4

The illustration (Fig. 2) includes a number of curves representing blends made with a fair grade of gasoline and good kerosene. These curves show very clearly the influence of both products. The gasoline when present to the extent of only 10 per cent lowers the boiling point to below 200 deg. F., while the kerosene, a heavy liquid, may be easily detected in every mixture and its behavior is well indicated from the starting of the curve through to the end point. While the initial boiling point of a heavy product may be lowered appreciably by the addition of a small quantity of light liquid, it is not possible to decrease the end point or lower the boiling points of the last fractions of a blend. The heavier particles persist and may be detected in a blended gasoline when present in very small quantities.

A comparatively low initial boiling point is a desirable property for a gasoline, because it insures easy starting of the motor. But should there be no rise in the curve the liquid would be too light for motor cars and the quantity required would be large, due to the exceedingly rapid rate of vaporization. A good body or staying quality is derived from the heavier constituents of the gasoline, and is indicated on a distillation curve by the uniform rise after the first 20 per cent fraction has distilled. An exceedingly rapid rise to the curve

would indicate the presence of a large quantity of heavy oils which might cause the deposition of carbon in the cylinders. Just what a safe rise would be and the proper end point have not been determined. The temperature of the explosion chamber is probably over 2,000 deg. F., and if the correct quantity of air were admitted, there can be no question that all ordinary gasolines would be altered to gaseous forms when exposed to so much heat.

Sulphur in Gasoline

The petroleum of the Mid-Continent district seldom contains more than 0.3 per cent sulphur and if the gasoline is properly refined it should contain less than 0.01 per cent total sulphur, but gasoline may be accepted on contract up to 0.04 per cent total sulphur. As indicated above, free sulphur is added to the unrefined gasoline during the refining process and if extreme care is not exercised the sulphur may be added in excess with the result that the completely refined gasoline will contain more sulphur than the untreated or unrefined product. Indeed the examination of a large number of gasolines indicates that many refiners are accidentally adding sulphur to their gasoline in this way. The harmful effect of the sulphur is evidenced in the corrosion of the copper tubing, the brass connections and the cylinders of the motors. The sulphur in the gasoline is particularly injurious to the brass and copper connections, with the result that the feed system often becomes clogged by the black scales collecting upon the openings to the vacuum feed. The sulphur is also deposited in the cylinders, and this, together with other black substances, is commonly called carbon. Analysis of this black deposit shows less than 65 per cent carbon, the remaining 35 per cent being made up of oil, asphalt, iron, silica and sulphur. Under the temperature existing in the cylinders, there can be no doubt that the sulphur combines with the iron and eventually causes serious damage.

Determination of Sulphur in Gasoline

A convenient and simple method for detecting the sulphur in gasoline has been proposed. A small piece of polished copper, or a clean penny, is placed in a beaker, covered with gasoline and heated over a steam bath for fifteen minutes. At the end of that time the copper is removed and examined. The surface will be found to have become tarnished or blackened according to the quantity of free sulphur. Analysis indicates that the deleterious action of the free sulphur becomes apparent when it is present to the extent of 0.008 per cent and very bad and corrosive in action when it is present to the extent of 0.018 per cent. The accompanying table gives the physical and chemical properties of Mid-Continent straight run gasoline obtained by direct distillation from the crude petroleum and a sample of unrefined pressure gasoline made by distilling gas oil under pressure.

In a very short period gasoline has advanced from an annoying substance to a product of great commercial importance. When first used as a motor fuel very simple requirements for quality were mentioned; usually gravity, covering a broad range, and color were sufficient.

The gasoline on the market today is classified under very carefully drawn specifications as illustrated in the accompanying table.

The Potash Deposits of Alsace

One of the outstanding questions of the great war was "Will Alsace be restored to France?" This question, full of national interest and appeal as it was to France and Germany, was of still wider commercial interest, for the only known deposits of potash of proved commercial value in the world except the deposits near Stassfurt, Germany, are in Alsace. The search for deposits in the United States, however, is being continued, and in that search a study of the origin, extent, and value of the deposits in Alsace is likely to be very useful. For this reason Hoyt S. Gale, of the United States Geological Survey, and Frank K. Cameron, of the Bureau of Mines, were sent to Alsace early in 1919, soon after the armistice had been signed, to examine and report upon the deposits there.

Location of the Deposits

The potash deposits of Alsace lie beneath an open stretch of the valley of the Rhine in southern Upper Alsace, about 25 miles north of the Swiss border.

No evidence of either the potash or of the large masses of common salt that are associated with it is found at the surface; the potash was discovered only by borings put down in search of coal. Under the German rule a large part of the potash field was owned and operated by the great potash monopoly, the German Kali Syndikat. All the potash properties in this region are now in the hands of representatives of the French Government.

Their Depth and Character

The potash deposits lie at depths ranging from 1,200 to 2,200 ft. below the surface, in two beds, one about 60 ft. below the other, which are mined through concrete lined shafts, somewhat as coal is mined. The appearance of the deposits in place is striking. They present high walls of sparkling crystalline salts, banded in nearly horizontal more or less wavy stripes of red and white, resembling a part of an immense flag. Much of the crude material is used for fertilizer after crushing only. In the refining processes the mother liquors are used repeatedly, as the accumulation of impurities in them is slow, this being considered one of the advantages which the French field has over the German. The resultant product from the refining of the Alsatian potash is a high-grade chloride.

Quantity of Potash in Alsace

Before the war, when the world's supply of potash was controlled by the Kali Syndikat, the mines in Alsace produced about 5 per cent of the total world's output of potash, equivalent in 1913 to about 220,000 tons of crude mixed salts containing 41,000 tons of potassium oxide (K_2O), or actual potash. The material mined carries an average of 18 per cent of potassium oxide. The deposits in Alsace are estimated to contain 300,000,000 tons of potassium oxide, enough to supply the world's need at the normal rate of consumption before the war for about 275 years.

Mr. Gale's report on the examination of these deposits has been published by the United States Geological Survey, Department of the Interior, as Bulletin 715-B, under the title "The Potash Deposits of Alsace." The report contains a valuable bibliography and is illustrated by a small map and several half-tone views. It may be obtained without charge from the Director of the Geological Survey at Washington.

Effect of Arsenic in Steel

By P. E. McKinney*

In view of the fact that the question has frequently arisen as to the effect of varying percentage of arsenic in steel, it was deemed expedient to make a few experiments in connection with the regular manufacturing operation on the effect of this element.

Two series of experiments were made. The first consisted of a comparison between a plain converter steel and steel from the same heat to which had been added 0.1 per cent arsenic. The second series was identical except that an addition of 0.5 per cent arsenic was made.

After adding the final addition to a regular converter heat, a 3[illegible]-in. diameter x 32-in. long split ingot mold was top poured from a bull ladle for the plain test. Then about 3 in. of steel was poured into a hot bull ladle of about 100 lb. capacity to cover the bottom, the metallic arsenic, mixed with several times its weight of thermit and wrapped in paper, was thrown in ladle, the ladle was then filled with steel, mixed and top poured into a similar mold. This constituted the arsenic test ingot; both series were handled in the same manner.

The ingots were stripped the following morning, sent to forge shop, heated and forged longitudinally from bottom end to [illegible] in. square and cut into 6-in. lengths, a convenient size for test-bars. They were not soaked or annealed before forging, but both series worked excellently while being forged. All of the 6-in. lengths were annealed at 1,400 deg. F. and then heat treated as shown in tabulation of results. The ingots whose heat numbers are followed by the letter A are those to which arsenic was added.

The result of these tests shows practically no difference between the steel containing no arsenic and that to which arsenic has been added, and if anything the result of test shows slight superiority in favor of the steel containing arsenic. While these tests were made on small ingots and the test-piece received considerable longitudinal forging work, the results of these preliminary tests would not indicate that arsenic has the detrimental effect to steel attributed to it by some authorities.

There is no noticeable difference in the properties of steel containing arsenic as compared with that to which no arsenic additions were made. In the pouring or forging the steel acted normal in every respect.

While it is evident from these experiments that 0.3 per cent arsenic is not injurious, as far as static testing can disclose, the fact must not be lost sight of that it is extremely hard to get rid of arsenic after it is once present in steel and if the steel is used for scrap purposes after its usefulness has ceased, there is a constant automatic augmentation of the arsenic content which will in time get beyond the limits desired. It would also be interesting to note the effect of arsenic upon shock-resisting qualities of the steel, which is of major importance where ordnance work is concerned.

Washington, D. C.

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*Chemist and Metallurgist, Naval Gun Factory.

Tests for Defects in Spring Steel

During the progress of some experiments made by the Bureau of Ordnance, U. S. N., to produce suitable recoil springs from a lot of [illegible]-in. round silicomanganese spring steel numerous breakages were obtained in the 24-hr. solid clamping test of the finished springs. In most cases the breaks showed deep seams. In torsion tests of the same material to determine the properties imparted by various heat treatments seams developed throughout the length of the specimen. In order to guard against receipt of such bars in the future it was first suggested to make a short torsion test of a fixed percentage of each lot. This would be an expensive procedure, and it was therefore decided to determine the effect of compression on a short length of the full size bar. This opened widely the seams noted in the above material and on twenty samples of material now in stock showed only three defective pieces. None of the defects was as serious as those in the [illegible]-in. silicomanganese steel. A paragraph is therefore being added to the specifications for spring steel requiring compression of a test piece of a length 1.5 times the thickness of the bar to a length equal to the thickness of the bar. This compression is sufficient to clearly indicate serious defects.

FIRST SERIES

Heat No.	C	Si	P	S	Mn	As	Remarks
C-1,082	0 18	0.26	0.025	0 021	0 60	0 031	No arsenic added
C-1,082A	0 19	0.24	0 023	0 030	0 62	0 089	0.1% arsenic added

Annealed	Oil Quenched	Drawn	Heat	P.E.L.	T.S.	Elong	Red	Rupture	Bend, Deg	Fracture
1,400			C-1,082	48,300	75,300	32 50	62 30	138,900	.	Perfect cup
1,400			C-1,082A	43,200	72,200	33 50	62 79	125,520		[illegible] cup
1,400	1,450	500	C-1,082	48,400	92,900	26 00	57 22	162,100	180	[illegible] cup
1,400	1,450	500	C-1,082A	53,500	88,100	28 50	60 56	164,800	180	Perfect cup
1,400	1,450	1,000	C-1,082	58,600	88,400	28 25	60 56	157,800		[illegible] cup
1,400	1,450	1,000	C-1,082A	53,400	85,300	31 25	64 42	179,200	. .	[illegible] cup
1,400	1,450	1,200	C-1,082	53,500	84,500	32 25	65 43	161,100	. .	[illegible] cup
1,400	1,450	1,200	C-1,082A	53,500	80,000	32 00	67 74	162,500	. . .	[illegible] cup

SECOND SERIES

Heat No.	C	Si	P	S	Mn	As	Remarks
C-1,123	0.13	0 25	0 019	0 048	0.57	0.065	No arsenic added
C-1,123A	0.12	0.33	0 018	0 045	0 57	0.310	0.5% arsenic added

Annealed	Oil Quenched	Drawn	Heat	P.E.L.	T.S.	Per Cent Elong.	Per Cent Red.	Rupture	Bend Deg.	Fracture
1,400	. . . .	. . . .	C-1,123	35,500	67,700	32 00	68.00	147,300	. . .	[illegible] cup
1,400	. . .	. . .	C-1,123A	39,600	67,800	31 50	67 50	139,000	. . .	[illegible] cup
1,400	1,450	500	C-1,123	45,800	75,100	31.00	62 20	143,800	180	[illegible] cup
1,400	1,450	500	C-1,123A	45,800	77,600	25 00	58 50	141,300	180	[illegible] cup
1,400	1,450	1,000	C-1,123	45,800	72,100	30.15	65.40	141,500	. . .	[illegible] cup
1,400	1,450	1,000	C-1,123A	49,600	74,000	33.50	64 60	143,700	. . .	[illegible] cup
1,400	1,450	1,200	C-1,123	42,700	69,300	32.00	70.40	157,300	. . .	[illegible] cup
1,400	1,450	1,200	C-1,123A	48,800	73,400	33.50	69.50	153,600	. . .	[illegible] cup

Wire-Baking Electric Oven

The application of electric heat to the process used in making steel wire has given such excellent results and is so economical of operation that it should be of interest to operators of all plants where wire drawing is done.

In the manufacture of steel wire the rods as received from the hot rolls are pickled in acid to remove the scale, dipped in lime-water to neutralize the excess acid, and then baked, to drive out the "acid in the steel," the amount of baking depending on how small the wire is to be drawn. If it is to be drawn only one or two holes, a short bake is enough, but for five or six holes the stock must be baked for several hours to withstand the severe drawing. The wire may be, in some cases, additionally heated to dry off grease or oil, or for a low anneal.

At the plant of the Halcomb Steel Co., at Syracuse, N. Y., where the following operation figures were obtained, there are two electric drying ovens, using G.E. apparatus, 16 x 6 x 6 ft. with 96-kw. connected, used for drying off the wire, at a maximum temperature of 600 deg. F., the other 40 x 6 x 6 ft. with 234-kw., for drying "acid in the steel," the wire being in the oven from 1 to 10 hr. at an average temperature of 350 deg. F. Coke and steam heated ovens are also used to do the same work. Thus it is possible to obtain comparative operation costs.

The following data show the cost of operation of the electric and coke oven for a considerable period of time on the ovens used in drying grease and oil from the steel, with normal production, and also the figures applicable if full production had been possible. The work of electric power in these tables is figured at $0.95 per kw.-hr.:

	Production Normal	Production Max
ELECTRIC		
Cost of power, net ton steel	$5 087	$1 19
Annual charges per net ton	7.839	727
Total cost per net ton	$12.926	$1 917
COKE		
Cost coke per net ton	$0.921	$0.171
Annual charges per net ton	21.368	1 983
Total cost per net ton	$22.289	$2 154

The efficiency of the electrically heated oven as actually operated amounts to 3.73 lb. per kw.-hr., or 535 kw.-hr. per ton, the maximum figures being 16 lb. per kw.-hr., or 125 kw. per ton.

The figures on the operation costs of the kiln for drying "acid in the steel" also show a greater economy in the use of the electric oven.

	Production Normal	Production Max
ELECTRIC		
Cost power, per net ton steel	$0.787	$0 515
Annual charges per net ton	.648	.187
Total	$1 435	$0.702
COKE		
Cost coke per net ton steel	$0 253	$0.146
Annual charges per net ton	1.766	510
Total	$2.019	$0 656

As operated, the efficiency of the electric oven is 24.1 lb. per kw.-hr., or 83 kw.-hr. per ton, while the maximum production figures would be 36.8 lb. per kw.-hr., or 54.4 kw.-hr. per ton.

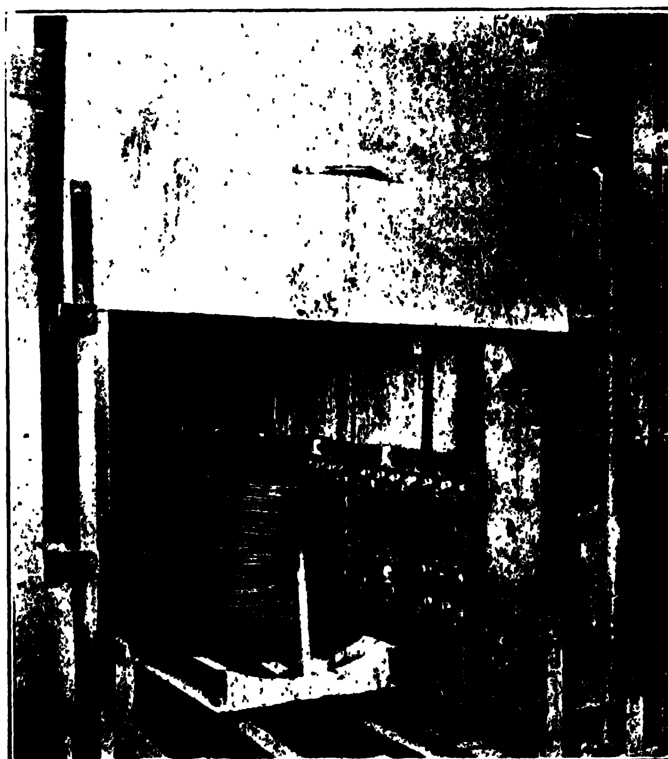
The use of an electric oven permits accurate duplication of results of the finished product due to the perfect temperature control, whereby the operating temperature can be quickly changed when desired.

Wedge Optical Pyrometer

Accurate measurement and control of high temperatures are essential to the production of the best results in the metallurgical and many other industries. It will soon be considered as absurd for a workman to attempt to estimate a temperature by the unaided eye as to attempt to measure up his work by the eye alone when rules and gages are available. The demand for a simple, portable instrument for temperature measurement, which can be used without long training or expert technical qualifications, has been met by the Wedge optical pyrometer, a reliable and practical instrument, requiring no accessories of any kind, which cannot get out of order, and may be placed with confidence in the hands of any intelligent workman.

This pyrometer can be used whenever the object to be examined shows a distinct coloration, that is to say, for any temperature above 525 deg. C. The size of the object or its distance makes no difference whatever to the reading.

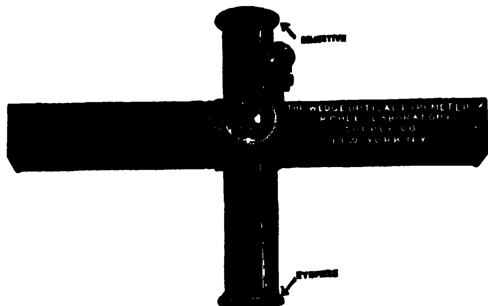
As shown in the accompanying illustration, the instrument consists of a brass tube, furnished with a small achromatic telescope, so arranged that the objective of the telescope focuses the image of the heated body on a movable prism placed inside the tube. The eye-piece of the telescope then reveals the magnified image on the prism to the observer. There is a suitable shield provided, to prevent exterior light reaching the eye. At one side of the tube is a milled head, actuating a rack-and-pinion which moves the prism through the field of vision. The prism is made of specially prepared dark glass, so arranged that it cuts off the light emitted by a heated body at different temperatures. For example, in looking at a heated bar of iron, as the thicker part of the prism comes gradually into the field of vision, the bar appears gradually darker and darker in color, until at a given point the image entirely disappears; this point gives the actual temperature. On



INTERIOR VIEW OF WIRE-BAKING ELECTRIC OVEN

looking at the scale on the side of the instrument, the pointer will be seen at (say) 1,000 deg. C. A similar operation takes place in every estimation. Naturally a little practice is required to decide the exact moment when the color disappears, and here, of course, the practiced eye of the operator comes into play.

The first readings will probably be within 20 deg. C., afterwards to 10 deg. C. or less. When great accuracy



WEDGE OPTICAL PYROMETER

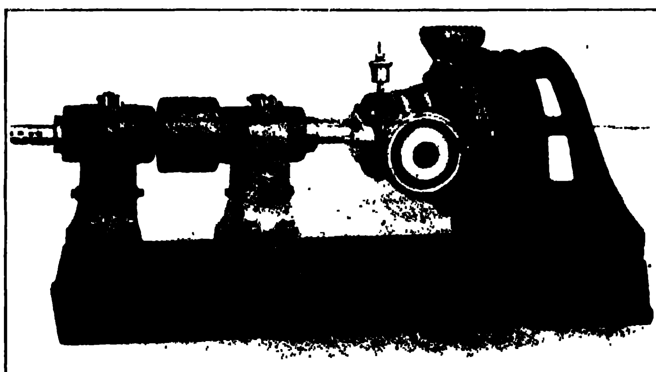
is required, and the heated body or furnace aperture is small, it is advisable to mount the pyrometer on a stand. The accuracy of the Wedge optical pyrometer has been demonstrated by trial by eminent experts under test conditions. It is introduced on the market by the Rohde Laboratory Supply Co., of New York City.

Non-Corrosive Centrifugal Pump

The Duriron Castings Co., of Dayton, Ohio, has placed on the market an improved Duriron single-stage centrifugal pump. Every part of the pump that comes in contact with the liquid handled is of Duriron, and thus resists virtually all acids, alkalis and salts as well as erosion.

Probably the greatest single source of trouble, certainly the most constant one, in acid pumps has been the limited service possible to obtain from the packing.

Contact of the corrosive handled with the packing made its life short, and frequent repacking of acid pumps has been considered a necessary evil. In this pump the packing cannot be touched by the liquid



DURIRON CENTRIFUGAL PUMP

carried, inasmuch as the suction is always under vacuum while the pump operates.

Operators should be instructed, however, to drain the pump when not in service and when the vacuum is lost.

All parts of the pump proper may be reached quickly and easily by loosening the bolts, removing the cover plate, and pulling out shaft and runner, and this without disturbing the suction and discharge connections.

By means of a cage gland the lubricant is forced from the container always and only in the direction of the packing.

The impeller is of such design that in case the discharge connections break and the head be reduced, the impeller will not admit more liquid than the motor will handle, so it automatically prevents damage to motor in direct connected installations. Helical vanes in impeller admit a free flow of liquid, consequently there is the least possible erosive action in operation.

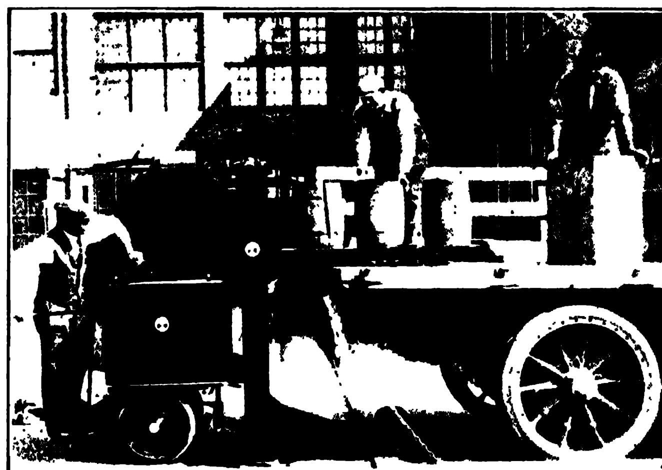
The suction and discharge connections are adjustable, and this pump will accommodate itself to any position or angle that may be necessary or desirable under any conditions of installation.

Where the liquid handled carries solids in suspension or material not suitable for the closed type of impeller, an open type that will handle a large percentage of solids may be used.

All parts of the pump are ground to gage and are therefore interchangeable.

New Truck to Save Space, Time and Man Power

A new industrial truck which, with its own power, elevates the loads to sufficient heights to put material in box cars, stock rooms or trucks, without rehandling, has been developed by the Lakewood Engineering Co.,



Cleveland, Ohio. Because of its ability to perform all the functions of a tiering machine as well as those of a load-carrying storage battery truck, the new machine is called the "Tier-Lift." It serves practically every purpose of a load-carrying industrial truck. This apparatus will, with its own power, elevate a 2-ton load to a height of 76 in., or to any intermediate height.

A 4-wheel steer permits turning in a circle 92 in. in radius. This permits easy turning in narrow aisles, or congested parts of a plant, and gives easy entrance into box cars.

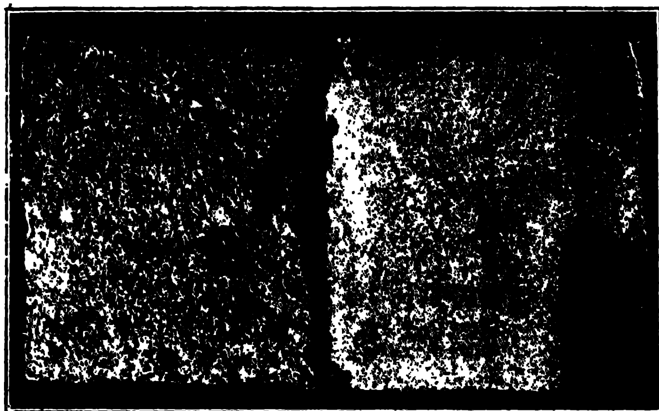
There are three speeds forward and three speeds reverse. The controller handle is conveniently located for operation for travel in either direction. The lifting mechanism is operated by means of a specially designed controller with one speed in either direction. The lifting is done by means of high-efficiency steel worm screws. A separate motor is used to raise the load.

The load platform is carried by a cantilever type support and the load is balanced over the load-carrying wheels. Ball bearings are used throughout and by a special design the friction losses in elevating and lowering the load platform are practically eliminated.

Acid-Proofing and Hardening of Concrete

The chemical division of the U. S. S. Lead Refinery, Inc., is producing a new solution for the hardening and acid-proofing of concrete surfaces. The manufacturing operations are carried on at the company's lead refinery located in East Chicago, Ind. This solution has become a product of intense interest to manufacturers of chemicals, particularly those industries where acids or oils enter into the processes, mainly because the tests made up to the present time and still under way show that ordinary concrete is rendered practically inactive to acid solutions and oils.

The concrete surface at the time of each treatment must be free from dirt, oil or grease, and must be dry



TEST WITH ACETIC ACID

and set at the first instance of application. One part of proofing solution is diluted with two parts of water and applied with a brush. After allowing to stand for twenty-four hours the second coat is put on, consisting of equal parts of proofing solution and water. This is allowed to stand for twenty-four hours and a third coat is applied, consisting of two parts of proofing solution to one part of water. When the concrete is very porous a fourth application of straight proofing solution is recommended.

At the completion of the process the surface is dried and flushed with water.

When the solution is thus brought in contact with the concrete, it precipitates acid-resisting compounds into the pores of the mass, causing the new surface to become an entirely different chemical composition from the original concrete, this effect penetrating to a depth of about ⅛ in. This new surface chemically formed is hard and flint-like in structure and is not attacked by acid solutions or oils. It is also very hard, being resistant to wear, as when put on concrete floors.

It is now in use on floors subjected to acid slops at the Willard Storage Battery Co. and is being considered by a number of chemical firms for the construction of acid tanks. Should it prove successful in the latter case, the benefit to the chemical engineer over the present method of lining these tanks or silos with acid-proof brick is obvious.

The accompanying illustration shows a comparison between a treated and untreated slab of concrete which has been immersed in a 20 per cent acetic acid solution over a long period of time. A complete series of tests on all of the acids is now under way at the Research Laboratory of the U. S. S. Lead Refinery, Inc.

Roto Piston Pump

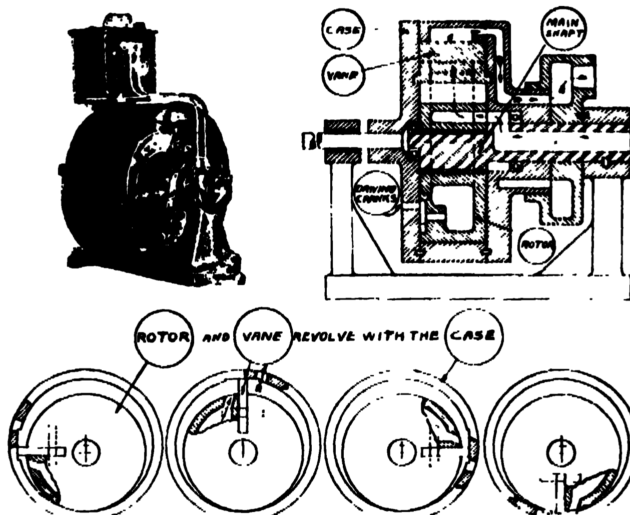
A totally different application of eccentric motion, obtained through the use of the "Roto-Piston," has been introduced by the Crescent Pump Co., of Detroit, in commercial vacuum and pressure pumps. Manufacturing high-duty, high-speed pumps, direct-motor driven, it has been sought to make durability the outstanding feature. By its ingenious construction and operation this has been so far accomplished as to justify a guaranteed length of life for each pump.

The vacuum pump will pull within ½ in. of mercury pressure under commercial conditions and down to $\frac{1}{10}$ in. in special use, according to the manufacturer's guarantee. Reversed as a compression pump, it will give 20 lb. to the sq.in.

An inner and an outer casing revolve at the same speed, greatly reducing friction, as all contact are rolling contacts. Flywheel vanes, valves and gears are eliminated. A single sliding vane accomplishes a continuous sealing with an oil film protection, being positively held by centrifugal force. It rotates with the inner and outer casings and at almost the same speed, having a sliding contact area of less than 3 in. on the outer casing.

The accompanying diagram illustrates the motion of the pump. One casing revolving on an eccentric alternately creates and fills a space into which air is drawn. At rapid revolution the action is continuous.

An important feature in the pump's long life is the compensation which is automatically made for wear.



ROTO PISTON PUMP

This wear takes place almost entirely in the bearings, which are standard ball and roller bearings. Because of this automatic compensation adjustment is unnecessary and leakage is easily prevented.

Careful balancing of all rotating parts practically eliminates vibration. The complete pump is compact, light and self-air-cooled, and can be easily moved. Heavy foundations are not required.

Porcelain Token Money

The city of Meissen and other towns have ordered porcelain coins for local use, to solve the small-change scarcity and obviate the present unclean and easily tearable paper currency. Germany is said to be about to introduce porcelain small-change coins.

Synopsis of Recent Chemical & Metallurgical Literature

Status of the Aluminum Industry in Germany During and After the War.—Among the industries which were most extensively developed in Germany during the war that of aluminum occupies one of the first places. L. DESCROIS has published in the April, 1920, issue of *Revue de Métallurgie* an article on this subject, of which the following is an abstract:

Up to 1914 the role of aluminum was quite unimportant, but the necessities of war required its extensive use by all the belligerent nations and especially by the Central Powers.

Aluminum alloys were extensively used in aëronautics and automobile construction; the iron industry used great quantities of a ferro-aluminum with 10-20 per cent aluminum and 3 per cent carbon as a deoxidizer; an aluminum alloy was used for the manufacture of fuses and even for small change money (pfennigs). Aluminum metal was used as a copper substitute for electric conductors, in fermentation industries and in nitric acid plants. In Austria aluminum powder entered into the manufacture of explosives.

Germany has no bauxite or cryolite deposits, except small quantities of very poor quality in Hesse near Frankfurt-a-M., and previous to the war 95 per cent of the bauxite treated in Germany was imported from France. The aluminum industry was monopolized by two companies; namely, (1) The Aluminium-Industrie Aktien-Ges. of Neuhausen (Switzerland), with plants at Neuhausen (4,000 hp.) and Chippis (50,000 hp.), both in Switzerland; at Rheinfelden, Germany (5,000 hp.), Lissa, Silesia, and Lend-Gastein (15,000 hp.), in Austria, and (2) Gebrüder Giulini of Mannheim, with plants at Lissa, Silesia, and Martigny, Switzerland (3,000 hp.).

These two companies controlled the entire production of the three states and during 1913 produced 12,000 tons of aluminum—i. e., 17.6 per cent of the total world production. Of this amount Neuhausen and Chippis produced 8,000 tons and Martigny 700 tons, so that the aluminum production in Germany in 1913 was not over 2,500 tons, although its consumption was about 12,600 tons—i. e., 18.5 per cent of the total world consumption.

With the outbreak of the war the supply of raw material was completely cut off and they had to rely on Switzerland for the needed aluminum, which they were able to obtain in exchange for coal. Thus during the second half of 1914 Germany imported from Switzerland nearly 4,000 tons of aluminum, about 9,000 tons in 1915 and more than 10,000 tons during 1916. This contributed to an extraordinary development of the aluminum industry in Switzerland, where in 1917 the production reached 20,000 tons, of which the greater part went to Germany. But even the increase in import did not meet their needs, and so the Germans started to build their own plants as early as 1915. The first aluminum war plant was put in operation at the end of 1915, using as raw material the timely discovered bauxite in the Carso region along the Adriatic Sea of the then Austrian Empire. From that region about 50,000 tons of bauxite was mined in 1916, besides the supply of the formerly known bauxite mines in Hesse, near Frankfurt-a-M. The need of aluminum encouraged extensive exploration for bauxite, with the result that rich deposits were discovered in Dalmatia and Hungary. Those of Hungary are especially valuable and it has been estimated that there is in reserve about 10,000,000 tons in the Bihar district alone, besides appreciable quantities in the valleys of Jad and Galbina and near Rey, Sonkolyos and Tizfalu.

The Bihar bauxite analyzes Al_2O_3 53-60 per cent; SiO_2 1.67 per cent; Fe_2O_3 20-35 per cent, TiO_2 1.5-3 per cent, and in 1915 as much as 50,000 tons was mined from this newly discovered field. It is also said that there was obtained in 1916 from the Oderberg district about 40,000 tons of bauxite analyzing Al_2O_3 54 per cent, SiO_2 2.6 per cent, Fe_2O_3 26 per cent, TiO_2 4 per cent. The Dalmatian and Carso mines, especially those of the islands of Veglia, Loparo and around St. Gregory, were worked with Russian prisoners. In May, 1916, it was stated that the German Norton Co. discovered near Laybach great quantities of very pure bauxite, but it would seem that not much use has been made of it, because the official figures given indicate that only 660 tons was mined in 1916 and 4,000 tons in 1917.

Great efforts have been made to recover aluminum from clay or from a mixture of clay with bauxite or cryolite, but it is certain now that all these efforts failed completely.

The importance of aluminum proved such that by the middle of 1916 the Imperial Finance Department approved the formation of three special aluminum companies; namely, (1) Erftwerk Aktien Gesellschaft, (2) Vereinigte Aluminium Werke Akt. Ges. and (3) Innwerk Bayerische Aluminium Akt. Ges. Up to now three new plants have been installed—namely, at Knappsack, near Cologne, by the first named company, and at Bitterfeld and Niederlausitz, by the Vereinigte Aluminium Werke. All these plants get their power from central stations using lignite as fuel. There are now in course of construction two plants by the Innwerk company to use respectively 50,000 and 75,000 hydro-electric hp. It is stated that when all these plants are in full operation their annual production will be 45,000 tons.

Aluminum is destined to occupy a very important place in industry, due to the great variety of applications to which it may be suited and to the relative abundance of the raw material.

The following table giving the production in thousands of tons for 1913, 1917 and after the war, shows the rapid increase in the aluminum industry in the main producing countries:

ALUMINUM PRODUCTION, THOUSANDS OF TONS

Countries	1913	1913 Per Cent	1917 According to Mineral Industry	1917 According to Engineering & Mining Journal	After the War According to R. Troger	After the War Per Cent
United States....	22.5	32.50	90.7	65	65	33.70
France..........	18.0	26.00	20.0	20	20	10.35
Great Britain....	7.5	10.80	6.0	12	12	6.20
Germany........	1.0 (?)	1.45	6.0	12	40	20.70
Austro-Hungary (now in Hungary and Jugo-Slavia	1.0 (?)	1.45	5.0	5	....	....
Switzerland......	12.0	17.35	15.0	20	25	13.00
Canada.........	5.9	8.50	14.3	8	8	4.15
Italy...........	0.8	1.15	7.0	7	7	3.60
Norway.........	1.5	2.15	18.0	16	16	8.30
Total	69 2	99.90	176.0	153	193	100.00

Mr. DESCROIS passes in review at length the prospects for the after-war German industry, and shows that these prospects are very gloomy, due to the low quality of raw material, the percentages of silica and titanium oxide being detrimental, and to the high cost of power. He analyzes the cost prices, especially those given by Dr. Hans Goldschmidt and Dr. C. Dux, both authorities on the aluminum industry, and concludes with the statement that even on the basis of the German calculations Germany will not be able to compete with the American, French and Swiss producers.

Enamels for Sheet Iron and Steel.—In response to the demand for a general treatise dealing with the technology of the manufacture of vitreous enamels for sheet iron and steel, the Bureau of Standards has issued Technologic Paper 165, by J. B. SHAW. This subject has not been treated adequately in any previous publication.

From the standpoint of mechanical equipment the sheet-iron and steel enameling industry has been probably the most progressive of all ceramic industries in the United States. The presses and machinery used for working the steel and forming the shapes are unsurpassed in ingenuity by those used in any other industry, and are constantly being improved. In this respect the sheet-metal enameling industry of this country has led the world. In the strictly ceramic lines of the industry having to do with the preparation and application of the enamels, progress has been less rapid. Up to a few years ago there was very little work carried on, and this little was seldom reported in print. Recently there has been a decided change in this respect. Representatives of the enameling industry have been joining the ceramic technical societies, have been contributing rather liberally to the journals of these organizations, and have been showing a decided interest in developing the technology of sheet-metal enameling. The leading manufacturers of the country are realizing that the sheet-iron enameling industry has reached the limit of development possible so long as it depends upon formulas rather than upon men with technical training which will enable them to improve and manipulate these formulas to meet varying conditions.

In collecting data for this paper an effort has been made to obtain reliable and authentic information wherever available and to correlate it in such a manner as to shed some light on the problems encountered by enamelers. The treatise is a compilation of data dealing with the subject of enameling from various publications, from the note book of the author, from the files of the Bureau, and from the experience of men engaged in the enameling industry in this country.

Among the subjects dealt with in connection with the properties and preparation of steel for enameling are physical and chemical requirements, sand blasting, treatment preliminary to pickling and methods of pickling. A chapter is devoted to the properties of the raw materials used in compounding enamels. The relations between chemical composition and physical properties of enamels are discussed fully. The procedure used in the preparation, applying and firing enamels is described in detail. The calculation of enamel formulas is fully explained and examples are given. The physical properties of enamels are dealt with in some detail and resistance of enamels to chemical action is fully discussed.

Recent Chemical & Metallurgical Patents

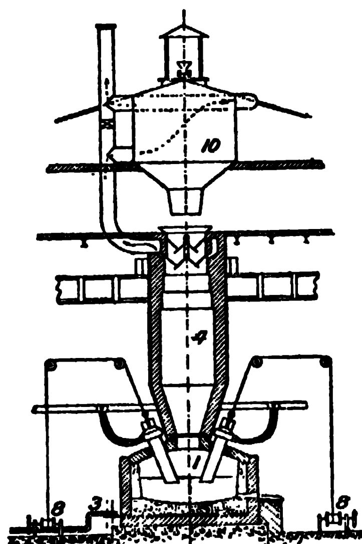
British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Sulphur. — Crude sulphur is purified by melting or dissolving in a suitable solvent, such as carbon bisulphide, and filtering through precipitated and ignited alumina or magnesia or mixtures thereof, or through ignited bauxite or magnesite or mixtures thereof. Solutions of sulphur obtained by extracting spent oxide with a solvent may be similarly treated. When exhausted, the filtering material is revivified by treating with steam or with a solvent for sulphur and then igniting. (Br. Pat. 140,844—1919. J. J. HOOD, London, May 27, 1920.)

Extracting Copper.—Lyes, used for lixiviating cupriferous pyrites, flow from a cock on to waste iron plates in a wicker-work basket, suspended above a tank, whereby a thin film of copper is allowed to deposit on the iron. The copper-coated iron is transferred to a tank containing cupriferous solution or lye to allow the film to increase in thickness. Finally, the copper is removed by means of a flexible blade, washed and dried, when it is ready for use for melting down, for electric refining, or for the manufacture of copper sulphate. The product contains 98 to 99 per cent of copper and a very low proportion, 0.35 per cent, of iron. (Br. Pat. 141,290—1919. H. P. SOULIE-COTTINEAU, Paris, June 9, 1920.)

Electrode Furnaces.—A furnace of known type, for the manufacture of hydraulic lime and slow or quick-setting cements by fusion of the ingredients, is provided with electrodes which dip into a crucible 1 and are adjusted by winches 8. Above the crucible is a cylindro-conical shaft 4 into which the materials are fed from a preheater 10. The hearth of the crucible is made of rammed conducting-material, such as earth, resting on a conducting-plate connected with the conductor bar 3. (Br. Pat. 141,142—1919. M. L. BOILOT and J. DAUDIGNAC, France, June 9, 1920.)



ELECTRODE FURNACE

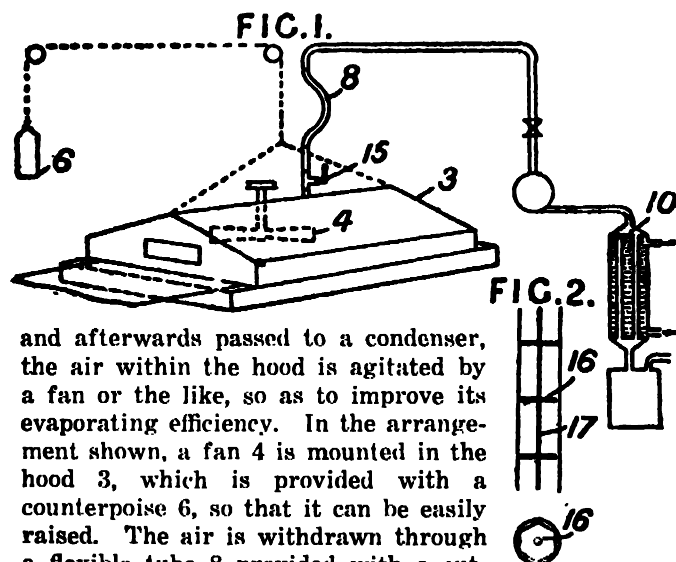
Purifying Oils.—Finely divided calcined phosphate is added to the oil, which may be stirred and kept at 40 to 50 deg. C. On standing, the mixture separates into layers, which are tapped off. The phosphates may be added in a dry state or suspended in water. A calcined natural phosphate such as apatite is used. Products obtained by calcining a mixture of an artificial phosphate,

such as tricalcium phosphate, with a metallic salt of a volatile acid or other substance contained in crude phosphates, e. g. halogen compounds or carbonates, may also be employed. The phosphate may be used in conjunction with other refining-agents. The calcined phosphate may be treated with acids, alkalis or other reagents. The precipitate obtained in treating the oil may be dried and used as a fertilizer. (Br. Pat. 141,028—1919. K. STIANSEN, Sanderfjord, Norway, June 2, 1920.)

Barium Carbonate.—Finely-divided barium carbonate is obtained by treating witherite or artificial carbonate with a fused salt, such as sodium chloride, which dissolves it. A small quantity of an oxidizing agent, such as sodium nitrate, may be added, or air may be blown through to oxidize iron compounds, and any sediment or scum is removed; or the fused mass may be submitted to a reducing atmosphere in the furnace. The material is then discharged into water, which dissolves the solvent salt, leaving the barium carbonate in a finely-divided state. (Br. Pat. 141,925—1919. H. LANGWELL, Stockton-on-Tees, June 23, 1920.)

Steel.—In making steel from scrap, a small part of the charge is melted in an open-hearth furnace with a carburizing agent whereupon the main part of the charge, preheated to about 800 deg. C., is added. Alternatively, the molten carburized metal may be added to the main charge in a separate furnace. The process may be worked as a continuous one. The preheating may be effected in containers erected over the hearth, or portable and traveling preheaters may be used. Metal and slag may be withdrawn from the furnace by means of a siphon. (Br. Pat. 141,956—1919. G. A. JARVIS, Wellington, Shropshire, June 23, 1920.)

Recovering Volatile Solvents.—In an apparatus for recovering volatile solvents, especially in the rubber industry, in which air is drawn through a closely-fitting hood covering the substance under treatment



and afterwards passed to a condenser, the air within the hood is agitated by a fan or the like, so as to improve its evaporating efficiency. In the arrangement shown, a fan 4 is mounted in the hood 3, which is provided with a counterpoise 6, so that it can be easily raised. The air is withdrawn through a flexible tube 8 provided with a cut-off valve 15 connected to the starting lever of the machine, by which it is closed when the material is not being drawn through the hood. From the hood the air passes to a condenser 10. It may be compressed before passing to the condenser. The condenser tubes may be of circular cross-section provided with hexagonal baffles 16 on a central rod 17, as shown in Fig. 2, to collect entrained liquid. (Br. Pat. 141,210—1919. D. V. PLUMBRIDGE, South Kilworth, Warwickshire, June 9, 1920.)

Artificial Threads.—To obtain very fine threads from viscose by the drawing-out process, the viscose used is prepared from a "very weak hydrated cellulose," and the original relatively-thick threads are stretched, while undergoing coagulation, in a slowly acting precipitating liquid, such as a 1 per cent sulphuric acid solution. After leaving the coagulating bath the threads are wound on reels revolving in a 2 to 4 per cent solution of sulphuric acid, by which they are finally hardened. (Br. Pat. 141,041—1919. GLANZFADEN AKT.-GES., Petersdorf-in-Riesengebirge, Germany, June 2, 1920.)

Secondary Disazo Dyes.—Secondary disazo dyes are prepared by diazotizing an aminoazo dye of the general formula



(R, R¹ — aryl radicals, substituted or not), and coupling with an aminonaphthol sulphonic acid, an acetylaminonaphthol sulphonic acid, or a pyrazolone containing a carboxyl group or a carboxyl group and a hydroxyl group in its aryl residue. The products are mordant dyes, dyeing wool in acid baths shades which become yellow to red or green-blue when afterchromed, and give similar tints when chrome-printed on cotton. Examples are given of the preparation of dyes from the following parent materials:—4-aminoazobenzene-3: 3¹-dicarboxylic acid and 1-2¹-carboxyphenyl-3-methyl-5-pyrazolone; 4-aminoazobenzene-3: 3¹-dicarboxylic acid and 1: 8: 2: 4-aminonaphthol disulphonic acid; 4-aminoazobenzene-5¹-sulpho-3:3¹-dicarboxylic acid and 1-phenyl-5-pyrazolone-3-carboxylic acid; 4-aminoazobenzene-5¹-sulpho - 3:3¹-dicarboxylic acid and 1:8:3:6-acetaminonaphthol disulphonic acid; 4-aminoazobenzene-2:3¹-dicarboxylic acid and 1-2¹-oxy-3¹-carboxy-5¹-sulphophenyl-3-methyl-5-pyrazolone; 4-aminoazobenzene-3:4¹-dicarboxylic acid and 1-2¹-oxy-3¹-carboxyl-5¹-sulphophenyl-3 - methyl - 5 - pyrazolone. (Br. Pat., 141,401—1919. SOCIETY OF CHEMICAL INDUSTRY, Basel, Switzerland, June 9, 1920.)

Aromatic Amines, Phenols, etc.—Coloration is removed from, or its development prevented in, aromatic amines or phenols or their sulphonic or carboxylic acids by treatment with a small proportion of a hydrosulphite or sulphoxylate, any excess of hydrosulphite or sulphoxylate being finally removed. Thus, a discolored finished product is dissolved or suspended in a solvent, decolorized by adding a small proportion of hydrosulphite or sulphoxylate, and then isolated from the solution or suspension in the usual way; or discoloration may be removed or prevented in a product by adding a small proportion of hydrosulphite or sulphoxylate to the parent materials used in the manufacture thereof. Examples are given of the treatment with sodium hydrosulphite of β-naphthol, benzidine, the solutions of sodium sulphanilate or naphthionate obtained in the manufacture of these acids, or the acidified alkali melts obtained in the manufacture of phenols such as β-naphthol, H-acid, or γ-acid; an example is also given of the addition of sodium hydrosulphite to mixtures of caustic soda solution and sulphonic acids, e.g. aminosulphonic acids, before heating in an autoclave to produce the corresponding phenols. (Br. Pat. 141,440. SOUTH METROPOLITAN GAS CO., London, and H. STANIER, Stoke-on-Trent, June 9, 1920.)

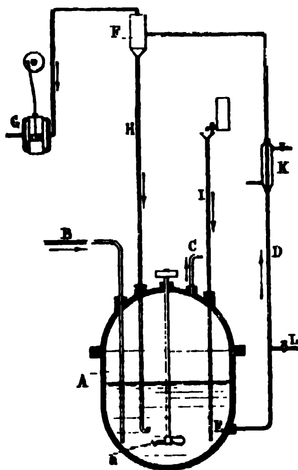
Acid- and Alkali-Proof Aluminum Ware.—Aluminum, aluminum alloys or vessels coated or lined with aluminum are rendered acid- and alkali-resisting by powdering the preliminarily roughened surface with finely-ground carbonate of lime (chalk, mussel shells, etc.), then heating in a furnace to about 550 deg. C. and binding the coating to the aluminum by rolling, pressing, etc. (Br. Pat. 140,069—1919. METALLINDUSTRIE SCHIELE & BRUCHSALER, Hornberg, Baden, May 12, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Purifying Brine.—In the purification of brine for use in electrolytic cells, the calcium sulphate is usually converted into calcium carbonate by means of sodium carbonate. Thus there is formed in the brine an equivalent amount of sodium sulphate, which oxidizes the graphite anode during electrolysis and accumulates in the cell until it interferes with the efficient operation of the latter. For the removal of this sodium sulphate, FRANK G. WHEELER, of Appleton, Wis., has devised an apparatus in which the impure brine is cooled by flowing over pipes containing refrigerated purified brine. The sodium sulphate which crystallizes out adheres to the pipes and has to be removed by a mechanical scraper. The mixture of brine and crystals passes to a settling tank, from the bottom of which the crystals are discharged into a centrifugal drier. The cold purified brine serves to cool the impure brine in a preliminary heat-interchanger. (1,342,519; assigned to Bleach Process Co.; June 8, 1920.)

Acetaldehyde From Acetylene.—In the preparation of acetaldehyde from acetylene, the catalysts used tend to polymerize a part of the aldehyde or to transform it into aldol, crotonic aldehyde, etc. The solution of this problem is the continuous removal of the aldehyde as rapidly as formed. Many methods have been proposed for the accomplishment of this result. The most recent is that of ALFRED GUYOT, of Salindres, France. An apparatus has been devised in which the aldehyde is extracted continuously by the use of a vacuum, which does not, however, act in such a manner as to draw the acetylene gas through the reaction vessel without being fixed. The reaction vessel *A*, into which the acetylene enters through tube *B*, is provided with a powerful agitator *a*. The residual gases escape through *C*. Under the influence of the vacuum pump *G* circulation of the liquid through tubes *D* and *H* is maintained in the direction indicated by the arrows. The rise of liquid in *D* may be assisted by introducing air at *L* or by heating at *K*. Arriving at *F* the acetaldehyde evaporates due to the diminished pressure, and the aldehyde-free liquor returns to the reaction vessel through *H*. Water entering into reaction or lost by evaporation is replaced through *I*. (1,343,715; assigned to Compagnie des Produits Chimiques d'Alais et de la Camargue; June 15, 1920.)



Porcelain.—Porcelain has heretofore been made of a mixture of clay, a flux, such as feldspar, and silica, these ingredients varying somewhat in proportion and chemical purity. The silica has been used as a sort of refractory skeleton or body during the vitrification of the other ingredients. CHRISTIAN DANTSIZEN, of Schenectady, N. Y., has discovered that the mechanical and insulating properties of porcelain may be improved by using in place of silica, in part or entirely, a stable refractory material, such, for example, as an oxide of zirconium, titanium, aluminum, magnesium, glucinum or thorium. A typical porcelain mixture in a "green" state before firing may consist of 45 parts clay, 35 parts feldspar and 15 parts flint. When a porcelain having the above composition and prepared in the usual manner is heated to 800 deg. C. and then plunged into water it becomes highly fragile so that it can be readily broken apart between the fingers. When the silica in such a composition is replaced by a refractory metallic oxide—for example, zirconia or zircite cement—the finished porcelain can be heated to 800 deg. C. and can be plunged into water without losing its mechanical strength. The modulus of rupture of a sample of porcelain was found to be 4,390; the modulus of rupture of a zirconia porcelain similarly prepared was found to be 7,400. The electrical resistance of ordinary porcelain and zirconia porcelain are closely the same at ordinary temperatures, but at elevated temperatures the electrical resistance of zirconia porcelain is greater than that of ordinary porcelain; for example, at 286 deg. C. the electrical resistance of ordinary porcelain was found to be 0.832 megohms, while at this temperature the resistance of zirconia porcelain is 2.43 megohms. The new porcelains are also less porous than silica porcelain. (1,343,040; assigned to General Electric Co.; June 8, 1920.)

Treating Waste Sulphite Liquor.—A process for the recovery of SO_2 from waste sulphite liquor which leaves the liquor in a favorable condition for fermentation, etc., is described by AUGUST SCHAEFER, of Portland, Ore. The waste liquor as discharged from the blow pit of the digester flows in a thin film over a series of vertically stacked steam-heated coils contained in a chamber in which a vacuum of 5 to 6 in. is maintained by a barometric jet condenser. The heat and diminished pressure facilitate the escape of the SO_2, which is recovered by absorption in water in a suitable tank situated between the evaporating chamber and the condenser. The remainder of the liquor is discharged through the bottom of the evaporating chamber, neutralized and cooled. It may then be fermented for the production of alcohol. (1,342,721; assigned to Northwest Process Co.; June 8, 1920.)

Halogenation in Side Chain of Aromatic Compounds.—Sulphur chloride (or sulphur) in the presence of acetyl chloride forms an efficient catalyst for the substitution of a halogen in the side chain of an aromatic compound. Thus, in the preparation of benzal chloride, 225 parts of dry toluene is mixed with 4.5 parts of sulphur chloride and 4 parts of acetyl chloride. After heating to 100 deg. C. dry chlorine is introduced rapidly and the temperature raised to 180 deg. C. When the liquid has a specific gravity of 1.272 the flow of chlorine is stopped. The liquid will be found to contain about 245 parts of benzal chloride. The preparation of benzyl chloride and benzotrichloride is also discussed. (1,345,373; LUCAS P. KYRIDES, of New York, assignor to General Chemical Co.; July 6, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Chemical Exposition Greater Than Ever

With accepted applications for space near the 400 mark—a new record—the preliminary details of the Sixth National Exposition of Chemical Industries in Grand Central Palace, New York City, Sept. 20 to 25 inclusive, make certain that the show will outclass the five previous ones. The program, aside from the exhibition proper, is also the most important that has ever been scheduled.

On the afternoon of Thursday, Sept. 23, the Chemical Engineering Symposium will take place. The American Institute of Chemical Engineers will hold a meeting in the Palace in the afternoon, and papers of great interest will be read. In the evening the engineers will have a dinner at the Technology Club.

Three other symposiums will be held during the week. One will be on Fuel Economy, one on Materials Handling, and one on Industrial Management. The Fuel Handling Division and the Materials Handling Division have developed such progress that it is necessary to give each a separate section at the coming Exposition. Important topics will be discussed on the days these two divisions meet.

Entering as it does practically every phase of industry, the Exposition offers a remarkable opportunity to the manufacturer and business man to see what has been accomplished since American chemists entered the field in earnest, or during the war. Discoveries that have revolutionized many manufacturing processes have been made. These have increased production and improved the quality of the merchandise and have resulted in those who have spent money in research finding that the investment paid.

A feature of this year's Exposition will be moving pictures. These will illustrate fields where American chemistry has advanced, and the subjects will be placed before the public in a manner that will enable the lay public to appreciate the difficulties that have been overcome during the past five years.

Research and experiments during the past five years, though successful to a wonderful degree, have proved that despite all that has been accomplished there is still a big field to be explored in dyes, pharmaceuticals and various organic products. American chemists are rapidly solving these problems, but they have no easy task. However, the United States has reached out and grasped the pilot's wheel in world chemistry and its chemists are determined that it will never again relinquish its leadership.

Chemical Merger Reported Consummated

It is reported that the much-rumored combination of the Big Four, the General Chemical Co., The Barrett Co., the National Aniline & Chemical Co. and the Semet-Solvay Co., has actually taken place and that only minor details now remain to be taken care of before the public announcement will be made.

The capitalization of the new company will be about $200,000,000. It is stated that Barrett Co.'s stock will be exchanged at the rate of 2.29 new shares for each share of Barrett stock, and that General Chemical Co. will be exchanged on a basis of 3.10 new stock for each share of the present General Chemical Co. stock. The terms under which the Semet-Solvay Co. will be taken in have not been determined, and will depend largely upon the adjustment that is made with reference to the entry of the National Aniline & Chemical Co.

Application will be made to list the new stock on the New York Stock Exchange and it is believed that it will be listed at about $70 per share and pay dividends at the rate of 6 per cent per annum.

Operation of Government Nitrate Plants Is Urged

Grinnell Jones, chief of the chemical division of the U. S. Tariff Commission, in his recent article published in the *Quarterly Journal of Economics*, summarizes some of his investigations regarding the fixation and uses of nitrogen both in peace and in war. After giving the arguments which have been advanced as to the future policy of the United States with respect to the Muscle Shoals nitrate plant and other plants, this author concludes his article as follows:

> A discussion of the pros and cons of private and Government operation of manufacturing enterprises is beyond the scope of this article. The important question is whether the plants are to be operated or dismantled. To allow them to stand idle is nearly equivalent to dismantling them, because they would rapidly deteriorate. Without an experienced operating staff and the constant improvements which come with operating experience they would be of little use in an emergency. If they can earn interest on any figure above their sale price as junk it will be profitable for the Government from a purely financial point of view to have them operated. Moreover, if operated they will be an important military asset and, if the need ever arises, will insure that the United States can make itself independent of imports of nitrate from Chile, just as Germany did. Should this need never arise these plants will continue to furnish a large supply of nitrogenous fertilizers, and thus increase the food supply. There can be no danger of excessive supplies of fertilizer material. There is plenty of land to put it on which has never received a pound of commercial fertilizer. In some way, and soon, the existing legal obstacles to the operation of the plants should be removed in order that they may forthwith contribute to the production of food for a starving world.

Whitehead Made Commissioner of Patents

Vacancies in the offices of Commissioner and First Assistant Commissioner of Patents were filled on Aug. 9 by recess appointments by the President. Robert F. Whitehead is to succeed James T. Newton, who recently resigned as Commissioner of Patents. The new First Assistant Commissioner is Melvin H. Coulston.

Both of the new appointees are lawyers. Mr. Whitehead received his professional training at the University of Virginia and Mr. Coulston at Cornell University. Each has been a member of the Patent Office staff for more than eighteen years. They have occupied positions in the various grades of examiners and are thoroughly familiar with the workings of the office.

Dr. Parsons on the Chemical Industry in Europe

Italy has the foundation of a number of great chemical industries well laid, in the opinion of Dr. Charles L. Parsons, secretary of the American Chemical Society, who just has returned from a three-months' trip in which he looked into chemical matters in several of the European countries. When the lack of raw materials and the scarcity of coal are considered, the Italian chemical development is little short of wonderful, he says. Italy, however, is making effective use of its two great assets, water power and cheap labor. In addition, full advantage is being taken of its supplies of sulphur, salt and the few other raw materials which Italy possesses.

While many chemical lines are being developed, the coal-tar and rubber industries are being conducted on a much larger scale than are any other individual chemical activities. Due to the coal shortage, electrification of the Italian railroads is being extended rapidly, Dr. Parsons reports. He predicts that all the railroads in Switzerland will have been electrified in the very near future.

In Rome Dr. Parsons attended the meeting of the International Union of Pure and Applied Chemistry. He is vice-president for the United States.

The chemical industries of Germany are only staggering along, Dr. Parsons asserts. Coal shortage, transportation difficulties and inability to secure raw materials are obstacles which the German industries are not surmounting with great success. He was particularly impressed with the practical applications which are being made in Germany of liquid oxygen as an explosive. These explosives are being used successfully on small operations, as well as in large mines and extensive works requiring blasting. The Germans have developed machines for the making of liquid oxygen which can be placed on motor trucks and operated by the truck's engine. Machines of this character are made as small as seven liters an hour capacity. He believes that liquid oxygen explosives could be used to great advantage in the United States.

Dr. Parsons made a special study of the application of oxidation of ammonia for the production of nitrous oxides to be used in the chamber process of manufacturing sulphuric acid. Germany is using ammonia almost entirely, he observed. Even in England 30 per cent of the sulphuric acid is being made by the newer process. He satisfied himself that large savings are being made over processes using Chilean saltpeter. He is confidently of the opinion that saltpeter is certain to be displaced in the sulphuric acid industry in this country.

In Scotland Dr. Parsons inspected dye works and paid a visit to the oil shale field.

Decreased American Production of Soda Ash in 1919

The domestic production of sodium carbonate in the form of soda ash was greatly curtailed in 1919. The sales amounted to only 981,354 tons, valued at $29,824,-245, as compared with 1,390,628 tons, valued at $35,635,-520, in 1918, according to R. C. Wells, of the United States Geological Survey, Department of the Interior.

The decreased demand in 1919 was well reflected in the price of soda ash quoted in the New York market. The year began with a sharp decline to $1.40 a hundred pounds for carload lots, the lowest price quoted for at least three years, from which there has been a slow and steady rise to the present price of $3.50 a hundred.

Soda ash is one of the cheapest and most widely used chemicals manufactured. It is used in making glass, soap, paper, caustic soda, chemicals, drugs, paints, leather, enamel ware, and cleansing compounds. Most of it is made from common salt, but a small quantity is obtained directly from the water of Owens Lake, in southeastern California.

The exports of soda ash in 1919 amounted to 50,481 short tons, valued at $2,656,608. This material was shipped principally to Canada, Brazil, Sweden, Mexico, and Australia, named in order of decrease in quantity exported. The imports amounted to only 415 short tons, valued at $12,998.

Notes of the Chemical Warfare Service

The Chemical Warfare Service will have about twenty commissions of the lower grades to award this fall. In an effort to arouse interest in obtaining these commissions the heads of twenty-five technical colleges have been apprised of the fact in the hope that some of their students will apply for the places.

The results of the recent examination for commissions are expected by Aug. 20.

With the idea of stimulating outside research on military gases General A. A. Fries plans to request a co-operative agreement with the American Chemical Society. He believes a way can be found to keep the profession interested in the idea of working on gas problems. General Fries points out that it cannot be hoped to secure sufficient appropriations in peace time to conduct the volume of research on military gases which should be in progress. Since all nations are paying considerable attention to chemical warfare, he believes it will be necessary to obtain a considerable amount of outside research if the United States keeps pace with other nations in this regard.

In order that cadets of the United States Military Academy may have a better idea of the uses of gases in warfare the Chemical Warfare Service is staging a series of demonstrations at Lakehurst, N. J., near the cadets' summer camp. Of the new class of cadets twenty-two have applied for transfer to the C. W. S. This is particularly pleasing to General Fries. He points out that while chemists are the most important need of the service, men with military training also are highly essential, since the work of the chemists would be useless unless the gas troops had sufficient military training to allow the orderly use of the chemists' product.

The chlorine plant of the Chemical Warfare Service at Belle, W. Va., has been sold for $300,000. This is 40 per cent of the original cost of the plant. Since the plant was built under war pressure, almost regardless of cost, the realization is regarded as a very fair one.

Leather Construction in Organs and Player Pianos

Quite an extensive report of the kinds of leather used in the manufacture of certain parts of organs and player pianos has been issued to tanners, dealers and manufacturers. At a conference held in New York on July 20, between the tanners and splitters and a representative of the Bureau of Standards it was decided to experiment with sheepskin skivers in order to produce leather in this country as satisfactory as that now imported.

Growth of the Union Tank Car Co.

During the past two years U.T.L.X. cars have grown from 18,000 to 26,000 in number. The Union Tank Car Co.'s equipment consists entirely of modern all-steel cars of the latest design and built substantially in excess of Master Car Builders' specifications. Entirely aside from its twenty-one shops for the repair of cars, the company's cars alone at present-day valuations very largely exceed the total of its security issues. Such cars cost today in excess of $3,000, at which figure its 26,000 cars would have a valuation of $78,000,000.

On the dissolution of the old Standard Oil Co. of New Jersey this subsidiary, formerly known as the Union Tank Line Co., was turned adrift and, incidentally, was compelled to borrow $1,000,000 immediately required for working capital. By the end of 1917 it had built up a surplus of $5,463,000 and by the end of 1919 this surplus amounted to $9,398,000. A record of its net earnings, before deducting depreciation and federal taxes, is as follows:

Year	Earnings	Year	Earnings
1919	$6,694,168	1915	$1,606,439
1918	6,051,375	1914	1,183,568
1917	1,467,165	1913	1,713,789
1916	2,683,145	1912	1,815,902

The business of a tank car company consists of owning and keeping in repair tank cars which it leases to the oil-refining companies. Not being a common carrier, it is not subject to the jurisdiction of the Interstate Commerce Commission or of the state commissions and therefore fixes its own charges for the use of cars in ordinary business negotiation with those whom it serves.

Southern Cotton Oil Earnings Over $2,000,000

The annual statement of the Southern Cotton Oil Co. for the fiscal year ended May 31 shows assets of $37,256,600 and earnings of $2,156,688 over dividends, etc.

ASSETS			
Capital assets:			
Real estate, plants and other permanent investments		$12,027,597 82	
Stocks owned		746,707.04	
			$12,774,304 86
Current assets:			
Raw materials, supplies and finished product		$15,255,079.47	
Accounts receivable	$4,936,452 54		
Bills receivable	871,443 39		
	$5,807,895 93		
Less—reserve for doubtful accounts and rebate of interest	338,187 21		
		5,469,708.72	
Liberty bonds (at market)		344,450 00	
Cash in banks and on hand		3,198,644 85	
			24,267,883 04
Interest, insurance, etc., paid in advance			214,413 03
			$37,256,600 93

LIABILITIES			
Capital stock			$10,000,000.00
Current liabilities.			
Bills payable	$7,575,745.00		
Accounts payable and other liabilities, including provision for Federal taxes	1,514,140 84		$9,089,885 84
Reserves:			
For depreciation		$421,944 41	
For summer repairs		170,000 00	
For insurance (fire and casualty)		155,199 71	747,144.12
Surplus:			
At May 31, 1919		$16,262,882.97	
Add earnings for year ended May 31, 1920		2,156,688 00	*
		$18,419,570 97	
Deduct—dividends paid		1,000,000 00	
			$17,419,570.97
			$37,256,600.93

* After paying and charging to operating expenses for repairs and replacements $2,157,150.45

Co-operation of Bureau of Standards With the American Committee on Electrolysis

Early in the year definite arrangements were made by the Bureau of Standards with the American Committee on Electrolysis, which represents all of the great national associations of utility companies, for co-operative work between that Committee and the Bureau in conducting an extensive research in the field of electrolysis mitigation. After this arrangement had been made, the Committee asked the Bureau to outline a program of research work to be carried out jointly, and such a program was formulated by the Bureau and approved by the Committee. During the last four months a number of somewhat extended investigations have been carried out in co-operation with this Committee in several Middle Western cities. This work has been confined largely, and almost exclusively, to the effect of pipe drainage on underground systems, especial attention being given to the possibility of joint electrolysis on high resistance joints and interchange of current between drained systems. Some attention has also been given to the three-wire systems of power distribution and also to automatic substation installation as a means of electrolysis mitigation. This joint investigation is an extremely important one and it is hoped that means will be found for continuing it during the coming year.

Need of Study on the Changes in the Structure of Hardened Steels Upon Tempering

Work has been started by the Bureau of Standards on quite an elaborate series of examinations to determine the changes which occur in the structure of hardened steels upon tempering. Very little information is available on this subject, and in particular, good micrographs, demonstrating the changes which occur, are rare. It can be shown by such other methods as magnetic tests and density determinations that pronounced changes occur in the hardened steel upon tempering, but the changes in the microstructure are much less plainly marked. For this reason there is need for more careful study of this phase of the metallography of steel. The specimens to be studied will include six different types, varying in carbon content from 0.07 per cent to considerably above 1 per cent. The steel will be hardened by quenching in water from various temperatures, and the length of time at which the material is held at the quenching heat will also be taken into consideration.

Refractories for the Glass Industry

The Bureau of Standards has commenced an investigation having for its object the development of improved refractories out of which to construct pots, etc., for the glass industry, with particular reference to their resistance to corrosion. The principle adopted has been to study systematically such bodies composed of siliceous bond clays mixed with aluminous grog and of aluminous bond with siliceous grog. In this matter it is hoped that the various possible combinations will be covered. A large number of crucibles have already been made from these mixtures. These are being fired, and will then be subjected to the action of a corrosive barium glass. Upon breaking the crucibles, the depth of penetration and degree of attack of the glass upon the material of the crucible will be determined. In addition, the transverse strength of the mixture, both in the dried and in the fired state, as well as the shrinkage, will be measured.

Changes in Exports and Imports of Chemicals

Material increases were shown in both exports and imports of chemicals in June, 1920, as compared with June of last year. This is shown by the latest returns to the Bureau of Foreign and Domestic Commerce. During June, 1920, imports of duty-free chemicals totaled $12,160,789 and dutiable chemicals totaled $6,100,996. This compares with $2,940,273 and $5,356,-904 respectively for June, 1919. The chemicals exported in June, 1920, were valued at $15,649,608. This compares with $12,266,274 in June, 1919.

The imports of coal-tar products in June, 1920, totaled $658,225 in value, as compared with $341,322 in June, 1919.

The total gums imported in June, 1920, amounted to 14,144,032 lb., valued at $5,217,950. This compares with imports of 4,605,105 lb., valued at $1,460,760, in June, 1919.

Acids exported in June, 1920, were valued at $565,347, as compared with exports valued at $561,242 in June, 1919. Exports of dyes and dyestuffs totaled $3,851,180 in June, 1920, as compared with $1,392,346 in June of last year. Exports of sodas in June, 1920, were valued at $2,404,080. The exports of June, 1919, were valued at $1,336,299.

The following tables are intended to show the changes in foreign trading, with records of a few chemicals which move in lesser volume:

IMPORTS OF CHEMICALS	June, 1919 Lb.	June, 1920 Lb.
Ammonia, muriate of	157,682	889,999
Arsenic, sulphide of	176,384	351,312
Fusel oil	90,318	662,176
Iodine, crude or resublimed	24,717	none
Lime, chloride of	none	33,984
Potash, hydrate of	12,000	197,253
Potash, nitrate of	none	536,645
EXPORTS OF CHEMICALS		
Calcium carbide	3,407,436	986,393
Glycerine	429,791	87,420
Lime, acetate of	688,041	262,443
Potash, chlorate	36,989	510,138

Consideration of Others Will Help Coal Shortage

Alarm over the coal shortage, especially in the Western fields, has developed to a point of economic hysteria which is not justified by the facts as investigated through the coal committee of the Chicago Association of Commerce. Harry A. Wheeler, ex-president of the U. S. Chamber of Commerce and chairman of this committee, made an extended report of the findings recently in which he states that the transportation factor is largely responsible for the present shortage and offers the following seven remedies for getting the supply back to a normal basis:

1. Frankly recognize the situation as serious, but one that can be met. Do not get into a hysteria of bidding for coal, thus giving the speculator an opportunity.

2. Comply with every regulation and help the railroads to get the greatest amount of work out of their equipment.

3. Demurrage charges should be graded so that the penalty for retaining possession of equipment for longer than free time will become an expensive and unprofitable operation.

4. Annul the proposition to average the time of cars in possession of the shipper or consignee. This rule invites speculation and carelessness in the use of transportation. The Interstate Commerce Commission and railroads should abandon it during this emergency period.

5. Watchfulness over the rule of the commission which permits the railroads to consign cars to carry coal for their own needs. Railroads must be generous in sharing the equipment with the public.

6. Consumer should take what coal he can get and not wait for products of more distant fields.

7. Conservation. It is estimated that Chicago market may alone save 70,000 cars by March 31. Save coal, save transportation—these are most important.

Mr. Wheeler's analysis shows that common sense and thoughtfulness for the welfare of the other fellow are just as necessary during this reconstruction and readjustment period as it was during the war. Then the majority of men were actuated by unselfish patriotism, now all must work to rebuild business relations. The motive for consideration of general business interests, while not so strong, shows promise of development to a degree far beyond the expectations of the pre-war period.

The Reorganization of Nela Research Laboratories

Nela Research Laboratory was organized in 1908, under the directorship of Dr. Edward P. Hyde, as the Physical Laboratory of the National Electric Lamp Association. The name was changed to Nela Research Laboratory in 1913, when the National Electric Lamp Association became the National Lamp Works of the General Electric Co. For some years the laboratory was devoted exclusively to the development of those sciences on which the art of lighting has its foundation, but in 1914 its functions were extended by the addition of a small section of applied science, which had an immediate practical objective.

The section of applied science is now being largely extended as a separate laboratory of applied science under the immediate direction of M. Luckiesh, who becomes director of applied science, and a new building is being constructed to house this branch of the work, which will be carried forward with a staff of several physicists, an engineer, an architect and a designer, together with the necessary technical and clerical assistants.

Dr. Ernest Fox Nichols, formerly president of Dartmouth College and more recently professor of physics at Yale University, has accepted an invitation to assume the immediate direction of the laboratory of pure science, under the title of director of pure science. The work of this laboratory, which will be continued in the present building, will be somewhat further extended under the new organization

The laboratory of pure science and laboratory of applied science will together constitute the Nela Research Laboratories, and will be co-ordinated under the general direction of Dr. Hyde, who becomes director of research.

Priority Transportation on Water-Refining Chemicals

Complying with a request of the Public Health Service, the American Railroad Association has issued a circular to all carriers asking that all chemicals used for water purification and the raw materials from which they are to be made be handled as expeditiously as possible. The circular covers the following material when consigned to municipal authorities or intended for the purification of public water supply: aluminum sulphate, bauxite, chlorine, calcium hypochlorite, soda ash, copperas, lime and empty cylinders for chlorine shipment.

The Relation of Composition to the Softening Point of Enamels

A knowledge of the effect of variation of composition of enamels on their softening points is of considerable technical importance in the enameled metal industry. While a few of those relations are understood in a general way, the results of a systematic investigation of the subject have never been published. The Bureau of Standards has undertaken a study of these relations and up to the present time seventy-four enamels, the compositions of which have been systematically varied, have been studied and their softening points determined.

From the data obtained so far it may be stated that the effect of various constituents on the softening point is not in accord with the chemical similarity of these constituents. For instance, certain basic oxides act as refractories in enamels, while others act as fluxes. The same is true for the so-called intermediate oxides and the acid oxides. In a given chemical group of oxides the fluxing effect is not in proportion to the molecular weight, and on the other hand equal percentage amounts of the various oxides do not have the same fluxing effect. The action of each oxide and mineral used in compounding enamels seems to be characteristic of that particular mineral or oxide and cannot be calculated by any system of *a priori* reasoning. It must be determined experimentally.

Hearings on Water-Power Regulations

Sections of the regulations which will be used in connection with the administration of the water-power act are being drafted and made the subject of hearings before officials of the Federal Power Commission. The regulations pertaining to form of application were the subject of criticism and discussion at a hearing on Aug. 12. On the following day representatives of banks and bond houses listened to the reading of the draft of the regulations pertaining to the financial aspects of the law. It is the policy of the commission to submit all regulations to those interested before promulgating them, with the idea of embodying such suggestions and criticisms as may be made.

Those interested in the Great Falls on the Potomac water-power project have been invited to attend a hearing before the Power Commission on Aug. 24. Each of the railroads entering Washington has been asked to send a representative to the hearing. The representatives of all large consumers of power in Washington and in the Great Falls area will be in attendance.

September Meeting of the International Bureau of Weights and Measures

The International Bureau of Weights and Measures will meet in Paris during September of this year. S. W. Stratton, director of the Bureau of Standards, has recently sailed to attend these sessions as the official representative of the United States.

There is in contemplation a considerable increase in the functions of the International Bureau to include other standards than those of simple weights and measures. This idea of extension of activity has been approved by representatives of the American Physical Society, the National Academy of Science and the National Research Council. It is expected that if the plan is adopted the International Bureau of Weights and Measures will have custody of numerous other types of standards and will eventually undertake the study of physical values and promulgation of constants based upon the best available information. Such constants would doubtless be adopted by most of the interested countries in the form of an international convention with respect to units and standards.

Electrical Smelting Steel Plant Established in Sao Paulo

The establishment in Ribeirao Preto of the Cia. Electrica Metalurgica Brazileira, whose object is the operation of a large electrical smelting plant, marks a new epoch in the industrial development of the State of Sao Paulo. Assistant Trade Commissioner Connell reports that the above-named company, in conjunction with the Empreza Forca Luz de Ribeirao Preto, which is to furnish the power, made final arrangements on May 18 for the erection of the plant at Ribeirao Preto, and work will be started as soon as the American contractors who are to construct the mill can get their engineers on the ground. The capacity of the mill will be sixty tons of steel daily, but it is believed that the plant will turn out only about half that amount during the early months of its operation. The ore is to be mined in the southern part of the State of Minas Geraes and will be hauled seventy-five miles to the mill at Ribeirao Preto, which enjoys easy rail access to the port of Santos, whence ultimate distribution of the finished product will be made. It is interesting to note that the inauguration of this company in Brazil marks the beginning in South America of the use of electricity for smelting purposes.

Ceramic Day at the Chemical Exposition

The committee on co-operation of the American Ceramic Society, H. Schmidt, chairman, is planning to have a Ceramic Day at the Exposition of Chemical Industries Friday, Sept. 24. The custom of having a special day set aside for the members of the Society during which papers are presented is a welcome one, as is indicated by the considerable attendance during the Exposition in Chicago last fall.

Personal

MELVIN H. COULSTON has been appointed First Assistant Commissioner of Patents. Mr. Coulston has been a member of the Patent Office staff for more than eighteen years.

C. O. DICKEN, head of the chemical laboratory of the E. J. Brock & Sons Candy Co., delivered a talk before the Chicago Chemists' Club recently on "Chocolate Refining for Candy."

Dr. GUSTAV EGLOFF of Chicago has been in New York for several days.

Dr. RALPH H. MCKEE recently left for Europe, where he has been called in consultation.

W. T. SCHALLER, after an extended period in private employ, has returned to the position of mineralogical chemist with the United States Geological Survey which he formerly occupied.

GEORGE SLOCUM, who for the past five years has been with the United States Rubber Co., in Java and Sumatra rubber plantation work, spoke before the Chemists' Club at Chicago recently on "Java and Its Rubber Plantations."

GEORGE OTIS SMITH now has the distinction of having served longer as the director of the U. S. Geological Survey than any of his predecessors. He will have completed his fourteenth consecutive year as head of the bureau next

May. The opinion is very generally held that the long tenure of office on the part of the directors of the Survey has been an important factor in the bureau's effectiveness. Clarence King, the first director of the Survey, accepted the position forty years ago only to organize the bureau and served but one year. The remaining thirty-nine years have been divided practically equally among J. W. Powell, C. D. Walcott and Dr. Smith.

F. H. TUCKER has resigned as associate chemist of the Bureau of Standards to take a research position in the New York Laboratories of the Chile Exploration Co. Mr. Tucker has already begun work in his new position.

R. G. WALTENBERG, who for a number of years has been a physicist on the staff at the Bureau of Standards, has been appointed an industrial fellow of the International Nickel Co. to continue research work at the Bureau of Standards on properties of nickel and monel metal. This is one of a number of fellowships recently established at the bureau for co-operative investigation in special industrial lines.

ROBERT F. WHITEHEAD has been appointed Commissioner of Patents, succeeding James T. Newton, who resigned recently.

Dr. L. F. WHITMER, who has been an associate chemist at the Bureau of Standards for a number of years, has recently accepted appointment as associate professor in the department of chemistry of Lafayette College, Easton, Pa. He will have charge of metallurgy and certain inorganic courses in this department from the beginning of the next college year.

Book Reviews

PRACTICAL CHEMISTRY. By *N. H. Black* and *James B. Conant*. 474 pp. 251 illustrations. New York: MacMillan Co.

The number of elementary introductory books on chemistry is very large and growing still larger, just as is the subject itself. The authors of "Practical Chemistry" are to be congratulated in having written a book that will give the beginner not only a grasp of the fundamental facts of the science but also some notion of the part played by chemistry in industrial life. The illustrations are excellent and should make it easy for the student to get quick and lasting impressions. While the text has been primarily prepared for class work, there is no doubt that it is suitable for general reading. Copies of it should be in every plant library so that all employees who desire a good start in chemical reading will have it available.

WALLACE SAVAGE.

Current Market Reports

The Iron and Steel Market

Pittsburgh, August 13, 1920.

For a month in which the steel market was reported as dull as it was last month the July unfilled tonnage statement of the Steel Corporation was very favorable, as the unfilled obligations increased by 139,651 tons during the month, this being 100,000 tons more than the 38,351-ton increase of June, and as shipments probably increased 50,000 or 100,000 tons from June to July the bookings appear to have increased by 150,000 or 200,000 tons. Yet July was one of the two proverbially dull midsummer months and June, being the end month of a quarter, should have witnessed the booking of a considerable tonnage of routine business which is simply entered up quarter by quarter.

It is understood that the Steel Corporation subsidiaries have not been soliciting any business, but are simply accepting such part of the business offered them as is to their liking. On account of the disparity in quoted prices by the Steel Corporation and the independents the corporation must hold its facilities for its regular trade. As to the independents, it is said that they are not soliciting business either. Some of them are sold up only a short distance ahead, but to solicit business would be to provoke a question as to why the quotations remain above those of the Steel Corporation, if additional orders are desired.

As an offset to the 11,118,468 tons of unfilled obligations which the Steel Corporation reports at the end of July there is the considerable tonnage that has been produced but not shipped, but this amounts to only about a month's output. At 90 per cent of rated capacity, 52,500 tons per working day, the output in nine months would be approximately equal to the unfilled obligations reported, so that it may be taken that the corporation is booked up approximately to April 1, 1921, as an average date.

STEEL PRODUCTION OFF

The rate of steel ingot output declined about 6 per cent from June to July, the July rate being about 39,900,000 gross tons per annum. The computation is based upon the monthly report of the American Iron and Steel Institute, showing the output of thirty companies which made 84.03 per cent of the total output of 1918, these companies reporting 2,980,690 tons for June and 2,802,818 tons for July. The rate of production of pig iron by steel works furnaces decreased about 2.2 per cent from June to July, the rate of steel ingot production decreasing about 6 per cent, as noted above. However, there is the disturbing element that Independence Day was a steel-mill holiday but not a blast-furnace holiday, and such facts are taken into account in the computations used for this report of production rates. The result is that while the thirty companies produced 178,000 tons less of steel ingots in the month of July than in the month of June the steel interests in general produced about 20,000 tons more pig iron in the latter month. Accordingly it would appear that they accumulated some pig iron, this being quite natural seeing that they accumulated large tonnages of semi-finished steel, production of finished steel being restricted by car shortage and large stocks already accumulated. The circumstance is interesting in view of the fact that merchant pig iron is scarce and furnacemen show a disposition to advance their prices.

In the past few days the Carnegie Steel Co., after a long interval, has been in the market for heavy melting steel scrap and has bought a total variously estimated at 20,000 or 30,000 tons, some of the purchases being at $29, when ten days ago the market was quotable at barely over $27 to consumers. It is normal, however, for the buyer of a large tonnage to pay more than the quoted price, for the dealers are buying odd lots every day and selling large lots only occasionally. Usually scrap purchases by the Carnegie Steel Co. are taken as indicating that the steel market has a particularly favorable prospect, but in this case the purchases may have been occasioned by the company having left so much of its steel lately in semi-finished form, whereby the production of works scrap has been temporarily curtailed.

PIG IRON ADVANCING

For several months there has been a waiting attitude in the pig iron market, the question being whether buyers or sellers would act first. The scarcity of prompt iron has caused some buyers to seek iron at whatever price has to be paid and the furnaces are showing a strong disposition to advance prices. Basic recently sold at $46.50, valley, in important transactions, an advance over the previously quoted market of 50c. Bessemer remains quotable at $47, valley, and foundry at $46, valley, but some furnaces are holding out for much higher prices and it is a question whether additional purchases of any of the three grades could be made at the prices here named. Whether an advance in the market predicated upon an insistent demand for early deliveries can be molded into a general buying movement for extended deliveries remains to be seen, but at the moment it looks as if the furnaces had the upper hand. An advancing pig iron market is somewhat anoma-

lous, seeing that steel prices show more likelihood of declining, by the independents dropping to the Steel Corporation level, yet pig iron prices are already too high in relation to steel prices.

TRANSPORTATION

If anything there is more complaint in the trade regarding transportation conditions than a week or two ago, yet there is no doubt that on the whole shipments of pig iron and steel products have been increasing for a fortnight, if not for a longer period. The shippers had hoped that transportation conditions would be entirely righted by this time, which accounts for their dissatisfaction now. Shipments of pig iron are probably equal to production, but steel still seems to be accumulating, though at a low rate.

Steel interests in the Pittsburgh, valley and Cleveland districts have discovered that a large number of gondola cars owned by railroads endeavoring to serve them are beyond the Mississippi River and are making representations to the Interstate Commerce Commission looking to the issuance of an order that these cars be returned to owner roads, just as box cars owned by Western roads were ordered west some time ago in order to move grain. Car supplies in the Connellsville coke region have been distinctly better last week, and this owing to cars moving somewhat less slowly. It is remarkable that placements have been as good as they have been, in view of the very slow movement. Various furnace interests have related their experience of having to have en route more than double as much coke as normally in order that daily receipts may be up to requirements, which of course means that the cars involved are moving at less than half normal speed.

Lake Superior iron ore shipments down the lakes in July amounted to 9,638,606 tons, a trifle more than in July, 1919, and a trifle less than in July, 1918, which held the record for a July. The season total to Aug. 1 is 26,079,111 tons. Taking the three preceding years as a criterion, using the rate of pig iron production shown each July as the basis of requirements to the opening of navigation the following year, the shipments this year to Aug. 1 fall 3.8 per cent of the indicated tonnage, but that is practically nothing in view of the millions of tons of ore regularly carried at furnaces and on Lake Erie docks. Shipments from Lake Erie docks have been a trifle below their normal relations to the vessel movement.

Several purchases of sheet bars, for conversion into sheets, have just been made at $70. At least four mills sold at this price, and two or three others would recognize the price. A trifle over a fortnight ago sheet bars brought $75, also for conversion.

The Chemical and Allied Industrial Markets

New York, August 13, 1920.

The slight activity exhibited in the chemical market during the last week has been confined almost entirely to actual requirements. Spot supplies on some of the items are increasing and as a result there has been an easing up of the firm tone that has been noticeable for some time previously; *formaldehyde* is among the foremost and spot sales are being made as low as 48c. per lb., with the possibility of still further drop due to the improved *alcohol* situation. However, former quotation of $5.50 per gal. for the *ethyl* grade still holds. Despite the increased cost of production manufacturers are finding it impossible to raise their prices with resale material being offered below the present market. This is the case in *sulphuric acid*, 60 deg., which can be obtained as low as $12 per ton, and as a result producers are awaiting the fall buying, which it is hoped will be very heavy. The increased arrivals of *barium chloride* from abroad have held this item down and it can be obtained in fairly large quantities at $150 per ton, although there is not enough material on hand yet to meet the normal demand. Due to weak inquiry both *caustic soda* and *potash* fell off during the week and the former is now quoted at 27@28c. per lb., while the latter is being held at $6@$6.50 per cwt. in resale lots.

COAL-TAR PRODUCTS

There is very little to report in this market during the week, as business has been very dull. The closing of a number of textile plants has cut off the only source of demand that has kept this market moving and a return to normal activity is not looked for before the fall. Some idea of the rise in *naphthalene* can be gained from the following table:

	Crushed	Flake	Balls
May, 1919	$0.06-$0.08	$0,07-$0.08	$0.10½-$0.11½
March, 1920	.06—.08	.07—.08	.10½—.11½
April, 1920	.08—.09	.07—.08	.08½—.10½
May, 1920	.15	.15	.15
June, 1920	.15	.15½—.17	.16—.18
July, 1920	...	.19	.19
August, 1920	...	.18—.20	.19—.21

The sudden rise in April was caused by a combination of circumstances; first, scarcity of the crude material, second, the dropping out of the market of one of the largest producers when a fire partly dismantled the plant. Although it is nominally quoted at 19@21c. today in small resale lots, deliveries on contracts, written in the early part of the year, are still being made at 6@8c. crushed, 7@8c. flake and 8½@10½c. per lb. for balls.

NAVAL STORES AND FLOTATION OILS

Heavy buying inquiry from England and South America is putting this market back on the road to normal prices. Advances have been made in all grades of *rosin*, and although there is very little material available in the local market Savannah has been active during the week, especially in the last few days. *Turpentine* has been quiet during the week, with very few inquiries, the former quotation of $1.70 still holding firm, with Savannah quoting $1.56 per gal. The *flotation oils* are somewhat weaker than last week, *pine oil*, steam dist., sp.gr. 0.930-0.940, being listed at $3.15, against $2.30 per gal. of previous report. *Crude turpentine*, sp.gr. 0.900-0.970, is down to $1.75 from $2 per gal.

VEGETABLE OILS

Conditions remain unchanged with low prices still prevailing and a tendency to still lower levels is noticeable. *Soya bean oil*, tank cars, f.o.b. Pacific Coast, sold as low as 9½c. per lb. for spot material, with very few buyers available. Practically the same condition exists in *peanut oil*, concessions being made on spot material and nobody willing to take these offerings. All grades of *coconut oil* are down, *Ceylon* being listed at 17½@18c., against 18½@19c. of last week, while *Cochin* grade fell from 16@16½c. to 15@16c. per lb.

The Baltimore Market

Baltimore, Md., August 12, 1920.

Since last report, the outstanding feature in the fertilizer business has been the heavy export demand and final consummation of order for about 25,000 tons acid phosphate, which has had a tendency to materially strengthen the market.

During the past week the car supply has been somewhat better, and the fertilizer manufacturers are now bending every effort toward getting off their shipments of complete fertilizer for the fall season, but there is still a shortage of labor which is handicapping the trade in general in this section.

Prime cottonseed meal for September-December shipment has further eased off, and is now obtainable as low as $7.75 per unit of ammonia, delivered Baltimore, no charge for phosphoric acid, potash or bags. Of course this price is based on the present rates of freight, and the increase which will become effective this month is to be for buyers' account. The manufacturers, however, feel that after increased rates go into effect, which will be correspondingly reflected in the delivered price per unit of ammonia, sellers of cottonseed meal will still further reduce their f.o.b. quotations, and are therefore holding off in their purchases awaiting further developments.

ACID PHOSPHATE

Practically all the important sellers of this material are now sold up, and the large export order has about

cleaned up all the summer surplus. It is reported that 25,000 tons was sold for shipment abroad at $19 per ton, in bulk, basis 16 per cent delivered to vessel at producer's works, Baltimore, for goods testing 16 to 18 per cent, pro rata charge for excess over 16 per cent. August-September shipments are practically unobtainable, and October-December is nominally quoted at $19@$20 per ton, in bulk, basis 16 per cent, pro rata charge for excess. The lower figure is for shipment by water, while the outside price is for car shipments, with sellers hesitating to take on any important business on account of the car situation, and such orders as are booked for shipment in this manner are subject to car supply permitting. Both phosphate rock and sulphuric acid are in short supply, with only occasional offerings on the market, which are eagerly taken up at market prices. Every indication points not only to the market being maintained, but ruling higher later on when it will be more a question of securing the goods than of price.

Tankage

While there has been an easing up in the Western market, which is now nominally $7.50 and 10c., f.o.b. Chicago, this price with freight added figures considerably higher than buyers have to pay Eastern packers, and foreign ammoniates are again coming into favor, as these are obtainable on a lower basis than packing house byproducts. Foreign nitrogenous material testing about 8 to 9 per cent ammonia and guaranteed 80 per cent availability is obtainable at $7.50 per unit, delivered Baltimore, but as only a limited tonnage of this class of material is required by the fertilizer manufacturers for their fall mixtures, more interest is shown in later deliveries than for August-September arrivals.

Nitrate of Soda

There has been a further recession in the market on this article, due to the lower rate of sterling exchange. August-September deliveries are now obtainable at $3.65@$3.70, October-December $3.80@$3.90, and January-April $3.95@$4.

It is understood that the easiness of the market is attributed to the foreign exchange situation, and if there should be an upward turn, there will doubtless be a corresponding increase in nitrate, as this material is being firmly controlled at producing point.

Potash

There have been no new developments in this since last report, as the fertilizer manufacturers are all holding off in their purchases in anticipation of their being able to secure their supplies for the coming spring season at materially lower prices than now prevail. In the meantime, only meager supplies of foreign potash are being received, and these are being quoted at somewhat lower than the previous market.

Early deliveries of muriate are now obtainable at $2.40@$2.50, kainit at $2@$2.10, and manure salt at $2.10@$2.20.

Fish Scrap

The market remains stationary at $7.50 and 10c. for dry unground scrap, f.o.b. factories, subject to catch and if made. However, on account of financial conditions the buying demand has eased up, but producers are comfortably fixed by having contracts which were booked some time ago.

Bone Meal

While the market on 3 and 50 per cent steamed bone meal remains at $54 per ton in buyers' bags, and little interest being shown at this price, every indication points to still higher prices ruling on this article, as well as raw bone meal, when the increased freight rates go into effect. The tonnage available is very limited, and while the present high prices have curtailed consumption, the material is not being produced in a large way, and any lots quoted under the market are rapidly absorbed.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.. -	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.30 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 16.00	16.25 -
Boric, crystals	lb.	.15½ - .16	.16½ - .19
Boric, powder	lb.	.15½ - .16½	.17 - .20
Citric	lb.	.78 - .80	.82 .84
Hydrochloric (nominal)	cwt.	2.00 - 3.00	3.10 - 4.00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 .07
Molybdic, C. P.	lb.	4.00 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).			
Nitric, 40 deg.	lb.	.06 - .07	.07½ .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ .09½
Oxalic, crystals	lb.	.55 .57	.60 - .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	. . .
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	-
Sulphuric, 66 deg., carboys	ton	-	
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 35.00	40.00 - .....
Tannic, U. S. P.	lb.	1.45 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.	.	.74 - .77
Tungstic, per lb. of WO	lb.	. - .	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%	gal.	-	3.25 3.30
Alcohol, Methyl, pure	gal.		3.50 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	. . .	1.10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.		1.05 - 1.10
Alum, ammonia lump	lb.	.05 - .05¼	.05½ - .06
Alum, potash lump	lb.	.08 .08½	.09 - .09½
Alum, chrome lump	lb.	.15½ .18	.19 - .20
Aluminum sulphate, commercial	lb.	.04½ -	- .
Aluminum sulphate, iron free	lb.	.06 -	..
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ - .10½	.11 .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.34 .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 .16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - .13½	.13½ - .14½
Ammonium nitrate	lb.	.09 .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ - ....
Amylacetate	gal.	- ...	5.00 . ..
Amylacetate tech	gal.		4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 - .21	.22 - .25
Barium chloride	ton	150.00 - 160.00	.
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .12	.12½ - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		... ..	
Blue vitriol (see copper sulphate)		.... - ...	
Borax (see sodium borate)		.. -	
Brimstone (see sulphur, roll)		.... -	
Bromine	lb.	.70 .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 3.55	
Calcium carbide	lb.	.04½ - .04½	.04½ - .05½
Calcium chloride, fused, lump	ton	25.00 - 30.00	35.00 45.00
Calcium chloride, granulated	lb.	.01½ - .01½	.02 .03½
Calcium hypochlorite (bleaching powder)	cwt.	. - .	4.50 6.00
Calcium peroxide	lb.	- .	1.50 - 1.70
Calcium phosphate, monobasic	lb.		.75 - .80
Calcium sulphate, pure	lb.		.25 .30
Carbon bisulphide	lb.	.08 .09	.10 .11
Carbon tetrachloride, drums	lb.	.14 .15	.16 .17
Carbonyl chloride (phosgene)	lb.		.80 1.05
Caustic potash (see potassium hydroxide)			- . . . .
Caustic soda (see sodium hydroxide)		..	. . . - .
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	-	2.00 2.05
Copperas (see iron sulphate)		. .	. .
Copper carbonate, green precipitate	lb.	.27 .28	.29 .31
Copper cyanide	lb.	. .	.65 .70
Copper sulphate, crystals	lb.	.08 .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		-	. .
Epsom salt (see magnesium sulphate)		. . -	.
Ethyl Acetate Com. 85%	gal.	1.10 1.30	1.40
Ethyl Acetate pure (acetic ether 98% to 100%)		-	1.75
Formaldehyde, 40 per cent (nominal)	lb.	.40 .45	.48 - .50
Fusel oil, ref	gal.		5.25 6.00
Fusel oil, crude (nominal)	gal.		-
Glauber's salt (see sodium sulphate)		. . . .	.
Glycerine, C. P. drums extra	lb.	-	.26½ .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 4.45
Iron oxide, red	lb.		.18 .20
Iron sulphate (copperas)	cwt.		2.20 2.50
Lead acetate, normal	lb.	-	.13½ .16
Lead arsenate (paste)	lb.	.11 .12	.15 .17
Lead nitrate, crystals	lb.	-	.50 1.00
Litharge	lb.	.14 - .15	.15½ .16
Lithium carbonate	lb.		1.50 -
Magnesium carbonate, technical	lb.	.12½ .13½	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 3.90	4.00 4.50
Magnesium sulphate, commercial	100 lb.	- . .	3.50 3.60
Nickel salt, double	lb.	. -	.14 - .16
Nickel salt, single	lb.	- .	.13 - .14
Phosgene (see carbonyl chloride)		. . - . .	......-. ...
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	.. ..	.35 - .37
Potassium bichromate	lb.	.50 - .55	.57 - .60

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 - $0.56	$0.57 - $0.58
Potassium bromide, granular	lb.	..... -	.70 - .73
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .25	.26 - .28
Potassium chlorate, crystals	lb.	.16 - .17½	.18 - .20
Potassium hydroxide (caustic potash)	lb.	.27 - 28	.29 - .33
Potassium iodide	lb.	..... -	3.35 - 3.60
Pot[illegible]	lb.	.17 - .17½	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 - .....
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$225.00 - 240.00	..... - .....
Rochelle salts (see sodium potas. tartrate)		..... -	..... - .....
Salammoniac (see ammonium chloride)		..... -	..... - .....
Sal soda (see sodium carbonate)		..... -	....
Salt cake	ton	..... -	40.00 - 50.00
Silver cyanide (nominal)	oz.	..... -	1.25 - .....
Silver nitrate (nominal)	oz.	..... -	.60 - .62
Soda ash, light	100 lb.	..... -	3.20 - 3.50
Soda ash, dense	100 lb.	..... -	3.55 - 3.65
Sodium acetate	lb.	10 - .15	.20 - .25
Sodium bicarbonate	100 lb.	2.50 - 2.75	3.00 - 3.50
Sodium bichromate	lb.	22 - .24	.26 - .27
Sodium bisulphate (nitre cake)	ton	7.00 - 8.00	9.00 - 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½ -	.10 - .11
Sodium borate (borax)	lb.	.09 - .10	.11 - .12
Sodium carbonate (sal soda)	100 lb.	1.50 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	.11 - .12	.12½ - .14
Sodium cyanide, 96-98 per cent	lb.	.25 - .30	.32 - .35
Sodium fluoride	lb.	.18 -	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	.. -	6.25 - 7.00
Sodium hyposulphite	lb.	..... -	.03 .04
Sodium molybdate	lb.	2.50 -	3.25½ - .....
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	16 - .18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb	- ..	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01¾	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1 60 - 1.70	1.75 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½ 10	.10½ - .11
Sodium sulphite, crystals	lb.	.04 - 0.4½	.04½ - .05
Strontium nitrate, powdered	lb.	.15 - 18½	.19 - .20
Sulphur chloride red	lb.	.08 - 09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	....
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	..... -	3.80 - 4.35
Sulphur, roll (brimstone)	100 lb.	..... -	3.40 - 3.90
Tin bichloride (stannous)	lb.	.42½ - .44	.45 - .46
Tin oxide	lb.	..... -	.55 - .65
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.13 - .13½	.13½ - .17
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.11 - .12	.12 - .13
Zinc oxide, U. S. P.	lb.	.17 - .25	..... - .....
Zinc sulphate	lb.	.03½ - .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1 40	$1.50
Alpha naphthol, refined	lb.	1 60	1.70
Alpha naphthylamine	lb.	.53	.55
Aniline oil, drums extra	lb.	.33	.34
Aniline salts	lb.	.40	.42
Anthracine, 80% in drums (100 lb.)	lb.	.90	1.00
Benzaldehyde (f f.c.)	lb.	2.00	2.10
Benzidine, base	lb.	1.35	1.40
Benzidine, sulphate	lb.	1.15	1.25
Benzoic acid, U S P.	lb.	.90	1.00
Benzoate of soda, U S P.	lb.	.80	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35	.40½
Benzol, 90%, in drums (100 lb.)	gal.	.33	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	.40
Benzyl chloride, tech.	lb.	.25	.35
Beta naphthol benzoate (nominal)	lb.	3.50	4.00
Beta napthol, sublimed (nominal)	lb.	...	..
Beta naphthol, tech (nominal)	lb.	.85	.95
Beta naphthylamine, sublimed	lb.	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1 05	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65	.75
Dichlorbenzol	lb.	.08	.10
Diethylaniline	lb.	1 50	1.60
Dimethylaniline	lb.	1 35	1.45
Dinitrobenzol	lb.	.30	.37
Dinitroclorbenzol	lb.	.32	.35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	.40	.45
Dinitrotoluol	lb.	.35	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	.40
Diphenylamine (nominal)	lb.	.80	.85
H-acid (nominal)	lb.	2 00	2.25
Metaphenylenediamine	lb.	1.25	1.30
Monochlorbenzol	lb.	.18	.20
Monoethylaniline	lb.	2.00	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	....
Naphthaline, flake	lb.	....	.19
Naphthaline, balls	lb.	....	.19
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	1.25
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.35	.40
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1.35	1.40
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.50	2.65
Paratoluidine	lb.	2.00	2.25
Phthalic anhydride	lb.	.60	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.20
Pyridin	gal.	2.00	3.50
Resorcin, technical	lb.	4.25	4.50
Resorcin, pure	lb.	6.25	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	.52
Salicylic acid, U. S. P.	lb.	.50	.60
Salol	lb.	.90	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	.26
Sulphanilic acid, crude	lb.	.32	.35
Toluidine	lb.	1.70	2.50
Toluidine, mixed	lb.	.45	.55
Toluol, in tank cars	gal.	.35	.....
Toluol, in drums	gal.	.38½	.40½
Xylidine, drums, 100 gal.	lb.	.50	.65
Xylol, pure, in drums	gal.	.47½	.50½
Xylol, pure, in tank cars	gal.	.45	.....
Xylol, commercial, in drums, 100 gal.	gal.	.32½	.35½
Xylol, commercial, in tank cars	gal.	.30	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	$0.39
Beeswax, refined, light	lb.	.37	.38
Beeswax, white pure	lb.	.63	.68
Carnauba, No. 1. (nominal)	lb.	.90	.95
Carnauba, No. 2, regular (nominal)	lb.	.55	.60
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.17	.18
Montan, crude	lb.	.35	.36
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb	.09¾	.10
Paraffine waxes, refined, 118-120 m p.	lb.	.11¾	.12
Paraffine waxes, refined, 125 m p	lb.	.12¾	
Paraffine waxes, refined, 128-130 m p	lb.	.14½	.15½
Paraffine waxes, refined, 133-135 m p.	lb.	.16½	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18½
Stearic acid, single pressed	lb.	.24	.25
Stearic acid, double pressed	lb.	.25	.26
Stearic acid, triple pressed	lb.	.27	.28

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f o b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0 940	gal.	$2.15
Pine oil, pure, dest. dist.	gal	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal	.48
Pine tar oil, crude, sp.gr. 1.025-1 035 tank cars f o b Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp gr. 0.965-0 990	gal.	.85
Pine tar, ref., thin, sp gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0 900-0.970	gal.	1 75
Hardwood oil, f.o b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$14 00	$16 25
Rosin E-I	280 lb.	16 00	16.75
Rosin K-N	280 lb.	17.00	17 20
Rosin W. G.-W. W.	280 lb.	17 25	17.50
Wood rosin, bbl	280 lb.	15 00	.
Spirits of turpentine	gal.	1 70	. .
Wood turpentine, steam dist.	gal.	. .	.....
Wood turpentine, dest. dist.	gal.	.....	.....
Pine tar pitch, bbl	200 lb.	.....	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	15.00
Retort tar, bbl	500 lb.	15.00	15.50
Rosin oil, first run	gal.	.72	.....
Rosin oil, second run	gal.	.75	.....
Rosin oil, third run	gal.	.92	.....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.33	$0.34
Upriver coarse	lb.	.21½	.22
Upriver caucho ball	lb.	.21	.21½
Plantation—First latex crepe	lb.	.30	
Ribbed smoked sheets	lb.	.29½	
Brown crepe, thin, clean	lb.	.27	
Amber crepe No. 1	lb.	.29	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	$0.18
Castor oil, AA, in bbls.	lb.	.19	
China wood oil, in bbls.	lb.	.17½	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.16½	.16½
Corn oil, crude, in bbls.	lb.	.14½	.15½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10	.11
Cottonseed oil, summer yellow	lb.	.12½	.13½
Coteonseed oil, winter yellow	lb.	.17½	.18½
Linsed oil, raw, car lots (domestic)	gal.	1.50	.....
Linseed oil, raw, tank cars (domestic)	gal.	1.40	.....
Linseed oil, boiled, car lots (domestic)	gal.	1.56	.....

Olive oil, commercial	gal.	3.00 — 3.10
Palm, Lagos	lb.	.10½ — .....
Palm, bright red	lb.	.10½ — .....
Palm, Niger	lb.	.11 — .12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½ — .12½
Peanut oil, refined, in bbls	lb.	.17 — .18
Rapeseed oil, refined in bbls	gal.	1.40 — 1.50
Rapeseed oil, blown, in bbls	gal.	1.60 — 1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14 — .14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ — .11

FISH

Winter pressed Menhaden	gal.	$0.90 — $1 05
Yellow bleached Menhaden	gal.	0.95 — 1.05
White bleached Menhaden	gal.	1.00 — 1 25
Blown Menhaden	gal.	1.00 — 1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 — $25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 — 20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00 — 10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 — 25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 — 19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00 — ....
Barytes, floated, f.o.b. St. Louis	net ton	26.50 — 28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00 — 11 25
Blanc fixe, dry	lb.	.05½ — .06
Blanc fixe, pulp	net ton	60.00 — 80.00½
Casein	lb.	.15 — .18
Chalk, domestic, extra light	lb.	.05 — .06
Chalk, domestic, light	lb.	.04½ — .05½
Chalk, domestic, heavy	lb.	.04 — .05
Chalk, English, extra light	lb.	.05 — .07
Chalk, English, light	lb.	.05 — .06
Chalk, English, dense	lb.	.04½ — .05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00 — 12 00
China clay (Kaolin) washed, f.o b. Georgia	net ton	12 00 — 15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00 — 22 00
China clay (Kaolin) crude f.o b. Virginia points	net ton	8 00 12.00
China clay (Kaolin) ground, f.o.b Virginia points	net ton	15 00 40 00
China clay (Kaolin), imported, lump	net ton	25 00 — 35 00
China clay (Kaolin), imported, powdered	net ton	30 00 — 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50 8 00
Feldspar, crude, f.o.b Maine	net ton	7 50 10 00
Feldspar, ground, f o b. Maine	net ton	21 00 23 00
Feldspar, ground, f o. b. North Carolina	net ton	17 00 — 20 00
Feldspar, ground, f o.b. N Y State	net ton	17 00 — 20.00
Feldspar, ground, f o b Baltimore	net ton	30.00 .....
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00 — .
Fuller's earth, powdered, f.o.b Fla.	net ton	18.00 — .
Fuller's earth, imported, powdered	net ton	35.00 — 40 00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	...... — .01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	...... — .02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	...... — .05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	...... — .10
Graphite, crucible, 85%, carbon	lb.	...... — .08
Graphite, crucible, 88%, carbon	lb.	...... — .09½
Graphite, crucible, 90%, carbon	lb.	...... — .10½
Pumice stone, imported, lump	lb.	.04 — .50
Pumice stone, domestic, lump	lb.	.06 — ..
Pumice stone, ground	lb.	.04 — .07
Quartz (acid tower) fist to head, f o.b. Baltimore	net ton	...... — 10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	...... — 14 00
Quartz (acid tower) rice, f.o b. Baltimore	net ton	...... — 17 00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 — 7.50
Shellac, orange fine	lb.	1 45 — 1.50
Shellac, orange superfine	lb.	1 55 — ...
Shellac, A. C. garnet	lb.	1 05 — 1 15
Shellac, T. N	lb.	1 20 — 1 30
Soapstone	ton	15.00 — 25.00
Talc, paper-making grades, f.o.b. Vermont	ton	10.00 — 20.00
Talc, roofing grades, f.o.b. Vermont	ton	9.00 — 15 00
Talc, rubber grades, f.o b. Vermont	ton	10 00 — 15 00
Talc, powdered, Southern, f.o b. cars	ton	20 00 — 25 00
Talc, imported	ton	60.00 — 70 00
Talc, California Talcum Powder grade	ton	20 00 — 35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90– 100
Chrome brick, 9-in. strs and sizes, f.o.b. Baltimore	net ton	90– 95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50– 55
Fire clay brick, 1st quality, f.o b. St. Louis	1,000	45– ...
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75– ...
Fire clay brick, 2d quality, 9 in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45– 55
Magnesite brick, 9 in. straights, f.o b. Baltimore	net ton	100 110
Magnesite brick, 9-in. sizes and shapes larger than 9 in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90– 100
Silica brick, 9 in. and 9-in. sizes, Chicago district	1,000	55– ...
Silica brick, f.o.b. Birmingham	1,000	51– 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	55– 60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 — $250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17 — .18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.19 — .20
Ferro-manganese, 76-80% Mn, domestic	gross ton	200.00 — 225.00
Ferro-manganese, 76-80% Mn, English	gross ton	195.00 — 220.00
Spiegeleisen, 18-22% Mn	gross ton	75.00 — .....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.25 — 2.75
Ferro-silicon, 10-15%	gross ton	60.00 — 65.00
Ferro-silicon, 50%	gross ton	80.00 — 90.00
Ferro-silicon, 75%	gross ton	150.00 — 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 — 1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 — .....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 — 7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60 .65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77 — .85
*Coke, foundry, f.o.b. ovens	net ton	20.00 — ..
*Coke, furnace, f.o.b. ovens	net ton	18.00 — 20.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 — .....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00 — 27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ — .02
Manganese Ore, 50% Mn, c i.f. Atlantic seaport	unit	.70 — 80
Manganese ore, chemical (MnO_2)	gross ton	75.00 — 85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.75 — .85
Monazite, per unit of ThO_2	unit	42.00 — .....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 — .....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ — .....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12 — .14
Pyrites, domestic, fines	unit	.12 — .14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 — ...
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 — ....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.00 — 7.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 — 3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 — 3 00
Vanadium pentoxide, 99%	lb.	12.00 — 14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 — .
Zircon, washed, iron free	lb.	.10 — .....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19 00
Aluminum, 98 to 99 per cent	33 00
Antimony, wholesale lots, Chinese and Japanese	7 50
Nickel, ordinary (Ingot)	43 00
Nickel, electrolytic	45 00
Tin, Straits, spot	48 50
Lead, New York, spot	9 25
Lead, E. St. Louis, spot	8 90
Zinc, spot, New York	8 25
Zinc, spot, E. St. Louis	7.90@8.40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2 50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	95@105
Iridium	oz.	350 00
Palladium	oz.	100.00
Mercury	75 lb.	88.00@90.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33 50
Copper bottoms	38 00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34 00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23 50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	15.25@15 75
Copper, light and bottoms	13.00
Copper, heavy cut and crucible	16.25
Brass, heavy	9.50@10.00
Brass, light	7.25@ 7.75
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@ 5.00
Lead, heavy	7.25@ 7.50
Zinc, scrap	5.25

Structural Material

The following base prices per 100 lb are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4 47	$3 97	$3 47	$5 00	$3.37	$3 97	$3 47
Soft steel bars	4 47	4 12	3.37	4.50	3 27	3.87	3 37
Soft steel bar shapes	4 47	4 12	3.37		3.27	3.87	3.37
Soft steel bands	6 32	5 32	4 07	6 25	....	....	.. .
Plates, ¼ to 1 in. thick	4.67	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Colorado

DENVER—The Tungsten Products Co. is building a chemical reduction plant for the exclusive treatment of radium ores in connection with its plant at Boulder. Estimated cost, $7,000.

Illinois

CHICAGO—The Charles H. Milles Fdry. Co., 2443 West 21st Pl., plans to build a 1-story, 100x200-ft. plant at West 35th and South Leavitt Sts. Estimated cost, $150,000.

MONTICELLO—The Bd. Educ. has awarded the contract for the construction of a 2 story, 111x172 ft. school, to Alfred Nelson, 36 West Rand St., Chicago, at $200,000. A chemical laboratory will be installed in same. Noted June 23.

Iowa

CENTERVILLE—The Judy Mfg. Co. has awarded the contract for the construction of a 1-story, 60x150-ft. foundry, to the B. S. Staley Constr. Co., at $30,000.

Kentucky

LOUISVILLE—The Louisville Chemical Co., 108 South 3rd St., is in the market for machinery for its new factory. B. F. Gregary, pres.

Maryland

ANNAPOLIS—The Public Utilities Co. plans to construct gas-plant additions. Estimated cost, $200,000.

Massachusetts

BOSTON—The Boston & Maine R.R. Co., North Station, will soon award contract for the construction of an overhead sewage disposal system, at Warren Bridge.

EAST EVERETT (Boston P. O.)—The Carpenter-Morton Co., 77 Sudbury St., Boston, has awarded the contract for the construction of a 4-story, 50x60-ft. factory on East Summer St., to J. E. Locatelli & Co., Inc., 46 Cornhill St., Boston. Estimated cost, $75,000.

SOMERSET—N. S. Chase, engr., Borden Block, Fall River, will soon award contract for the construction of a 1-story, 70x160-ft. iron foundry. Estimated cost, $50,000. Owner's name withheld.

Michigan

DETROIT—The National Alloys Co., Woodbridge St., plans to build a 1-story, 60x100-ft. foundry. Estimated cost, $25,000. Horace H. Lane, Dime Bank Bldg., engr.

Minnesota

PINE ISLAND—The Bd. of Educ. plans to build a 2-story, 60x106-ft. high school. L. L. Cornwell, secy. Stebbins & Haxby, 415 Auditorium Bldg., Minneapolis, archts.

Montana

FORSYTH—John E. Edwards & Co. plans to build a sugar factory. Estimated cost, $1,500,000.

Nebraska

MINATARE—The Great Western Sugar Co., Scotts Bluff, plans to build a sugar factory with a capacity of 1,200 tons.

New Hampshire

DOVER—The National Woodworking Machinery Co., B'way., has awarded the contract for the construction of a 1-story 50x100-ft. foundry, 1-story 35x200-ft. machine shop and a 1-story 40x100-ft. pattern shop on Locust St., to Chesley & Co., 11 Middle St. Estimated cost, $125,000.

New Jersey

ATLANTIC CITY—The city is having plans prepared for the construction of a sewage disposal plant. Estimated cost, $60,000. Clyde Potts, 30 Church St., New York City, engr.

Ohio

CANTON—The Bowman Bros. Drug Co., 3rd and Court Sts., N. W., has awarded the contract for the construction of a 2 story warehouse on Schroyer Ave., S. W., to the Van Orman Bros. Estimated cost, $60,000.

CINCINNATI—Hill Griffith, 1262 State Ave., plans to build 1- and 1-story, 150x300-ft. addition to foundry. Estimated cost, $100,000. Bert Baldwin, 2nd National Bank, engr.

CLEVELAND—The Cleveland Can Co., 1836 Euclid Ave., plans to build a 3-story factory. Estimated cost, $200,000. J. A. Brown, 1836 Euclid Ave., mgr.

PIQUA—The Champion Fdry. Co. has awarded the contract for the construction of a 2-story factory to the Dorris Hunt Constr. Co., Dayton. Estimated cost, $15,000.

URBANA—The United Paper Board Co. is having plans prepared for rebuilding and remodeling its plant recently destroyed by fire. Estimated cost, $500,000.

Pennsylvania

PHILADELPHIA—The Taylor Wharton Iron & Steel Co., 25th and Washington Sts., has awarded the contract for the construction of a 1-story, 80x100-ft. machine shop addition at 51st and Grays Sts., to the Hughes-Foulkrod Co., Commonwealth Trust Bldg.

Rhode Island

CUMBERLAND—A. H. Humes, archt., 229 Main St., Pawtucket, will soon award the contract for the construction of a 1-story, 60x80-ft. factory on Abbott St., for the Standard Nut & Bolt Co. Estimated cost, $25,000.

PAWTUCKET—The What Cheer Chemical Co., Grotto Ave., will build a 1-story addition to its factory. Estimated cost, $35,000. Work will be done by day labor.

Texas

AMARILLO—The city plans to vote on a bond issue for the construction of an incinerator, $18,000; sanitary disposal plant, $18,000; sanitary sewers, $60,000; fire alarm station, $30,000; and a coliseum, $200,000. Address the Mayor.

Wisconsin

CUMBERLAND—The city will build a sanitary sewer system and treatment plant. Estimated cost, $80,000. Work will be done by day labor. Noted July 7.

GRAND RAPIDS—The Grand Rapids Fdry. Co. will build a 1-story, 50x104-ft. pattern shop here. Work will be done by day labor.

MENASHA—The Simple Gas Engine Wks. plans to build a 60x100-ft. foundry. J. D. Frankland, De Pere St., mgr.

WAUKESHA—The Waukesha Castings Co., 340 B'way., is in the market for new foundry equipment. W. Blair, purch. agt.

WEST ALLIS—The Nelson Pulley Co., 857 27th St., Milwaukee, will build a 1-story, 60x120-ft. machine shop and foundry. Work will be done by day labor.

Ontario

HAMILTON—The Steel Wks. of Canada, Harvey Lane, plans to build a 1- and 2-story steel plant and foundry. Estimated cost, $300,000.

KAPUKASING—The Spruce Falls Co., Toronto, plans to build a pulp and paper mill here. Estimated cost, $800,000.

ST. THOMAS—The Elgin Milk Products Co. plans to build a 2-story, 55x200-ft. condensed milk factory on Talbot St. Estimated cost, $100,000.

ST. THOMAS—S. Gilbert, mgr., will soon award the contract for rebuilding the plant, which was recently destroyed by fire, of the Canada Iron Fdry. here.

Manufacturers' Catalogs

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O., calls attention to Bull. 51, on its new gas producer. This bulletin is practically a text-book on gas producers, and has also many illustrations, some in color.

PORTABLE MACHINERY CO., Passaic, N. J., has just published a 24-page catalog entitled "Portable Conveyors." This is complete with illustrations showing the various uses of the Scoop Conveyor and other portable conveyors manufactured by the company, and describes clearly the labor, time and money saving features of the machines in storing, reclaiming, loading and unloading material such as coal, coke, ashes, sand, gravel, crushed stone, fertilizer, cement, chemical, etc. Copies of the catalog will be sent free upon request to the manufacturers.

THE NATIONAL CARBON CO., INC., New York, has issued a booklet entitled "The Carbon Electrode." The purpose of this booklet is to place in the hands of those interested in electric furnace operation certain suggestions relative to the handling, storage and use of carbon electrodes, and a comprehensive bibliography.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, on Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

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Fall Conventions And Expositions

AS SUMMER approaches its end, and usually while the dog days are still upon us, we have to roll up our sleeves and get ready for the tumultuous month of September. It becomes a time for pleasant meeting and profitable discourse among men of science and technology. Many regard it as in agreeable post-vacation to attend the meetings. As editors we enjoy them also, but they can scarcely be construed as vacations. Editorial flowery beds of ease seem to be out of commission during September. Indeed, this year from the middle of August to the middle of October there is a continuous succession of professional gatherings in which chemists and metallurgists are interested. Outstanding features are the pilgrimage of the mining and metallurgical engineers to the Lake Superior country, the gathering of chemists in Chicago, the convention and exhibits of the steel treaters in Philadelphia, the Sixth National Exposition of Chemical Industries in New York, the meeting of electrochemists in Cleveland and of the Institute of Metals Division of the A.I.M.E. in Columbus. The dates of these gatherings are given elsewhere in our regular column devoted to that purpose.

Following our usual custom, we will herald the approach of the Chemical Exposition with a special issue, to be published Sept. 8. Literally speaking, months have been spent in its planning and preparation. Leaders in a score of industries have contributed their ideas of the progress which must be made in order to establish those industries on a truly scientific basis. As a consequence the issue will possess special character as a symposium by forward-looking specialists each of whom is in the front rank of his industry. At our invitation they have spoken freely and frankly of those things which must be done if rule of thumb is to be superseded by science. Rarely have we commented in advance upon the quality of material which we expect to publish, but in this instance the product of many minds is not only worthy of advance notice, but undoubtedly will be considered fit for preservation.

Small, but Quite Important

SCARCELY a week passes without announcement of some new fellowship or research award from endowment funds or other agencies interested in the reports of research. However, a large majority of these awards are for sums of $500 to $1,000 per year, or less. Recently there was noted one case where six awards were made from a single fund, the largest being $500, the total less than $2,000.

It is rather strange that so much attention is given to these small sums, each of which amounts to less than the annual wage for a new office boy; but they suffice to hold post-graduate students for a year or two of research, or they provide some instructor or professor with enough funds to defray expenses of special apparatus and equipment.

The technical significance of these awards is very great, and they should be encouraged. Indeed, it is high time that our industries took a greater interest in encouragement of special research by the appointment of men at educational institutions or public laboratories that are particularly well fitted to work on their problems. Even though the companies do not realize handsomely on some of these investments, it is more than likely that the benefit from such support of special investigations will far exceed the average success in hiring the afore-mentioned office boy. Certainly there is no more promising way than this to use a small investment for research.

Contentment, Complaint And Present Progress

THE notion remains that a great many things are wrong industrially, financially and economically. It might be well to stop a moment and question whether there is not something wrong with the mirror of the mind that reflects the things observed. Perhaps we are taking things too seriously. It is quite true that progress is made through discontent. If one is contented with his condition he is not likely to strive to get somewhere else. Discontent with things over which one can have no influence, however, is a totally different matter.

The disposition to complain is obviously very strong. That is in part a product of the war and of the war-ending. During the war we saw certain things done by team work, by the people having a common purpose and we feel somehow that in these days everything ought to be righted by similar methods, but that is impossible because the single common purpose that existed during the war is lacking.

It certainly does seem as though discontent and the disposition to complain are greater than they should be or need be. For instance, there is "the transportation situation," which common talk would have it is almost indescribably bad. Transportation conditions have been improving rather steadily since the latter part of April. More freight cars were loaded in July than in June, and more than in July of last year. The quantity of transportation is not up to the requirements, and the quality is not what is desired, for when the freight does move it does not move as rapidly as it should. This is not the first time these things have occurred, but we are particularly sensitive on the subject now on account of the vast amount of public discussion of railroad matters.

Then there is coal. Many people talk as if there were a tremendous shortage, yet the fact is that production is very heavy and is probably in excess of current requirements, apart from the matter of stocking, which of course is desirable. The main thing about coal is the extremely high price. A ton of coal will buy a pair of shoes, whereas at one time it required three or four tons. The price of coal, however, is largely psychological, in that the market has been made by excited and more or less careless bidding, while the fact that coal is a particularly essential commodity has had an important influence.

Again, as to "labor" there has been much complaint. The supply of labor has been insufficient, but the matter can be put the other way, that there is an excess of desire to employ labor. Then there is complaint as to remuneration, that some vocations that require "years of preparation" do not furnish as good pay as the pick-and-shovel man gets, but the latter may rejoin that some people could prepare all their lives and then not have acquired the kind of back necessary for pick-and-shovel work.

One man tells us that money rates are too high, while another tells us that costs are so high capital will not seek investment. Both cannot be right. Everyone has his own complaint. Yet we have had the free play of forces for twenty-one months, since the Armistice, and really it is rather a strong demand upon us to admit that nothing has been adjusted or settled or equalized in that period. If collectively we have accomplished scarcely anything in nearly two years, a great many of us are likely to die before all the adjustments have been made. It would seem better to cultivate contentment with the circumstances forced upon us, to endeavor to complain less, and to make more effort at individual progress, taking things as they are, even though they are different from conditions before the war or conditions we expected to obtain after the war.

Where Are The Chemists?

UNDER the caption "How Best to Serve" appears an interesting editorial in the August *Journal of Industrial and Engineering Chemistry* which may be taken to express the attitude of officials of the American Chemical Society toward the movement leading up to the Federated American Engineering Societies. It is in answer to the question "Where are the chemists?" propounded in the June 23 issue of CHEMICAL & METALLURGICAL ENGINEERING, and is to the effect that the American Chemical Society actually is now functioning in public affairs by passing resolutions, by its officials' testimony before Congressional committees and advice to Government bureaus, and by the issuance of a news service recounting chemical facts in non-technical language. Past achievements convince the officers of the Society that they can continue to do good work all by themselves, without incurring the expense of affiliation in a national organization.

It is possibly due to obscure writing that the editor of the *Journal* has apparently missed our point. More simply stated, it is this: The new Federation is to be composed of engineering and allied technical organizations. Incontestably there is a big work to be done by it in furthering the public welfare wherever technical knowledge and training are involved. Where are the chemists? Such large numbers of them are engineers or engaged in work so closely related to engineering that it seems to us the officials of the Chemical Society are overlooking the inter-relationship of this new forward movement with chemical progress. A formal invitation to join has been extended to the American Chemical Society in common with all others of related interest and no doubt will receive careful consideration before an official reply is made.

Manufacture of Aluminum Castings

A SERIES of comprehensive papers by R. J. ANDERSON discussing the manufacture of aluminum: copper alloys starts in the present issue of CHEMICAL & METALLURGICAL ENGINEERING, in which debatable points in the practice are discussed in the light of experimental results. As may be known, the so-called No. 12 alloy (containing about 92 per cent aluminum and 8 per cent copper) and other light aluminum: copper alloys for sand castings are manufactured by two distinct methods: First, by adding solid copper to liquid aluminum in the required proportions by weight, and second, by charging a copper-rich alloy with the purer aluminum.

Many kinds of rich alloys are employed in nonferrous alloy metallurgy, including phosphor-tin, phosphor-copper, manganese: aluminum, manganese: copper, silicon: copper, nickel: copper, and copper: aluminum, for making fixed additions of elements in the manufacture of alloys. Similarly, in alloy-steel metallurgy, such well-known ferro-alloys as ferrotungsten, ferrochromium, ferrosilicon, ferromanganese, ferrovanadium, ferromolybdenum and other minor iron-alloys are employed for particular purposes. A rich alloy is employed for one or both of two purposes: First, for deoxidation or scavenging, and second, for making fixed additions of certain elements in the manufacture of alloys. From the metallurgical standpoint, rich alloys are generally preferred to commercially pure ingot because such alloys can usually be made with such melting points that they are readily incorporated in a bath of liquid metal. Furthermore, the liability of oxidation and slag losses of valuable metals is less.

Contrary to such general ideas ordinarily held by foundrymen about rich alloys, some foundries casting No. 12 alloy make the alloy by simply charging light copper punchings into a bath of liquid aluminum, hotter than usual, but still far below the melting point of copper. The copper alloys with the aluminum partly by diffusion and partly by solution and the rate of alloying is therefore dependent upon many conditions. A number of foundries in the United States employ this method exclusively, while many others decidedly oppose it on the ground that it is unsuitable for commercial practice. It certainly requires the bath to be superheated at some portion of its history, a practice which is quite liable to induce blow-holes and sponginess in the resultant castings. Some of the casting losses have been attributed to this method, it being claimed that, because of non-homogeneity of successive heats and even of a single ill-mixed melt, the castings are liable to run "hard and soft."

In view of the rapidly expanding use of aluminum castings, such a discussion of practice with recommendations for its improvement as will be presented by Mr. ANDERSON should be very interesting to metallurgists and foundrymen engaged in this work.

The Functions and Training Of the Chemical Engineer

MANY attempts have been made to define in a few words that branch of applied science which is known as chemical engineering. That such efforts have not been entirely successful is due largely to the fact that the profession is still in a formative stage of development.

The change in the training of the chemical engineer —from a mechanical engineer with a smattering of chemistry to a physical chemist with an engineer's point of view—has been brought about by a realization that chemical engineering is a distinct branch of engineering involving more than the mere adaptation of mechanical engineering principles to new environments. However, a clearer conception of many of the fundamental principles of the new science, of the chemical engineer's duties and of his true place in the industrial world will be necessary on the part of the instructing staffs in order that they may be qualified to train men for a profession which is destined to become one of the leading branches of engineering. That much remains to be done is evident from a recent statement that there are probably not more than six hundred qualified chemical engineers in the United States!

The question of chemical engineering education has received considerable attention lately, particularly in England, where the discussion on "What Is a Chemical Engineer?" at the May meeting of the Chemical Industry Club and the papers on "Functions and Training of the Chemical Engineer" by Lord MOULTON and Professor J. H. WEST of the Royal College of Science have brought out many interesting points. In order to encourage expressions of opinion or criticism from chemical engineers and others in this country, Professor WEST'S views are set forth in full elsewhere in this issue.

In this paper it is clearly pointed out that there are different kinds of chemical engineers and that the duties of a chemical engineer in plant work vary somewhat with the size of the plant and the complexity of organization of the technical staff. The statement that the daily routine connected with the operation of a smoothly running plant is not real chemical work or chemical engineering may come as a shock to some. While the man who is constantly on the alert for ways and means of increasing the efficiency of the process for which he is responsible may be pardoned for taking exception to this statement, does it not apply with full force to the man who is satisfied when he has filed away the day's data sheets and made the necessary entries on the production records?

In the light of this and similar discussions, we may summarize briefly the requirements for a chemical engineer. He must first of all be thoroughly familiar with all types of standard equipment for carrying out chemical engineering operations. A knowledge of the changes in chemical and physical properties of materials with varying temperature, pressure and concentration is also essential in considering the design or material of construction to be used in apparatus for a particular process. He should know how to calculate and apply quantitative flow sheets for heat and materials. The chemical engineer should appreciate fully the possible effects of change of scale upon the smoothness of a process developed in the research laboratory or in the small-scale plant. While he should not be expected to handle problems of a purely mechanical engineering nature, he should be sufficiently well versed in the fundamentals of this and allied engineering fields to be able to confer intelligently with experts in these branches. In this respect he should resemble the head of a large corporation who, although not an expert accountant, is able to tell his accounting department what is wanted and interpret its reports.

While all these phases of chemical engineering training are recognized today, it is doubtful whether a single educational institution could be found which is satisfied that its present course is so standardized that further improvement is unnecessary. Much progress will undoubtedly be made through suggestions from graduate chemical engineers who have learned through experience the weak points of the courses which they took. It might indeed prove profitable for departments of chemical engineering to keep in touch with their more experienced graduates for the purpose of strengthening their curricula through the constructive suggestions of these men, who are in the best position to interpret the needs of industry.

Auto-Catalytic Improvement

WHEN the Interstate Commerce Commission practically embargoed all other freight by giving open-top car priority to coal it did not at once appear that this remedy was to prove as quickly effective as now seems likely. The process of improvement in the fuel supply of the country, however, seems to have been catalyzed twofold by this arrangement. In the first place, coal, having priority, moves first, last, and all the time. In the second place, other raw materials and products requiring open-top cars do not move at all adequately to permit industrial activity on a full scale. As a consequence much construction work and many industrial activities, finding a shortage of cars, are unable to operate at all or must do so at part capacity. Their coal requirements are immediately reduced by this decrease in activity. The secondary effect of the order, therefore, is perhaps even more important in relieving the apparent fuel shortage in all markets than the primary relief. It is to be hoped, however, that this secondary effect will not progress too far and result in extreme curtailment of industrial activity. If it does we may well expect the cure to be almost as bad as the disease which the I.C.C. is treating.

Interrelation Of Sciences

THE untimely death of Surgeon-General WILLIAM C. GORGAS again reminds us of the important relation of one science to another. Without the wonderful work of this famous officer in the field of sanitation, much of the American success in cleaning up Cuba would have been impossible. His work as the chief sanitary officer in the Panama Canal Zone was, too, a fundamental contribution of greatest importance to this engineering project. Any who are disposed to exaggerate the importance of their own science can well consider this case and realize that it is only by adequate co-ordination of chemistry with engineering, chemistry with sanitation, chemistry with physics and mathematics, chemistry with biology and medicine, that the greatest accomplishments of the chemical profession may be achieved.

Readers' Views and Comments

Intercrystalline Brittleness

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have just been reading Technologic paper 158, of the Bureau of Standards, dealing with "A Peculiar Type of Intercrystalline Brittleness of Copper."* This is an interesting paper and there is food for thought in the following remark taken from page 5:

> It may be assumed, therefore, that only a relatively very thin skin has been rendered brittle by the electrolytic action; the properties of the entire rod have, however, been very profoundly changed.

At various times I have given some thought to the phenomenon of brittleness due to the action of sulphuric acid, on an iron bar, for example. It has often occurred to me that here is merely a surface action and yet, as is stated, the entire rod is "profoundly changed."

It seems inconceivable that any extensive alteration of the interior of the rod has occurred. Would it not then be possible that this brittleness is an electronic phenomenon, which might be described as a change in surface tension? In other words, may not the molecules of the metal be held together through surface action or tension, in effect binding the mass of material together, as the mass of molecules is held together in a drop of mercury?

While the placing of a bar of metal in a lathe and shaving it down does not alter this cohesion of the surface, yet some chemical action due to acid or alkali or to occluded gases might impair this skin effect, as has been so well described in circular 158 mentioned above.

Maybe we shall some day revise our views with respect to the forces which hold the particles of masses together. A. C.

New York City.

Balanced Reactions in Steel Manufacture

To the Editor of Chemical & Metallurgical Engineering

SIR:—George F. Comstock has called my attention to a contradiction which I readily acknowledge in my paper "Balanced Reactions in Steel Manufacture," published in your issue of April 7, 1920. He writes:

"In the fifteenth line of the first column on this page it is stated that with much FeO in solution the ratio of CO_2 to CO will be great. But in the eleventh line from the bottom of this same column it is implied that this ratio should be higher with less FeO in solution. Is there some error here, or can you explain how these two statements can both be true? It seems to me that the 'CO_2 : CO ratio' in the tenth line from the bottom, and also in the little table, fourth line from the bottom, should really have been written 'CO : CO_2 ratio.'"

In the second paragraph of course the ratio CO_2:CO should read CO: CO_2.

Since writing that paper, however, I have found that the method of Goerens for estimating the gases in steels is liable to serious error. His method is based on fusing steels in a mixture of metals in which these gases do not dissolve and measuring the volume of gas which is evolved. The carbon in the steel sample cannot be dissolved either, and it rises to the surface of the molten mixture, where it reduces any CO_2 to CO, so that the total volume of gases is probably correct considered as an equivalent in CO, but the proportion of CO to CO_2 is entirely altered and no longer represents their relative ratios when present originally in the steel.

This vitiates any conclusions based on such results and makes my statement referred to one which may be true, but is not yet supported by any experimental evidence.

I would rather withdraw the paragraph entirely until figures to support it or disprove it can be obtained.

ANDREW McCANCE.

Glasgow, Scotland.

*CHEM. & MET. ENG., vol. 22, p. 347 (Feb. 25, 1920).

Shattered Zones in Rails

To the Editor of Chemical & Metallurgical Engineering

SIR:—Editorial correspondence appearing in your issue of June 30, reviewing papers presented at the recent meeting of the American Society for Testing Materials, devotes some space to my observations concerning shattered zones in steel rails. If it is important to give credit to those who have advanced the subject, I should be inclined to state the matter differently than you have on page 1,189.

Messrs. Waring and Hoffammann at the very outset announced the presence of shattered zones in new rails; therefore it was not reserved for any one else to prove their pre-existence. What Waring and Hoffammann found, others have of course also found.

The high points in the investigation of shattered zones comprise:

1. Their presence in the heads and at junction of web and base in both new and used rails.
2. Hot sawed ends do not show shattered metal.
3. Certain medium hard rails have not yet been observed to display such zones, which, on the other hand, have been found in hard steel rails and wheels.
4. No foreign inclusions have been found in the shattering cracks.

Item 2 fixes the time of their formation in the stage of cooling after hot sawing. Curing by hot sawing is contrary to all known principles.

So many irrelevant and untenable conjectures have been made regarding transverse fissures that it has not seemed worth the while to discuss those on which there seems no basis of support. However, I think all tangible suggestions have been looked into. The reason for an interior origin of a fissure I think I stated clearly in 1911, arguing from a principle of mechanics.

JAMES E. HOWARD.

Washington, D. C.

$1,000,000 Louisiana Oil Plant

About $1,000,000 will be the cost of a plant for manufacturing essential oils to be built at Bogalusa, La., by the Essential Oils Co. of Philadelphia. The company has contracted to obtain its supply of wood waste from the big mills of the Great Southern Lumber Co. At least 500 men will be employed to operate the oil works.

Some Theoretical Principles of Alloying

A Discussion of Possible Applications of Such General Concepts as May Be Drawn From the Equilibrium Diagram, Heat of Alloy Formation, Thermit Reaction, Diffusion and Solution to Problems Connected With the Production of Aluminum : Copper Alloys in the Foundry

BY ROBERT J. ANDERSON*

IN A detailed discussion of the manufacture of aluminum: copper alloys—except aluminum bronze—it is desirable to commence by a brief presentation of the equilibrium diagram for the Al : Cu system, as well as the effects of heat of formation, thermit reaction, diffusion, convection and solution. In the commercial preparation of metallic alloys the influence of various factors may be overlooked, but a thorough understanding of the fundamental metallurgical principles of alloying will permit corrective measures to be applied more readily when foundry troubles, due to the alloy, arise.

EQUILIBRIUM DIAGRAM

The aluminum : copper series of alloys is of interest to the non-ferrous metal industry because it embraces many light castings, the rich alloys used for introducing copper into aluminum, and also the so-called aluminum bronzes. The curve shown in Fig. 1, after Carpenter and Edwards,[1] agrees well with that published by Guillet, except in minor details. With reference to this diagram foundrymen are interested mainly in the alloys containing 2.0 to 14.0 per cent copper, in those containing 33.0 to 60.0 per cent copper, and in those of aluminum: bronze composition, i.e., about 90.0 per cent copper and 10.0 per cent aluminum.

Three intermetallic compounds are known, viz., $CuAl_2$, Cu_3Al and Cu_4Al. An investigation with regard to the solubility of $CuAl_2$ in aluminum at different temperatures has recently been carried out by Merica[2] and his collaborators. These investigators have found that the solubility of $CuAl_2$ in aluminum decreases with decreasing temperature from about 4.0 per cent at 525 deg. C. to about 1.0 per cent at 300 deg. C., and it is less apparently at still lower temperatures. This means that the line dropped from *k*, in Fig. 1, to the base should not be perpendicular, but it should curve in accordance with the temperature-solubility of $CuAl_2$. Detailed discussion of the diagram is not necessary, nor will information as to equilibrium between the phases of the alloys be germane to the present article, but the diagram will be found useful for reference.

It may be emphasized, however, that not many alloys as commercially cast are in final equilibrium as indicated by their diagrams, and very fast or very slow cooling may be required to produce an alloy in true equilibrium. In fact, it is rather generally true that alloys are not usually in equilibrium unless actual precautions have been observed to insure this condition. The properties of alloys are influenced by this deviation, and the interpretation of phenomena which occur in alloys will be easier if this deviation from equilibrium is borne in mind.

HEAT OF FORMATION

When alloys are formed from their components the union takes place either with a development or an absorption of heat, but the possibility that other reactions may affect the heat change should not be overlooked. Few calorimetric determinations of the heat changes occurring in the formation of alloys have been made, but some are due to Person,[3] and Richards and Forbes,[4] and in the case of aluminum: copper alloys to Longuinine and Schukareff.[5] Direct estimation of the heat of solution (formation) of alloys is practicable only with metals and alloys of low melting points, and the difficulties involved in determinations of metals of high melting points are almost insuperable. The indirect method of determining the heat of solution consists in measuring the amount of heat developed when an alloy is dissolved in a liquid chemical reagent and then comparing the result so obtained with the heat calculated (for an alloy of the same chemical composition) from the observed heats of solution of the component metals dissolved in the same chemical reagent. If the measured heat of solution of the alloy is less than that calculated by the rule of mixtures, then the difference is said to represent the heat developed in the formation of the alloy. If the observed heat of solution is greater than that calculated the difference represents the heat absorbed. This method for determining the heat of solution of alloys was originally carried out by Hess, and has been employed by Galt and Baker in determinations of various alloys.

In the experiments of Longuinine and Schukareff the heats of formation were determined by measuring the heat of solution of aluminum, copper, and alloys of the metals in aqueous solutions of bromine and potassium bromide. These investigators found that an alloy corresponding to the formula Cu_4Al had the greatest heat of formation, but no such intermetallic compound exists; hence, the validity of their results is somewhat conjectural. The subjoined figures for the heats of formation of alloys of aluminum and copper are from the work of these investigators; most of the compositions given do not correspond to known intermetallic compounds.

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*Metallurgist, U. S. Bureau of Mines, Pittsburgh, Pa.

[1]Carpenter, H. C. H., and Edwards, C. A., "Eighth Report to the Alloys Research Committee on the Properties of the Alloys of Aluminum and Copper," *Proc.;* Inst. of Mech. Engrs., vol. 72, 1907, p. 370.

[2]Merica, P. D., Waltenberg, R. G., and Freeman, J. R., "Constitution and Metallography of Aluminum and Its Light Alloys With Copper and With Magnesium," *Bull.*, Amer. Inst. of Min. and Met. Engrs., July, 1919, pp. 1031-1049, CHEM. & MET. ENG., vol. 21, p. 551 (Oct. 29, 1919).

[3]Person, C. C., "Untersuchung über die latente Schemlzwärme," *Ann. der Physik.*, vol. 76, 1849 (II), p. 586.

[4]Richards, T. W., and Forbes, G. J., "Energy Changes Involved in the Dilution of Zinc and Cadmium Amalgams," Carn. Inst. of Washington, 1916.

[5]Longuinine, W., and Schukareff, A., "Thermal Examination of Some Alloys of Aluminum and Copper," *Arch. Sci. phys. Nat. Genéve,* vol. 15 (IV), 1903, pp. 49-77.

Baker's experiments[6] indicate that the greatest heats of formation in the copper: zinc system occurred in the

Compound	Calories	Compound	Calories
Cu[illegible]Al	123.5	CuAl	20.8
Cu_2Al	137.9	Cu[illegible]Al[illegible]	48.9
Cu[illegible]Al[illegible]	71.0	Cu[illegible]Al	57.2

intermetallic compounds; it is to be expected that the same would be true of the aluminum: copper system.

Entirely satisfactory figures for the heat of formation of various alloys of aluminum and copper are not available, but there is sufficient evidence to show that part of the rise in temperature which occurs when the two metals are alloyed is due to this phenomenon. It is a well-known fact that when aluminum is added to liquid copper there is an appreciable and immediate rise in temperature, but some disagreement has existed as to whether this temperature rise should be ascribed to heat of formation or to a thermit reaction between the aluminum and the oxygen in the copper.

Thermit Reaction

The possibility of reactions other than heat of formation contributing to the heat change observed when aluminum is added to liquid copper, or *vice versa*, has been mentioned. Ordinarily when aluminum is added to liquid copper there is a rise in temperature which, according to some observers, is from 40 to 250 deg. C., and often, according to others, sufficient to raise the temperature of the liquid melt to an intense white heat. The available evidence appears to indicate that this should not be attributed solely to heat of solution of aluminum in copper, as has been done,[7] but rather in part to the interaction of aluminum and copper oxide, or to aluminum and oxygen, or both. This is a strongly exothermic reaction. The reasons for the rise in temperature observed when aluminum is added to liquid copper have been gone into rather thoroughly in the discussion of the work of Carpenter and Edwards,[8] who found that when aluminum was added to liquid copper a very marked evolution of heat occurred; they did not find, on the other hand, any great rise in temperature provided the copper had been properly protected from oxidation. The conclusion was that the rise in temperatures should be attributed, not to the combination of aluminum and copper, but to that of aluminum and oxygen. Other investigators have found that if just sufficient aluminum is added to reduce all the copper oxide present in a melt of oxidized copper, subsequent additions of aluminum will not produce any considerable rise in temperature.

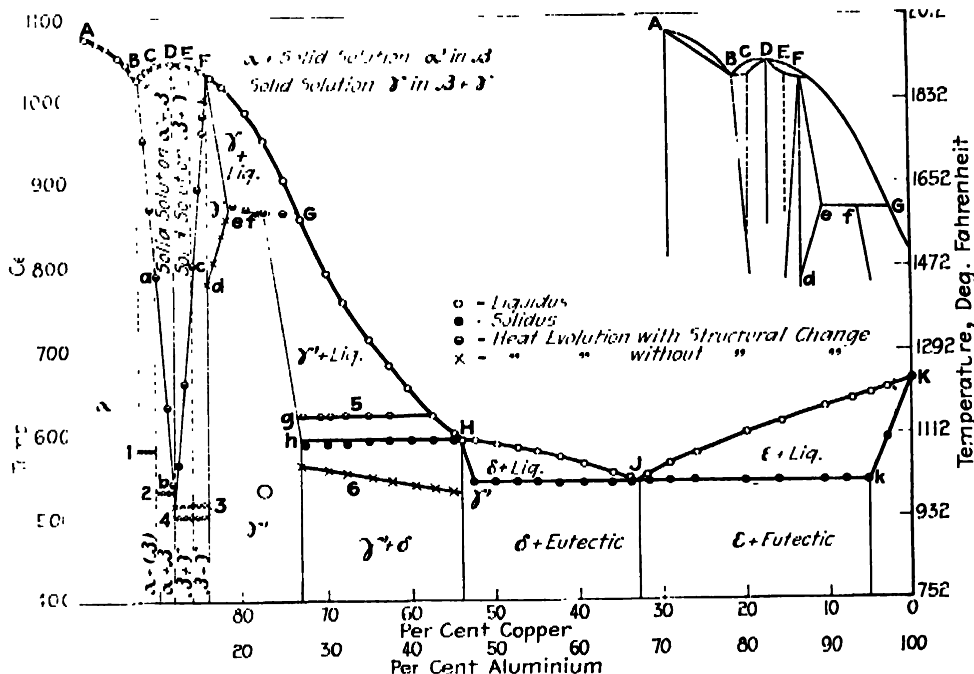


FIG. 1. EQUILIBRIUM DIAGRAM OF THE ALUMINUM: COPPER SYSTEM (AFTER CARPENTER AND EDWARDS)

[6]Baker, T. V., "The Thermo-Chemistry of the Alloys of Copper and Zinc," *Phil. Trans. Roy. Soc.*, vol. 196A, 1901, pp. 529-516.

[7]Curry, B. E., and Woods, S. H., "The Tensile Strengths of the Copper-Aluminum Alloys," *J. Phys. Chem.*, vol. 11, 1907, pp. 461-491.

[8]See footnote 1.



FIG. 2
Diffusion of copper into aluminum; etched with NaOH; × 50.

FIG. 3
Diffusion of copper into aluminum; etched with NaOH; × 50.

FIG. 5
$CuAl_2$ (light) and eutectic (dark), from one of the bands in Fig. 4; etched with NH_4OH + H_2O_2; × 200.

Experiments carried out at the Bureau of Mines have shown that there is always a rise in temperature when aluminum is added to liquid copper, due to the heat of formation of the resultant alloy, but that the large rise in temperature described as a "white heat" is due mainly to the thermit reaction of aluminum with copper oxide. This large rise in temperature is very destructive of crucibles and iron pots in foundry practice, and it can be guarded against by melting the copper under a charcoal cover (if badly oxidized copper is used), by deoxidation with boron suboxide, or by otherwise preventing the oxidation of high-grade copper. The question of both heat of formation and thermit reaction in connection with the manufacture of aluminum: copper alloys is highly important as affecting dross losses.

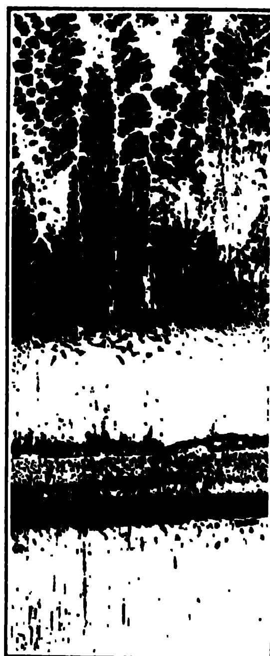


FIG. 4

Micrograph of diffusion of copper into aluminum; etched with NH_4OH + H_2O_2: × 25.

There is plenty of evidence to show that the diffusion of metals in the solid state is a very general phenomenon, the classical experiments of Roberts-Austen[9] being particularly well known. That one solid metal can dissolve another has been shown by maintaining carefully surfaced pieces of two different metals in intimate contact for a long time. At atmospheric temperatures the diffusion is very slow, but it becomes more rapid at higher temperatures; and if a solid metal of higher melting point is placed in a liquid metal of lower melting point diffusion may be extremely rapid, depending upon the individual metals, the size and shape of the immersed metal, the relation of volume of liquid metal to surface of solid metal exposed, rate of agitation, amount of convection and the temperature.

From the practical standpoint diffusivity figures are not of much value, and furthermore they are liable to be in error when determinations are made of the diffusion of solid into liquid metals because of the effect of other factors such as convection, solution, and the changes occurring during alloying where the liquid metal is becoming progressively richer and richer in the solid metal. The object in calling attention to these factors is to indicate that they must be considered in the manufacture of alloys, but diffusivity figures in themselves are not necessarily applicable to foundry practice.

The process of diffusion may be conveniently observed (in the case of copper and aluminum) by placing a rod of solid copper in a crucible of liquid aluminum for a short time. On withdrawing the rod a fairly adherent coating will be found, consisting of a brittle silvery-colored alloy rich in aluminum. On analyzing the metal remaining in the crucible varying amounts of copper will be found, depending largely upon the time period of immersion of the copper rod and upon the temperature. If a microsection of the alloyed rod be examined, varying structures will be found, depending upon the thickness of the coating. Figs. 2 and 3 show the diffusion of copper into aluminum. The white areas above the black band separating the copper (below) and the aluminum: copper alloy (above), correspond to copper-rich compositions; the characteristic rectangular structure of $CuAl_2$ is shown, and the alloy becomes leaner in copper with increasing distance from the copper. These micrographs were taken on a sample obtained by suspending a cylinder of solid copper in liquid aluminum for a short time at a temperature below the melting point of copper and then freezing the aluminum with the copper in place. Fig. 4 is a view taken across an area of a diffusion sample obtained by freezing a copper rod in liquid aluminum after suspending it for five minutes at 700 deg. C. Starting with copper at the lower band in Fig. 4, the changes in microstructure from bottom to top of the photograph illustrate the variation in copper content (copper becoming leaner in the alloy with increasing distance from the copper rod). Fig. 5 shows the microstructure of one of the bands in Fig. 4; the structure corresponds to an alloy of about 55.0 per cent aluminum and 45.0 per cent copper in composition. The delta constituent, $CuAl_2$, appears light, since it is electronegative to the eutectic. The diffusion of metals may also be shown well by making small superposition ingots according to the method of Le Chatelier or otherwise. The principle of filiation,[10] enunciated by Le Chatelier in 1900, consists in the superposition of two metals in the liquid state in the order of their densities. The diffusion of one metal into the other makes it possible to obtain in a single specimen the entire series of alloys which can be formed by the metals. The series of alloys ranging from one pure metal to the other will be confined in a relatively restricted area, and the width of the area will depend upon the length of time during which one or both metals were liquid, upon the rate of cooling and upon the amount of agitation. While the preparation of superposition ingots serves a useful demonstrative purpose, it has a rather well-defined limitation in studying alloys. Fig. 6 shows the superposition of aluminum and copper, according to Le Chatelier.



FIG. 6

Superposition of aluminum and copper (after Le Chatelier).

[9]Roberts-Austen, W. C., "On the Diffusion of Gold in Solid Lead at Ordinary Temperatures," *Proc. Roy. Soc.*, vol. 67, 1900, pp. 101-105; and "Diffusion of Molten Metals," *Philosophical Trans. Roy Soc.*, vol. 187A, 1896, pp. 383-415.

[10]Le Chatelier, H., "Alloys by Superposition," *Proc. Inter. Asso. Testing Materials*, VI Congress, New York, 1912, II_2; and see also Bronlewski, W., "Relation Between the Structure of Alloys and Their Electric Properties," *ibid.*, IX_3.

Convection currents in melting pots hasten the solution and diffusion of copper in aluminum—for example, in the manufacture of No. 12 alloy by charging copper punchings into liquid aluminum. There is more or less convection in any vessel heated over part of its external surface, and both diffusion and solution are more rapid with increased convection.

Convection is not to be confused with agitation, but the latter also hastens diffusion and solution. The importance of agitation by frequent stirring was early recognized in German practice, where charges of liquid aluminum and solid copper were stirred for several hours so as to insure thorough alloying. However, there is no necessity for stirring for such long periods.

Solution

Copper forms a compound, $CuAl_2$, with aluminum, and this compound has a limited solubility in aluminum in the solid state, the solubility varying with the temperature. The fact that copper may be alloyed with aluminum when solid copper is placed in liquid aluminum at a temperature considerably less than the melting point of copper is ascribed to the combined influence of solution and diffusion. Both factors are affected by temperature, and the rate of both solution and diffusion is more rapid at, say, 900 deg. C. than at 700 deg. C.

Production of Potash in the United States*

Incomplete returns thus far received by the Department of the Interior indicate that 110,309 short tons of crude potash salts, containing 30,899 short tons of available potash (K_2O), valued at $7,889,440, was produced in the United States by 73 firms in 1919.

In 1918 there were 128 firms operating plants, which produced 207,686 short tons of crude material containing 54,803 short tons of available potash. In 1917 only ninety-five firms were operating plants, which produced 126,961 tons of crude material containing 32,573 short tons of potash.

Plants Reopened

More than 60,000 tons of domestic crude potash material was in storage in January, 1919, and most of the plants were closed for a part of the year, some of them for the larger part. These conditions were brought about by the expectation of large imports of potash salts from abroad—an expectation that was not realized. Instead the stored material was sold, and many of the

*Statement by the U. S. Geological Survey of output in 1919 and in the first quarter of 1920.

POTASH PRODUCED IN THE UNITED STATES IN 1919, CLASSIFIED ACCORDING TO SOURCE

Source	No. of Producers	Production of Crude Salts (Short Tons)	Available (K_2O) (Short Tons)	Percentage of Total	Total Value	Percentage of K_2O in Crude Product
Natural brines						
Nebraska lakes	8	35,837	9,045	29 3	$1,889,416	22 28
Other brines	6	32,385	11,293	36 5	2,875,908	11 50.5
	14	68,222	20,338	65 8	$4,765,324	.
Alunite	5	6,594	2,293	7 4	683,055	8-52
Dust from cement mills	13	11,750	1,258	4 1	272,090	2 5-60
Dust from blast furnaces silicate rock and kelp	7	2,200	250	0 8	62,035	3-32 5
Molasses distillery waste	6	8,498	2,792	9 0	801,331	14-39 8
Steffens waste water	8	12.459	3,616	11 7	1,078,291	9 5-44 5
Wood ashes	20	586	352	1.2	227,314	60
	73	110,309	30,899	100 0	$7,889,440	

POTASH PRODUCED IN THE UNITED STATES IN THE FIRST THREE MONTHS OF 1920, CLASSIFIED ACCORDING TO SOURCE

Source	No. of Producers	Production of Crude Salts (Short Tons)	Available (K_2O) (Short Tons)	Percentage of Total	Total Value	Percentage of K_2O in Crude Product
Natural brines:						
Nebraska lakes	7	23,337	5,859	49 0	$1,280,819	22-28
Other brines	5	9,726	4,104	34 3	936,161	15 8-56
	12	33,063	9,963	83 3	$2,216,980	.
Alunite, blast-furnace dust and silicate rock	3	1,336	565	4 7	174,912	9 8-52
Dust from cement plants	7	4,015	314	2.6	44,246	2 3 35
Wood ashes	14	108	65	0 5	36,671	60
Steffens waste water	3	1,870	440	3 7	118,666	12 42
Kelp and molasses distillery waste	4	1,616	622	5 2	146,720	26-51
	43	42,008	11,969	100	$2,738,195	....

plants were reopened in the autumn, though some of them were again obliged to stop work because of shortage of coal.

The potash produced in the United States during the first three months of 1920, as reported to the Geological Survey from forty-three plants, amounted to 42,008 short tons of crude material containing 11,969 short tons of available potash, valued at $2,738,195.

Natural Brines

The only notable gain seems to be an increase in production from natural brines elsewhere than in western Nebraska. In 1919 six plants that produced potash from these brines made an output of 11,293 short tons of potash. In the first quarter of 1920, five plants working the same brines produced 4,104 short tons of potash, and if they continued production at the same rate during the entire year they would produce 16,416 short tons. The production of potash from cement kilns is proceeding at almost exactly the same rate in 1920 as in 1919, although there were only seven producers in the first part of 1920, against 13 in 1919.

Alunite was used in 1920 only in experiments made by companies that reported production of potash from this material in 1919.

The accompanying tables were compiled by M. R. Nourse.

British Columbia Plans to Develop Its Iron Deposits

Plans to establish an iron and steel industry on the Pacific coast of British Columbia are being considered by Canadian interests. Deposits of magnetic iron ore are known to exist in the territory, together with the necessary flux and fuel. The Canadian Collieries, with its extensive coal fields on Vancouver Island, its coke ovens and iron-ore-bearing properties, is probably better situated than any other corporation to undertake this important project.

Already a group of engineers has been in consultation with the government authorities, to establish ways and means of erecting a 300-ton furnace. It is felt that there is enough demand for iron and steel in the district to take care of the output of such a furnace, and if this demand does not materialize, the establishment of railroad car and equipment shops in this section would solve the difficulty.

Government co-operation is assured in the form of bonuses for pig iron in British Columbia produced from local ores. For a 300-ton plant this would amount to about $1,000,000 yearly.

Progress in the Byproduct Coke Industry*

Description of the Modern Practices and Methods Exemplified in the Ford Plant—Coke-Oven Gas—Market for Byproducts—Ammonium Sulphate—Light Oil and Gas Enrichment—Tar

BY C. R. BELLAMY

THE year 1919 is memorable to the coke industry in the United States, for in it for the first time the production of byproduct coke exceeded that of beehive coke. This fact is at the same time of vital importance to all our industries. For as Floyd Parsons has expressed it, "The industrial prosperity of leading civilized nations depends upon their utilization of fuels and metals." In this statement is found the real significance of the change from beehive to byproduct coke predominance. Better utilization of coal, our basic fuel, is the beginning of real conservation.

Our byproduct coke-oven industry, with close to 11,000 ovens in operation at this time, is one of huge dimensions, and the modern coking plant is one of the great achievements of chemical and mechanical engineering. The results of a modern plant show what progress has been made. The high yields indicate improved methods, while the uniform yields indicate the extent to which operation is under control. A better knowledge of the factors that are essential to good results, coupled with the ability to control these conditions, is the feature of our best plants. Before going into details concerning operation data of one of the most modern plants let us briefly trace the growth of this industry and the progress that has kept pace with this growth. In the writer's opinion, the expansion of the byproduct coke oven has been marked by three distinct periods, which with the attributed causes are given in order of sequence:

1. Recognition by the steel industry that byproduct coke could be made that was superior to any beehive coke.
2. Recognition by the gas industry of the fact that in the byproduct coke oven was its opportunity for development on the lines of real efficiency and economy.
3. General conviction that the market for benzol, ammonia and tar was firmly established and able to absorb all possible production from coke ovens.

The first period was realized by overcoming the old-time prejudice of the blast-furnace operator and then seeking his co-operation in determining what constituted a satisfactory metallurgical coke. To illustrate this, the work of the Semet-Solvay Co. in conjunction with that of different blast furnaces is most interesting. For years this company made daily all the tests of which it had knowledge, such as specific gravity, porosity, shatter, loss in CO_2, size of pieces and structure. These tests, accompanied by investigation and research at ovens and furnaces, finally led to the fixing of certain definite standards, and by strict adherence to these standards byproduct coke has come to sell at a premium. Factors which are considered essential to the production of high-grade furnace coke are:

1. Proper preparation of the coke in all respects, including size.
2. Uniformity of the coal mixture used in the manufacture of coke, thereby producing coke of reliable chemical composition.
3. Uniformity of heating of the charges in the oven, thereby controlling the physical structure of the coke.

COKE-OVEN GAS

The commercial value of the surplus gas from byproduct coke ovens was slow to be appreciated, and it was only about eight years ago that any general recognition of this value was apparent. Since then the progress in this direction has been so remarkable that today the byproduct oven looms up as the real solution to the problems confronting our public gas utilities. Very many of the large cities east of the Mississippi River are now supplied with coke-oven gas straight or mixed with water gas. The literature of the gas industry as concerns manufacture is now largely devoted to the byproduct oven and it has given us many valuable papers upon this subject.

In this field, again, co-operation has meant success. Joint investigation by the two industries concerned has made it possible for the modern byproduct plant to deliver a coal gas that will pass the most exacting specifications as to B.t.u., candle power and purity. And this gas can be produced so economically that no other process can compete. Some of the factors that make the production of such high-grade gas possible are:

1. Proper mixture of proper coals.
2. Tight ovens.
3. Proper regulation of pressure in ovens and in the hydraulic mains.
4. Proper carbonization temperatures.
5. Constant and reliable observations.

MARKET FOR BYPRODUCTS

During the world war the byproducts from coke ovens were found to be indispensable. Because of their exten-



FIG. 1. PUSHER SIDE OF OVENS, LIGHT OIL PLANT IN FOREGROUND

*Read before the American Institute of Chemical Engineers, Montreal, June 29, 1920.

sive application at that time the merits of these products are now appreciated to the extent that they are just as indispensable in times of peace. As soon as this market was established the coke and gas industry was quick to avail itself of the fact and the growth of the industry has been very rapid since then (1914).

The byproducts are the same now as before the war, although at that time the Semet-Solvay Co. was the only commercial producer of light oils. Improved methods have, however, resulted in much better yields of these products. This improvement consists chiefly in the control of operating conditions. There is an old coke-oven axiom, "Temperatures, incident to the so-called high-speed operation, seriously affect the yields." Under modern practice this has been changed so that it can be said that temperatures properly related to the speed of operation do not seriously affect the yields. And likewise the other determining factors are now under regulation.

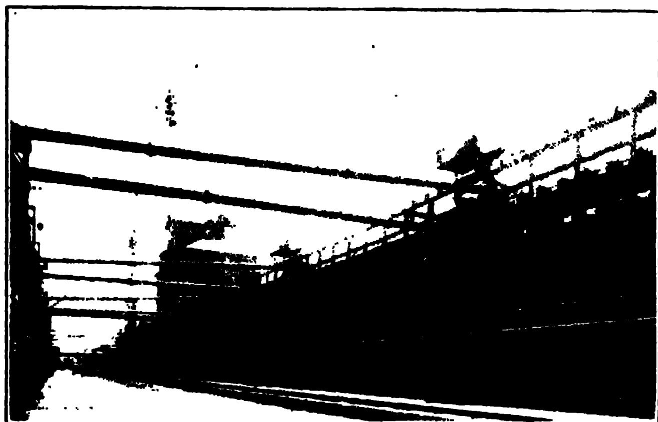


FIG. 2. PUSHER SIDE OF BATTERY

THE FORD PLANT

The modern practices and methods are well exemplified by the plant of the Ford Motor Co. at River Rouge, Mich., which is considered by many to be the finest byproduct coke-oven plant in the world.

Early in May it was my good fortune to study this plant for several days, and in this article I want to discuss certain features of the equipment, operations and results which particularly impressed me. The data given here are those of actual results. The yields are especially important, not only because they are high but because of their uniformity through varying speeds of operation.

This plant was completed and put in operation in October, 1919. Its chief function is to supply a high-grade metallurgical coke to the Ford blast furnaces. At the same time a contract with the Detroit City Gas Co. calls for 10,000,000 cu.ft. of 18 cp. and 600 B.t.u. gas per day. Thus these ovens constitute a combined coke and gas plant and must maintain the highest quality in both products. To do this the speed of operation must not give rise to conflicting factors, but rather all conditions must be properly co-ordinated to the speed of operation. Due to the unsettled conditions in the coal and railroad industries this plant has not had any really fast operation. In fact, very few plants have operated at full capacity during the period under discussion. The operation, however, has been performed at somewhat varying speeds, so that a study can be made of the effects, if any, of such changes.

The Ford plant consists of 120 standard Semet-Solvay regenerator coke ovens, built in two batteries of equal size. Each battery is independent of the other in regard to control of operation. The gas direct from the ovens is received by a double hydraulic main, one main taking the rich gas given off during the first period of carbonization, while the second main receives the remaining lean gas. This separation of gas during carbonization is performed in the usual manner—that is, by valves which are easy to open and close and which can be reversed when and as often as desired. The rich gas and lean gas are treated exactly alike up to the benzol scrubbers. Here the treatment is different and after passing through these scrubbers the two gases travel different paths, the lean returning to the ovens, the rich gas after enrichment and purification going to the city. The apparatus and equipment used to handle the gas is built in triplicate, one unit for the rich gas, one for the lean, with the third and middle unit as a spare. This spare unit is so connected to the system that it can take care of either the rich or lean gas as necessary. The importance of this feature is that repairs, apparatus cleaning and inspection do not cause inefficient or irregular operation. Having a spare system of byproduct recovery apparatus and a spare for all essential machinery used on the ovens, this plant is enabled to operate on a time-table schedule. Every oven is pushed at the exact time scheduled, the schedule being observed with railroad precision. This regularity of operation which is essential to the production of a satisfactory quality of surplus gas, where high standards are required, means also that the load on byproduct apparatus is uniform and favorable for maximum byproduct yields. In the table of results it will be noted that the initial rich gas has been produced without an appreciable variation in B.t.u. value for over three months.

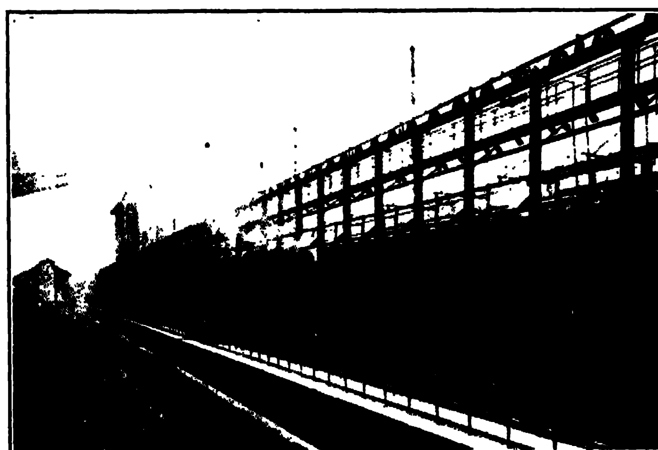


FIG. DISCHARGE SIDE OF OVENS AND COKE WHARF AT LEFT

Each oven is designed for a charge of fifteen tons of pulverized coal and to carbonize this coal in any period from 16 to 30 hr. as desired. The capacity of the oven and the uniform coal charges are points that are worth emphasizing. At the Ford plant not only is the daily average charge per oven uniform but there is very little variation in the weights of coal charged in the different ovens. The regularity maintained in this operation is shown by Fig. 4, which gives average daily weight of coal charged per shift. This curve is posted in the foreman's office and closely watched by all three shifts.

The size of an oven is determined by the amount of coal that it can successfully carbonize. Size has so far been an index to the progress of the industry, increasing capacity resulting in lower unit costs. This because the plant, exclusive of ovens, and force required for operation and maintenance of complete plant are fixed and independent of oven capacity. That is to say, the power plant, byproduct recovery apparatus, piping and other machinery will be practically the same for any given plant regardless of the capacity of its ovens, while the number of workers will be almost the same. The increased tonnage due to larger capacity of units will therefore give its yields at little or no cost of production.

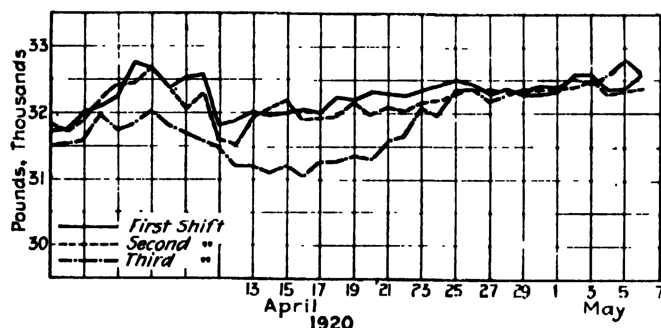


FIG. 4. OPERATING DATA, FORD PLANT. AVERAGE NUMBER OF POUNDS OF COAL CHARGED PER OVEN PER SHIFT

Operating on an 18 hr. schedule the Ford plant has a daily capacity of 2,400 tons of coal. Were these ovens of 12-ton size the capacity of the plant on a like schedule would be 1,920 tons. In a 30-day month this would mean that the 15-ton unit plant would carbonize 14,400 more tons of coal than the smaller unit plant. The yields from this increased tonnage would be about 10,000 tons of coke, 345,000 lb. of ammonium sulphate, 45,000 gal. of light oil, 115,000 gal. of tar and 86,000,000 cu.ft. of surplus gas. Figuring that the value of the coke recovered would cancel the cost of the additional coal and cost of producing byproducts there would be a net gain something like this:

345,000 lb. $(NH_4)_2SO_4$ @ 5c. per l	$17,250
45,000 gal light oil @ 15c. per gal	6,750
115,000 gal. of tar @ 4c. per gal	4,600
86,000 M. cu.ft. gas @ 20c. per M.	17,200
Total monthly gain.....	$45,800

It is true that the initial cost of the larger plant would be greater, but the returns just enumerated would yield handsome interest on the additional capital required.

Ammonium Sulphate

The recovery of ammonia at the Ford plant is performed by the Semet-Solvay direct ammonium sulphate process. This process, which represents over eight years' extensive experience with direct methods, marks a notable achievement in chemical engineering. The process is direct in procedure, practically automatic in operation and produces a pure white salt. The high yields which are obtained are readily explained by the direct manner in which the gas is treated and by the control of the ammonia reactions.

In the first place, each oven is properly filled with coal, as previously described, so that favorable conditions exist at the start. The coke-oven gas upon leaving the ovens travels a short distance from the hydraulic main and then passes through a two compartment cooler. From these coolers an exhauster (Curtiss steam turbine) takes the gas and sends it under pressure through a tar extractor of the P. & A. type, then through another two-compartment apparatus, called an economizer, from which apparatus it goes to the saturator. The gas leaves the saturator minus its ammonia, is freed of acid and then cooled for benzol recovery. This is the full journey of the gas so far as ammonia is concerned.

The gas enters the two-compartment cooler at a temperature slightly above 80 deg. C. In the first compartment the temperature is lowered about 30 deg. C. and in the second compartment it is brought down to 30 deg. C. This temperature of 30 deg. C. has been found to be the critical one for proper condensation in conjunction with minimum effort for subsequent heating. The cooling medium is a weak ammonia liquor, which, traveling over grids counter-current to the gas, is very efficient. The strength of this liquor is maintained so that only a minimum amount of NH_3 will be absorbed in the cooling of the gas and the condensation of the light tars. Separation of the tar and liquor is effected in the coolers, which have a large base, by means of decantation. The tar is drawn off from the bottom and runs to a decanter, while the liquor entering the suction pipe of the pump at a higher point is sent through cooling coils and then back to the gas cooler. Each compartment of this cooler has its own circulation. A special constant level overflow device maintains a constant volume of liquor for circulation by carrying away an amount equivalent to that added by condensation and absorption of ammonia. Ammonia thus held in solution has to be liberated by steam and lime in a still, from which it returns to the gas at inlet to saturator. With this exception the process is "direct."



FIG. 5. BYPRODUCT PUMP HOUSE

The Curtiss steam turbine, whose primary function is that of an exhauster, serves in a threefold manner, for in pumping the gas it is at the same time an efficient tar extractor. Due to heat of compression, the gas leaves the turbine at 50 deg. C., or about 20 deg. C. higher than it entered. Thus the turbine is exhauster, tar extractor and heater combined. The P. & A. tar extractor removes the last trace of tar.

From the tar extractor the gas goes to the economizer, where it is brought in contact with the liquor of condensation from the hydraulic main to pick up and restore to the gas some of the water of condensation and free ammonia; the gas leaving the economizer is at the proper temperature for the sulphate reaction.

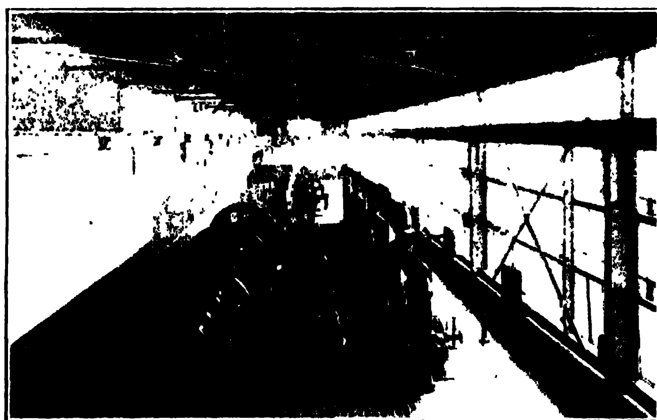


FIG. 6. EXHAUSTER AND COMPRESSOR ROOM

The clean gas at 70 deg. C. enters the saturator, which contains sulphuric acid of 45 g.p.l. strength, that is, nearly normal acid. The saturated acid is lifted by means of an air ejector into a sludge tank in which crystallization takes place and the unsaturated acid drains back to the saturator. The salt goes to a centrifugal, where it is first dried and then washed with water. It is dumped from the centrifugal into barrows, weighed and conveyed to a large hopper, from which it is handled into storage by an overhead crane.

A small stream of fresh acid (60 deg. Bé.) flowing into the saturator keeps the strength at the proper mark. With acid of the proper strength and gas at the proper temperature objectionable crystal formation does not take place in the saturator. The small amount of crystals that are bound to form on metal surfaces are not permitted to accumulate. Once each day for a few minutes the acid strength is built up to 125 g.p.l. and thus all crystals are dissolved and a clean saturator is maintained.

The results obtained at the Ford plant are indicative of the progress that this process makes in ammonia recovery. The high yields as shown in the table of operation data were obtained from a coal mixture containing 20 per cent low volatile coal From straight high volatile coal even higher yields may be expected.

As important as the yield of a byproduct is the cost of production. The unit cost is the test that tells the tale. During the month of April this plant produced over 1,500,000 lb. of $(NH_4)_2SO_4$ with an operating force of five men per 8-hr. shift and one foreman. This foreman also has charge of the light oil plant.

One of the most essential points in a direct ammonia sulphate process is clean gas. Practically all the treatment through which the gas passes preparatory for entrance to saturators is made with the one purpose of obtaining clean gas. Upon the success of this treatment the purity and color of the sulphate depend. Hence the vital question is, "How clean is the gas?" To determine this the filter paper method devised by the Semet-Solvay Co. has been found very valuable. The apparatus, which is called the tar camera, needs little description other than that given in Fig. 7.

An apparatus is here shown by means of which a known volume of gas can be drawn through filter paper and a comparison made of the color produced on the filter paper to indicate the degree of purification of the gas. As usually performed two filter papers are used for each test to absorb the tar from 8 l. of gas.

The amount of tar carried by the gas should be reported by comparing these filter papers with a photographic scale, similar to that used in any color comparison quantitative test. Or where great accuracy is required the determination is made by weighing the filter papers before and after the picture.

This apparatus can also be used for the determination of H_2S in gas. In this test the filter papers used are, of course, moistened with lead acetate.

FORD OPERATING DATA 1920

Actual Results of Semet-Solvay Direct Ammonium Sulphate Process

Date	Dry Coal Charged, Tons per Day	Coal Moisture, per Cent	Sulphate Yield, Com. Lb. per Ton	Per Cent NH_3 in Sulphate	Acid Consumed per Lb. $(NH_4)_2SO_4$	Per Cent Free Acid in Sulphate	Per Cent Moisture in Sulphate
January	1,813	5.2	25.7	25 01	1 07	0.169	2.25
February	1,813	4 4	26.5	24 94	1.01	0.135	2.42
March	2,030	4.0	25.9	25 00	0.95	0.125	2.46
April	2,022	3 5	25 8	24.99	1 00	0 112	2.16
May	1,911	3 5	26.8	25.00	1.02	0.151	1.84

SURPLUS GAS

The method employed for the preparation for sale of the surplus gas from the coke-oven plant is determined by the specifications which the gas has to meet. The general trend in the industry is toward the elimination of candle-power specifications and lowering the calorific value of the gas required for cities. Canada has now permanently adopted a standard of 450 B.t.u. and no candle power. Only three of the larger cities of the United States still cling to a high-candle-power specification. This development is in direct line with the conservation of the natural resources of the country and is to the economic advantage of both producer and consumer of gas. It is no longer good economy to enrich gas with benzol to produce candle power when the requirements for motor fuel are rapidly outstripping the supply. Money spent for enrichment of gas is practically all wasted, as, with very few exceptions, the

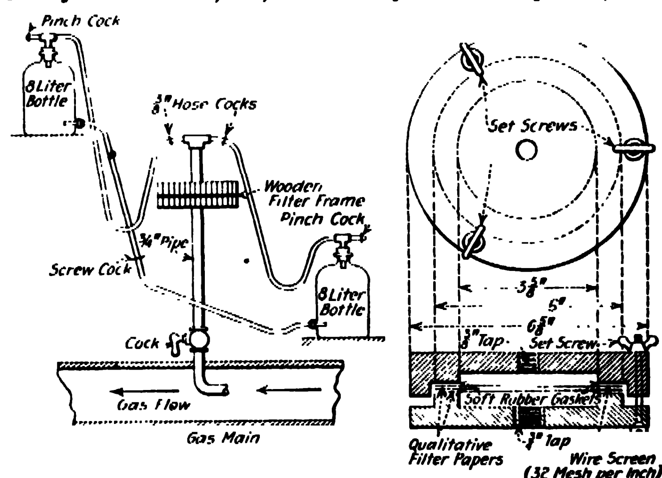


FIG. 7. TAR CAMERA. LEFT—GENERAL LAYOUT OF APPARATUS. RIGHT—FILTER FRAME

consumer derives no benefit therefrom. The purchase of special coals or the separation of the rich gas from the lean, or any other operation involving cost, to increase the calorific value of manufactured gas brings no benefit to the consumer, who must, of course, pay for this increased cost, and the Public Service Commissions and gas manufacturers should join in the determination and adoption of the standard of calorific value which permits a million B.t.u. to be delivered to the consumer at the lowest price. Of course, gases containing high percentages of nitrogen, like producer

gas, are not to be considered in this discussion. This argument is illustrated by the following table, which shows the B.t.u. per cu.ft. in the various gases when mixed with the theoretical amount of air required for their combustion. This mixture of gas and air is what the consumer actually burns, so it is clear that any of these gases, when properly burned with the correct percentage of air, will give the same results.

	Natural Gas	Oil Gas	Retort Gas	Coke-Oven Gas	Carburated Water Gas	Blue Water Gas
B.t.u.	91	93	91 7	91	92	88
Flame temp., deg ...	1,852	1,915	1,896	1,892	1,914	1,928

So the real point of interest to the consumer is which gas can be furnished to him at the lowest cost per million B.t.u.

In several cities, however, the legal standards still require the delivery of gas of high candle power and high B.t.u. content, and the gas from the Ford plant has to meet the standard of 18 candles and 600 B.t.u.

Light Oil and Gas Enrichment

The recovery of light oil at the Ford plant is so closely related to the enrichment of gas that these two subjects can well be treated together. As is usual in plants where surplus gas of high calorific and candle power specifications is sold to public utilities, the rich and lean gases follow parallel but separate paths throughout the byproduct recovery system. Up to the benzol scrubbers they are treated exactly alike, but from here on the treatment differs.

It is a comparatively simple matter to obtain large yields of surplus gas that will pass the average B.t.u. requirements, which have recently been lowered in most states. In such cases it is possible to remove practically all the light oils from the gas, and if so the rich and lean gases can be treated alike in the recovery of benzol, or the gases may be treated without separation, if the calorific standard permits. In being freed of its light oil the surplus gas is lowered in B.t.u. value, but at the same time it has all of its naphthalene removed. This treatment gives a gas suitable for distribution and, if separated, of 590 to 600 B.t.u. value. Such a gas meets the requirements of many cities which retain a high calorific standard, but it will not pass a high candle-power specification, and where such exists it is necessary to produce a very high-grade gas. Proper oven operation will yield such a gas, after which this quality must be maintained and delivered to the city without loss. For distribution it is essential that this gas be free of C_nH_n, but it cannot stand the loss of any other illuminant. Of course, all the light oils could be washed out, freed of naphthalene and then used to enrich the gas to the proper mark. A high-grade gas would result, but the process would be rather inefficient and very expensive. The correct way is to take out the C_nH_n without removing the light oils. This is accomplished ratus and methods. The procedure is as follows:

The lean gas, upon leaving the saturator, is cooled and at the Ford plant by the standard Semet-Solvay appa- enters the benzol scrubber at a temperature of about 25 deg. C. In this tall tower it is completely stripped of its light oil content by being washed with an absorption oil of like temperature. This absorption oil, straw oil or ordinary gas oil, is circulated counter-current to the gas flow and leaves the scrubber containing about 2 per cent of light oil.

The rich gas, upon leaving the saturator, is likewise cooled and enters a benzol scrubber at the desired temperature. Here it is washed by one-half of the benzolized absorption oil from the lean scrubber, the other half of this oil going directly to the light oil still. The small circulation of benzolized oil absorbs all the C_nH_n from the gas, also some toluol and xylol, but removes very little benzol. Thus the gas is purified of C_nH_n without serious loss of other illuminants. The drop in B.t.u. and candle power, due to this treatment, is so slight that very little enrichment is necessary. According to the latest figures, only 0.027 gal. of light oil is vaporized per 1,000 cu.ft. of gas to bring the gas above specifications.



FIG. 8. DIRECT SULPHATE APPARATUS

The most important feature of this surplus gas operation is the uniformity of results. Not only has the surplus gas yield been high, as will be noted from table of operating data, but it has been a yield of high-grade gas. That is the important fact, for the yield of surplus gas means nothing until compared with the quality. Furthermore, this yield has been almost constant in amount through the varying speeds of operation. Every day from Jan. 1 to June 1 the gas company has received practically 10,000,000 cu.ft. of gas from these ovens—gas that has always been above the standard. This gas has been produced and delivered with scarcely any varia-

FORD OPERATING DATA, 1920

Surplus gas, light oil and tar yields

Date	Dry Coal Charged, Tons per Day	Total Gas per Ton of Coal, M. Cu.Ft.	Gas to City per Day, M. Cu.Ft.	Candle Power Initial Rich Gas	Candle Power Gas to City, Official	Light Consumed for Enrich., Gal. per M. Cu.Ft.	B.t.u. Gas to City	Light Oil Produced, Gal. per Ton	True L.O. Yield, Gal. per Ton	Tar Yield Gal. per Ton
January.......	1,813	10.53	9,959	12.83	18.08	0.33	636	2.32	2.65	6.02
February......	1,813	10.39	10,135	13.82	18.17	0.14	647	2 35	3.74	8 09
March.........	2,030	10.63	10,004	14.05	18.14	0.10	648	2.61	3.76	8 84
April..........	2,022	10.50	9,906	14.27	18.21	0.10	638	2.43	3 68	8 64
May..........	1,911	10.04	10,518	15.12	18.12	0.05	643	2 42	3 45	8 51

tion in B.t.u. or candle-power values. The uniformity of these results appears remarkable in comparison to those obtained only a few years ago, but shows what can be expected from modern ovens with advanced knowledge and methods for regulation. The maximum gas recovery which is here shown is one reason also for the uniformly high sulphate yield.

A description of the light oil still is hardly necessary, as it is of the standard Semet-Solvay type. No fractionation is made, but the light oil is purified, washed and redistilled and sold as motor fuel. A satisfactory motor fuel consisting of benzol, toluol and xylol, mixed with an equal amount of gasoline, has the following distillation results:

Boiling Point, 71 deg. C. Sp.gr. @ 16 deg. C., 0 811

Off at, Deg. C.	Per Cent	Off at, Deg. C.	Per Cent
85	10	114	60
88	20	130	70
91	30	154	80
96	40	195	90
103	50	218	95

Loss on distillation, 2 per cent. Residue, 3 per cent.

During the switchmen's strike there was a gasoline shortage in Detroit which caused some worry but little or no inconvenience, due to the fact that the Ford plant was able to release 300,000 gal. of purified light oil for motor fuel. Tank wagons from the various companies came to a plant for oil and distributed it throughout the city. Thus a serious situation was averted.

The light oil that is recovered by the method described comes mainly from the lean gas. The true yield is therefore the sum of the oil produced and the oil left in the rich gas. This total would mean a high commercial yield, and one that would be possible wherever the gas specification was below 600 B.t.u., with no candle-power requirements.

Tar

The old-time problem, "What is to become of the tar?" has apparently been solved satisfactorily. With the enormously increased supplies the market has kept pace and today tar is selling at a decidedly higher price, but yet somewhat below its true value.* Tar lends itself readily to a variety of uses, many of which are just beginning to be appreciated. The Ford experience affords an interesting illustration in this respect.

The original boiler equipment contained eight 400-hp. Wickes boilers, arranged for gas firing. The demand for gas was so heavy that tar was utilized in its place most satisfactorily and at a decided saving over coal, the value of tar being taken at 5c. per gal. When using tar the pump at the storage tank is run continuously, so that there is a constant circulation sufficient to meet the highest peaks and yet allow excess tar to be bypassed from the discharge to the suction line. In order to keep the tar hot the discharge line is wrapped with two 2-in. steam lines and the tar reaches the boilers at a temperature of 90 deg. C. At that point superheated steam is used to raise the temperature to 100 deg. C. and by means of steam injectors delivered to the tar burners.

When the price of fuel oil became almost prohibitory the Ford company began experimenting with tar to take the place of oil in the heat treatment of forgings, etc. This worked out so satisfactorily that the company expects shortly to be using 15,000 gal. of tar per day, which will do the same amount of work as the 25,000 gal. of fuel oil formerly used. Part of this is due to the higher efficiency of the tar and the remainder to improvements in operation. This tar is as it comes from the byproduct coke plant, no further refinements being necessary.

In conclusion, I wish to acknowledge the assistance given by A. A. Kelkenney, superintendent of the Ford coke plant, in preparing the operation data and curves shown here and to express my appreciation of the courtesies and assistance given me by his organization.

The Solvay Co.
Indianapolis, Ind.

Progress in Low-Temperature Carbonization of Coal

Developments in the low-temperature carbonization of coal are taking place in the United Kingdom, and a number of important industrial concerns have entered into contracts to secure the products of this process. It is understood that three plants are to be operated in the execution of existing contracts, which contemplate the combustion of bituminous coal by low-temperature methods in order to conserve the potentially rich constituents, such as motor spirit or gasoline substitute, fuel oil, sulphate of ammonia, and gas. Among the industries which have recently made agreements to utilize the byproducts of the process are an electric power company, a large municipality, a firm of steel manufacturers, and a general manufacturing firm.

The exponents of low-temperature carbonization estimate that 1,000,000 tons of coal will be consumed annually under existing contracts and that plants for the exploitation of the process will supply, in addition to 7,000 million cubic feet of gas, the following products:

Products	Use	Approximate for S per An
		Gal.
Motor spirit	Motor cars, aeroplanes	3,000,000
Fuel oil	Suitable for Navy and ship fuel	16,000,000
		Tons
Smokeless fuel	Domestic fuel	700,000
Sulphate of amm	Fertilizers and high explosives	9,000

It is understood that the process has been patented in this country and abroad. Although it appears that any important industry normally consuming large supplies of bituminous coal may utilize the process, the greatest development in its future exploitation will be through the erection of large plants in the colliery districts, where the constituents can be economically extracted and distributed.

Canada's Paper and Pulp Exports

The Canadian Government statistics for the year ended March 31, 1920, give the total value of the pulp and paper exports of the Dominion as $104,636,901. This is the first time that these figures have reached the hundred-million mark. In 1919 the exports were valued at $82,569,680, and in 1918 at $63,344,143, the totals for the three years being made up of:

	Year ended March 31		
Paper and pulp	1918	1919	1920
Paper and manufactures of	$37,723,251	$47,862,909	$63,253,419
United States	32,768,348	38,621,265	50,367,339
United Kingdom	710,516	1,040,857	4,813,577
Chemical pulp	19,133,813	30,226,856	33,000,063
United States	16,171,096	26,256,265	25,550,882
United Kingdom	1,603,738	611,399	3,212,119
Mechanical pulp	6,487,079	4,479,915	8,383,419
United States	6,487,079	4,418,555	5,765,871
United Kingdom	....	3,033	1,802,281
Total	$63,344,143	$82,569,680	$104,636,901
United States	55,426,523	69,296,085	81,684,092
United Kingdom	2,314,254	1,655,289	9,827,977

The 1920 paper exports included 14,272,513 cwt. (713,625 long tons) of newsprint, valued at $53,203,792, constituting more than 50 per cent of the total. The United States took 12,553,349 cwt. (627,667 long tons), valued at $46,809,178.

Legal Notes

By Wellington Gustin

Decision on Patents of Cottrell and Speed

The United States Circuit Court of Appeals, Ninth Circuit, has reversed and remanded, with directions, the decree of the District Court, dismissing the infringement suit of the Petroleum Rectifying Co. brought against the Reward Oil Co. The suit was based on alleged infringement of the Cottrell and Speed patents, Nos. 987,115 and 987,116, for a process and apparatus for separating and collecting particles of one liquid suspended in another. The first-numbered patent covers the process and the second is for apparatus by which the process is carried out.

Specifications of Patent Involved

The specifications in the invention say:

"There is a large class of oils that cannot be economically freed from water without distillation. These are largely oils in which the water is in very small globules, often less than one-thousandth of an inch in diameter, and behaving as if surrounded with a membrane-resisting coalescence of the drops . . . Many natural petroleums as taken from the wells contain from ½ to 50 per cent of water in the form of small drops (i.e., emulsions), and after being allowed to stand for months still hold a great proportion of the water in suspension."

Judge Gilbert in his opinion says: "The specifications go on to say that the inventors had found that, when these emulsions are subjected to the action of high potential electric charges in the manner thereinafter described, they are rapidly de-mulsified, the water settling to the bottom of the vessel, collecting into large masses, which can be readily withdrawn, leaving the oil dry.

"The process involved in the invention, as shown by the specifications, is substantially this: Oil loaded with water in the form of minute globules is passed between two electrodes separated at a proper distance, the electrodes being connected to a source of electricity of sufficiently high potential to create between the electrodes an electrostatic field or field of electric strain, which will cause the minute globules of water to conglomerate and coalesce until they become so large that they will settle out from the oil by gravity. For present purposes it is sufficient to quote the first claim:

"'The improvement in the art of separating and collecting particles of one liquid suspended in another, which latter is essentially a non-conductor of electricity, consisting in bringing the material to be treated between electrodes connected to a source of electricity of sufficient voltage to produce coalescence of the suspended particles in such wise as to cause the rapid separation of the two liquids throughout the body of the mixture, and at the same time prevent the coalescing globules from forming complete chains, short-circuiting the electrodes.'

Contention of the Appellee

"The appellee (Reward Oil Co.), operating under a patent issued Oct. 26, 1915, No. 1,158,253, for 'Process of Dehydrating Oil,' removes the moisture from oil by passing the oil between electrodes connected to a source of electricity of sufficient voltage to cause the suspended particles to coalesce in such wise as to produce rapid separation of the two liquids throughout the body of the mixture. But the appellee contends that it does not infringe the appellant's (Petroleum Rectifying Co.) patent for the reason that it does not prevent the coalescing globules from 'forming complete chains, short-circuiting the electrodes.' Therein is the whole ground of controversy in the present suit. In both processes there are the electrodes, the sufficiently high voltage to produce coalescence of the moisture, and to separate the same from the oil. The only question is whether the operation involves different methods of electrical action. In the application for the McNear and Bowles patent reference was made to the appellant's patent as follows:

"'Said patentees (Cottrell and Speed) relied upon the electromotive force only to break down the oil partitions between the water globules, and took especial pains to prevent short-circuiting between the electrodes, and, indeed, their inventions consisted wholly in the prevention of short-circuiting. We have discovered that far better results are obtained by relying, not upon electromotive force, but upon heat as an agent to produce coalescence between the water globules, this heat being produced by the passage of the very large electric current which is produced by short-circuiting, the amount of heat being such as to convert water globules in the path of the current into steam, and by said conversion breaking the electric current in said path.'

"This fanciful explanation of the effect of the current in the appellee's process may be pardoned in view of the fact that neither the patentees of that patent nor any expert witness was able to say just what does occur in the mass of the fluid when under treatment in either process. The theory that in the appellee's process the water globules are by the electric current converted into steam is not established by evidence, and is discredited by the appellee's expert witnesses. The defense of noninfringement, therefore, rests upon the appellee's contention that in the appellant's process there is no passage of electric current from one electrode to another, and that the dehydration of oil accomplished therein is the result of the maintenance of an electrostatic condition in the fluid between the two electrodes, whereas in the appellee's process the dehydration is accomplished by the passage of currents of electricity from one electrode to another. In other words, according to the appellee, it is essential to the appellant's process that short-circuiting be avoided, while it is essential to the appellee's process that short-circuiting be produced. We are led, therefore, to the inquiry what is short-circuiting as referred to in the appellant's claims, and what is the proper construction of the appellant's claim where it provides for a source of electricity of sufficient voltage to prevent the coalescing globules from forming complete chains short-circuiting the electrodes."

Conclusions of the Court

In concluding this inquiry the court says:

"The term 'short-circuiting' in the appellant's claims, if susceptible of two meanings, should be given that which the specifications show it was intended to have, if that meaning is not repugnant to the plain and clear terms used. Cottrell and Speed were the first to discover the process of dehydrating oil by electricity. Their invention went into large and extensive use. For

a time it was used by the appellee under a license. Prof. Cory states that so far as he knows it is a pioneer invention. It should receive a fairly liberal construction that will uphold rather than destroy. The construction given the term 'short-circuiting' by the court below is, we think, erroneous. What the inventors meant by the term was a total short-circuiting, and not the succession of minute short-circuits snapping from one electrode to another, whereby dehydration is accomplished in both the appellant's and the appellee's process. The claims of the appellant's patent must be read in the light of the invention as disclosed in the specifications. It appears therefrom that the inventors recognized the essential value of the formation of chains between the electrodes and the instantaneous disruption of the chains by electric current, and at the same time the necessity of maintaining the potentiality of the main current, and that it was to express that necessity that they inserted in the claims the caution against such short-circuiting of the current as to interfere with the process. They realized that the momentary passage of short currents between the electrodes would not 'short-circuit' their current in the sense in which they used that term in their claims."

Further the court said that it was not essential that patentees should either understand or set forth the scientific principle on which the patented process operated. It quoted from another decision where that court said:

"It may be that the inventor did not know what the scientific principle was or that knowing it, he omitted, from accident or design, to set it forth. That does not vitiate the patent. He sets forth the process or mode of operation which ends in the result, and the means for working out the process or mode of operation."

Opinion of Expert Witness—Views of the Court

Prof. Cory, expert witness for the appellee, was of the opinion that chains were formed in appellant's process, the theory of which, as stated by the court, is that, if the voltage is sufficiently high, chains are formed and a current flow instantaneously occurs, which demolishes the chains, whereby the flow is arrested. That a variation in the current does occur in practice is shown in appellant's specifications, which state that when the proper electromotive force is applied the ammeter will show "irregular variation" in the current, or "occasional momentary variation."

Further, the appellee contended that the extensive use and great utility of appellant's process is owing to the use of the rotating type of treater disclosed in the Cottrell and Wright patent assigned appellant, and not involved in the present suit, and that the inventions disclosed in the patents in suit are not operative.

This contention the court held to be not sustained by the record. In the first, said the court, the fate of appellant's process patent is not linked with that of its apparatus patent. "No process patent is in theory either helped or harmed by the excellence or worthlessness of the disclosed apparatus by which it is illustrated." (255 Fed., 83.) In the instant case the court said: "Again, the evidence shows that it is not true that the first apparatus was a failure. A 'treater' constructed under the apparatus patent in 1909 was in use for several years. The evidence is that it required readjustment, and that it was not perfect in operation, and that some three years later the appellant resorted to the use of treaters with revolving electrodes as disclosed in the Cottrell and Wright patent, and thereby increased the efficiency of the process from 15 to 25 per cent. No defects in the process patent, therefore, can be predicted upon defects in the apparatus patent, and the fact that the first apparatus was defective is no reason for denying protection to either the patented process or the apparatus. . . . If, as we have found, the appellee uses the appellant's process it is immaterial that by improvements in structure of its apparatus, the appellee has so increased the efficiency of its machine that it marks a distinct improvement upon the appellant's apparatus."

Purchaser Should Use Good Faith in Making Resale of Goods Not Up to Specifications

Judgment for Smith, DeMacedo & Co., Inc., Philadelphia, against Swift & Co. was recently affirmed by the Supreme Court of Pennsylvania. Swift & Co. had sold to the former company thirty-four tons of oleostearine, an article represented to be suitable for the same uses and to comply with the specifications set forth for stearic acid. It was to be resold and shipped for use in Portugal. Upon arrival there it was found the commodity did not conform to the specifications, and the customer declined to accept the shipment.

With concurrence of Swift & Co. the shipment was directed to be sold for the best price obtainable. Thereupon, the court said, it became the duty of Smith, DeMacedo & Co., Inc., through its agent, to exercise good faith, reasonable judgment and diligence in making a resale. If this were not done and the first seller sustained a loss thereby, the buyer cannot enforce the rule that the damages would be the difference between the value of the goods at the time of delivery and the value they would have had if they had answered the warranty (specification set forth on order) at the time and place of delivery.

There was evidence to show that a resale was necessary, and that owing to the lack of shipping facilities, the article could not be sold elsewhere than in Lisbon. The law is that in such cases the loss must be minimized by the holder of the goods and he will be held responsible for any negligence in reducing loss to the product.

Evidence as to the price obtained on the resale, introduced to show the measure of damages, such damages to the brokers being the difference between the contract price and the market price of the product, was objected to on the ground that the witness testifying knew nothing of market conditions. But the court said the sale took place through an experienced broker for the very best price obtainable, and it was not shown that such sale lacked good faith, nor that the circumstances under which the sale was made were calculated to produce the best price obtainable or to procure the best market price, nor for the reason that the evidence was but the opinion of the witness, nor because it did not appear that Smith, DeMacedo & Co. used reasonable efforts to secure the best obtainable price.

That the witness had no knowledge of the market condition was not availing since the price obtained through a fair sale would establish a market condition for that sale, and certainly would be the best price obtainable as agreed upon by the parties in ordering the resale. Of course, when such sale is unfair and damage results because the sale is below the market price, this latter price becomes important in establishing the seller's loss. Judgment for the brokerage company was affirmed.

Cure of Flakes by Proper Heat Treatment

An Account of a Heat-Treatment Practice Evolved for Heavy Nickel Steel Forgings Which Reduced Flaky Test Bars to 15 Per Cent of the Total, Based on the Idea That Most Flakes Are Caused by Internal Strains in the Metal

BY C. S. CROUSE*

THINKING that the problems met and solved in evolving a standard practice in one plant might possibly prove of assistance to others, I have outlined the following observations which were taken over a period of about eight months and cover the time from the start of treating, through the experimentation period, up to and including the time when a standard practice was developed.

FURNACE EQUIPMENT

The heat-treating plant under observation was equipped with seven vertical, electric resistance type furnaces furnished by the General Electric Co., each one having six rows of nichrome heating elements or ribbons, the upper three and the lower three rows acting as independent units. Power was furnished by a three-phase, 220-volt alternating current. The furnaces (shown in Fig. 1) were cylindrical in shape, being made of firebrick with a boiler plate shell, and a capacity of nine type A or eight type B forgings, which types will be explained below. The forgings were hung in a circle from a supporting spider (Fig. 2) so that their outer sides were within a few inches of the heating ribbons. Attached to the spider, by means of a heavy round bar, was an eye so that the whole charge might be handled as a unit by means of an overhead crane.

The charge and spider were in turn supported in the furnace by being suspended, by means of a square, flat plate under the eye, from two movable eye-beams which in turn rested on rails on either side of the furnace pit (see Fig. 1). After the charge was placed in the furnace the top was closed by rolling two semi-circular covers into place, these covers being made of brick incased in a casting. After the covers were closed there was very little loss of heat by radiation, thus making for a high heat efficiency.

The furnaces were further equipped with an automatic temperature control furnished by the Leeds & Northrup Co., which operated as follows: There were twelve holes in the sides of the furnace arranged in three rows spaced at thirds around the circumference, the holes in each row being spaced about equally from top to bottom of the furnace. These holes were for the purpose of inserting iron-constantan thermocouples through the wall of the furnace to actual contact with the forgings, all the holes, however, not being in use at any one time. There were also two other holes so situated that a couple might be inserted to get the nichrome ribbon temperature, one couple getting the temperature of the upper three rows of ribbons and the other that of the lower three rows.

*Professor of metallurgy, University of Kentucky.

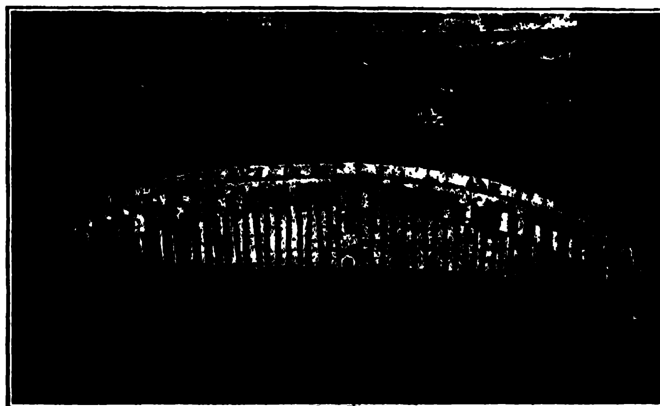


FIG. 1. ELECTRIC RESISTANCE-TYPE FURNACE, COVERS ROLLED BACK. LOOKING DOWN

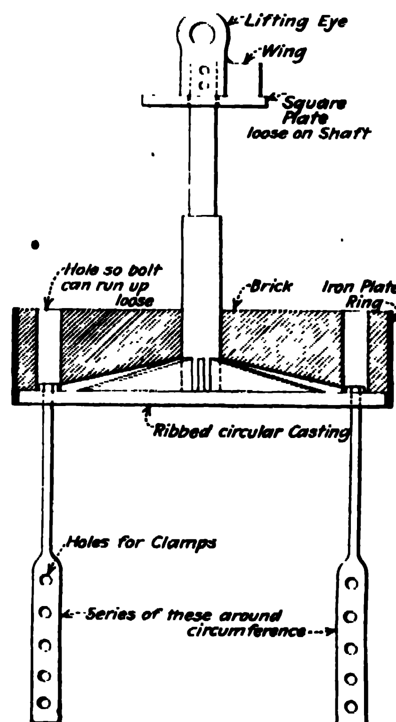


FIG. 2. SKETCH OF FORGINGS SUPPORTING SPIDER

Each half of the furnace was furnished with a recording pyrometer which plotted both the ribbon and the forging temperature in that part of the furnace and, being set for any temperature, automatically threw the current off and on so as to maintain that temperature. In addition there were extra thermocouples placed in each furnace and connected to a Leeds & Northrup multiple point recorder, this arrangement acting as a check on the other.

All cold junctions were carried up to the instruments in the pyrometer room, where they were automatically compensated. In addition, all couples and instruments



FIG. 3. FURNACE ROOM
Left, furnace pit; center, quenching tanks; right, cooling pit.

were carefully checked and standardized at frequent, stated intervals.

In addition to the furnaces, there were four cooling pits similar in design to the furnaces, but having no provision for heating. There were also two quenching tanks, one for water and the other for oil. However, after the first few weeks of treatment the oil, which was Robisoil No. 2, specific gravity 0.865, flash point 395, viscosity 140, was supplanted by water. In order to keep this cool, it was pumped out of the building, sprayed and returned to the tank. A general view of the whole department is given in Fig. 3.

Forgings to Be Treated

There were but two main classes of forgings treated, one of which will be called class A and the other class B, as shown in Fig. 4, the latter having the greater cross-sectional area, but being shorter. Both classes, however, varied in cross-section within themselves—that is, there was a certain cross-sectional area down to a shoulder and then a certain greater area below the shoulder.

Class A forgings were 9½ ft. long, the small section extending for 3 ft. 9 in. to a shoulder. The overall diameter at the small end was 6 in. and the diameter of the bore 2½ in., leaving a wall thickness of 1¾ in., while the overall diameter at the large end was 6⅝ in., with a bore diameter the same as the other end, leaving a wall thickness of 2 1/16 in. The first 6 in. of the smaller end, which was the waste or test metal, was slightly larger than the balance, thus leaving a slight shoulder under which clamps were placed and the forging thus attached to the spider. The approximate weight of the forging was 780 lb.

Class B forgings were 4 ft. long, the small section extending for 2 ft. 8 in. to a shoulder. The overall dimension at the smaller end was 9 in. and the diameter of the bore 5⅜ in., leaving a wall thickness of 1 13/16 in. The larger end was quite irregular, but averaged about 11½ in for an outer diameter, while the bore diameter was 7 in., leaving a wall thickness of 2¼ in. This forging was suspended from rods thrust through holes bored in the 6 in. of test metal at the smaller end, as there was no shoulder at this end. The bore at the shoulder contracted to about 2½ in. in diameter for about ½ in. of length, making a heavy section at this point. The approximate weight of the forging was 407 lb.

Operations were started on 3 per cent nickel steel forgings (although a few contained some chromium as well as nickel), the carbon averaging around 0.38 per cent. The forgings were received direct from the forge plant with nothing done to them aside from a green anneal to relieve the forging strains. After receipt at the plant they were rough machined and bored, then heat treated and tested, then finish machined, bored and assembled.

Careless Original Practice

The initial heat-treating practice was to place the forgings in a furnace entirely disregarding its temperature and without making any attempts to segregate the forgings in a charge with respect to their carbon content. The temperature of the furnace at this time, prior to the introduction of the forgings, averaged around 1,225 deg. F. (660 deg. C.). The charge was then brought to a temperature which averaged 1,425 or 1,525 deg. F. (775 or 830 deg. C.), depending on whether the forgings were to be quenched in water or in oil, in a length of time that averaged 3½ hr., when it was quenched in either water or oil, the medium chosen depending on the uniformity or lack of uniformity of the cross-sectional area of the forging, the one of uniform cross-sectional area being quenched in water and the one of irregular cross-section in oil. The object of this was, of course, to avoid cooling one part faster than another and so prevent strains from being set up that might crack the forging.

The temperature of the water before quenching was between 80 and 90 deg. F. (30 deg. C.) and the time of immersion averaged around 2 min. The temperature of the oil was a variable depending on how frequently it was used, as there was no provision made for cooling it. The time of immersion varied somewhat with the temperature of the oil, but for the same temperature it was always several times the period of immersion when water was used.

After quenching, the forgings were immediately put back into a furnace for the draw, its temperature averaging around 1,000 deg. F. (540 deg. C.) before the forgings were placed in it. The charge was then raised to a heat of between 1,100 and 1,200 deg. F. (620 deg. C.) and held at that temperature for about 1¼ hr., the time of raising to heat being about 2½ hr.

In all cases the time that it took to raise a charge to heat varied with conditions and the time of holding at heat was regulated by the necessity of having each forging heated entirely through at the particular temperature desired. Also the operator had to be sure that sufficient time was given for the necessary changes to take place in the steel after the critical range had been passed, these changes being somewhat slowed up by the presence of the nickel.

After the draw was complete the charge was removed to a cold pit and allowed to cool to below 600 deg. F. (315 deg. C.) with the pit covers closed. This was for the purpose of protecting the forgings from air currents which might cause unequal cooling, setting up strains in the steel and causing warping and cracking.

As previously stated, there was about 6 in. of waste metal left on each end of both classes of forgings for

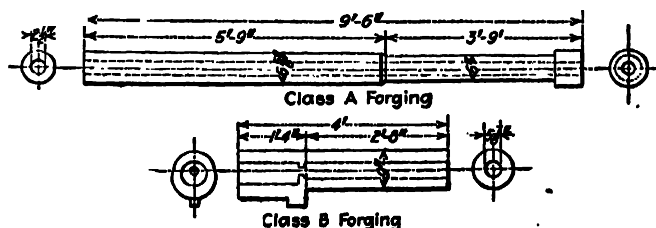


FIG. 4. SIZES OF NICKEL-STEEL FORGINGS TREATED

the purpose of furnishing test metal. After heat treatment, transverse bars were cut from this waste metal, one from each end, the bar from one end being diagonally opposite from the bar on the other. These bars were then shaped in shapers and turned down in lathes to the standard test bar 0.505 in. diameter, 2 in. between prick points. There were batteries of saws, drills, shapers and lathes kept for this purpose only. The bars were then pulled on one of three Riehle testing machines and the data carefully recorded and the fractured test pieces saved. The shapers, lathes and testing machines were run by girls under the supervision of men and, after a short period of training, they became very proficient.

After a considerable number of forgings had been tested, it was found that while some of them passed specifications there was no uniformity of result and something would have to be done to improve the percentage of acceptable pieces. The fractured test bars also showed a large number of flakes, of which I will say more later.

Segregation According to Composition

A careful study of the results indicated that each heat-treatment charge should be made up of forgings with similar carbon content, within limits, and the heat treatment, especially the drawing temperature, regulated accordingly.

This was then done and the treatment changed so that the quenching temperature averaged about the same as before, but with the drawing temperatures ranging as low as 970 deg. F. (520 deg. C.). The time of holding at heat in the draw was also lengthened to 6 hr., though subsequently it was found that while this long time did no harm neither did it apparently do any good, so for the sake of economy it was materially reduced.

This practice increased the percentage of passed forgings to some extent, as was expected, but flakes and streaks still continued to appear in the fractured test bars.

Description of Observed Flakes

Before going any further I will define "flake" and "streak" as they occurred in the transverse test bars. A flake is apparent to the eye as a spot of any size occurring in the fractured surface of the test specimen and extending transversely across it, the plane of the flake being parallel to the long axis of the forging. A streak is a bright band, generally about 0.02 in. (0.5 mm.) in width, apparently of the same nature as a flake, but having the plane of the defect at right angles to the long axis of the forging. In other words, when testing transversely a "streak" is a flake parallel to the axis of the test piece, a "flake" is perpendicular to it.

Flakes Ascribed to Strains in Steel

A cause for the existence of these flakes and streaks was then sought, and it was generally agreed that they were due to strains in the steel, but whether they were in the steel before heat treatment, whether heat treatment caused them, or whether, if they were present before treatment, the treatment could eliminate them was not plain. Accordingly a careful study of the treatment was made to see if undue strains were being set up in the forgings by the practice being followed at that time, and it was decided that the habit of putting a cold forging in a hot furnace was very apt to set up strains in the steel and that even though these strains were not sufficient to cause flakes the practice was not a good one and should be eliminated. In this connection the following test was made. One end of a small metal rod, on the other end of which was a telephone receiver, was thrust through a thermocouple hole in the side of a furnace and up against a forging. By listening at the receiver a person could hear what seemed to be straining or cracking noises when the forging was heated rapidly and this apparently indicated a rather severe straining of the metal under the given conditions. However, this experiment could not be taken as conclusive, as the intensity of the sounds, and even the very existence of them at all, varied with the listener.

However, in view of the above findings, the experiment was tried of putting the forgings into a cold furnace and bringing them to heat very slowly, the time varying from 16 to 20 hr. and, at times, even longer. This practice was tried for about 10 days, but only as an experiment, being diametrically opposite to the previous practice of putting the forgings in a hot furnace and bringing them to heat as rapidly as possible. Ten days was found to be sufficient to get enough data on which to base conclusions.

Of course the extreme length of time involved in bringing the charge to heat precluded the adoption of this method commercially, but the results obtained showed that it was a step, though a radical one, in the right direction. However, flakes and streaks still persisted, and it was decided that they must be formed prior to forging, which the writer had contended right along, and experiments were accordingly undertaken with that idea as a basis.

Flakes Found in Ingots

As previously stated, the steel was made and forged at another plant than where treatment and machining were done. The casting practice at that time was to cast into square ingots and cool in the air. Experiments were begun at the beginning of things, therefore, and a number of these square ingots were cut open. It was found that flakes appeared along the diagonal lines across the ingot from corner to corner. As the corners or edges of a square ingot cool first, thus setting up strains along these same diagonal lines, it was deduced that flakes were caused, in part at least, by cooling strains and experimentation proceeded accordingly.

The shape of the ingots was changed from square to octagonal and the hot ingots were stripped and buried in ashes to cool, thus insuring very slow and uniform cooling. A number of these ingots were then cut open and flakes were found to have been practically eliminated. This casting and cooling practice was accordingly followed from then on, with such modifications as conditions from time to time indicated, and very little further trouble was experienced with flakes.

This all proved that while the initial heat-treatment practice was not all that it might have been, still the low percentage of passed forgings was due as much to poor steel as it was to poor heat treatment.

As stated before, the long time required to bring a forging to heat when put in a cold furnace and raised very slowly precluded the use of this practice commercially, so the following scheme was evolved which worked out very well.

It is generally agreed, I believe, that if the difference in temperature between the furnace and the forgings

is not more than 300 to 400 deg. F. (175 deg. C.) no undue strains will be set up in the steel and also that after the forgings are raised to a temperature of between 600 to 700 deg. F. (340 deg. C.) even a greater difference in temperature will do no harm. Working on these premises, one furnace was set aside for a preheating furnace, the cold charge being placed therein when the furnace temperature was around 400 deg. F. The charge was then brought up to about 700 deg. F., when it was removed to another furnace which was at a considerably higher temperature and there brought to heat. The temperature of this second furnace before receiving the charge varied from 1,000 to 1,200 deg. F. (600 deg. C.) depending on circumstances. As far as the draw was concerned, the forgings were removed from the quenching bath at a sufficiently high temperature so that they could be put into a furnace at a relatively high temperature without any harm ensuing.

The foregoing improvements in both steel and treating practice resulted in a material increase in forgings passed, but the percentage was not yet what it should have been and a study was made of the quenching and drawing temperatures to see what improvements could be inaugurated along those lines.

At this time 3 per cent and 2 per cent nickel-steel and 3 per cent nickel-chromium steels were being treated, and it was found that the quenching temperatures could

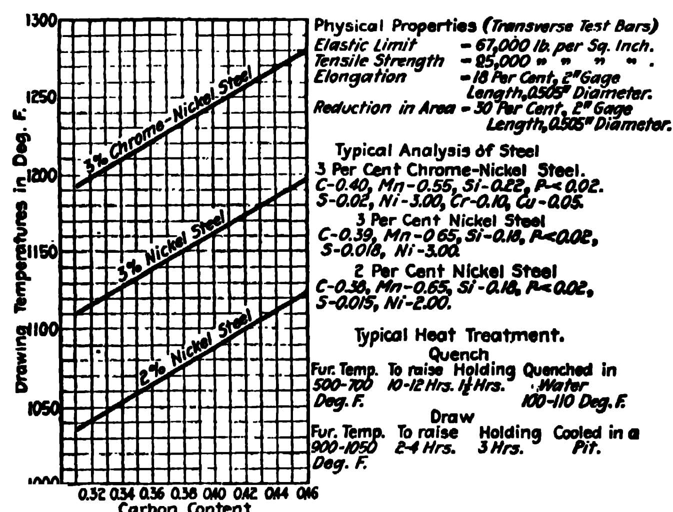


FIG. 5. RELATION BETWEEN PHYSICAL PROPERTIES AND DRAWING TEMPERATURES IN THE HEAT TREATMENT OF LARGE NICKEL-STEEL FORGINGS

be practically standardized for all three classes if the drawing temperatures were properly adjusted. The following practice was accordingly evolved, which resulted in passing about 85 per cent of the forgings on the first treatment.

The forgings were placed in a furnace which was at a temperature of from 500 to 700 deg. F. (315 deg. C.), heated through to this temperature, and then transferred to another furnace which was at a higher temperature, as explained before. In this second furnace class A forgings were raised to a heat of 1,475 deg. F. (802 deg. C.) and class B forgings to 1,500 deg. F. (816 deg. C.) in a time of from 8 to 12 hr. They were then held at heat for a time of 1½ hr. for class A and 2 hr. for class B forgings and quenched in water.

For class A forgings the time of total immersion was 1¼ min., at the expiration of which time the forgings were pulled up till the shoulder was just beneath the surface of the water, when the heavy section was given an additional quench of 30 sec. In the case of class B forgings the time of immersion of the whole forging was 1 min., with an additional minute for the heavy section. These quenching times were found to be adequate for getting the proper quenching effect and yet did not cool the forgings so low as to cause cracks, which danger is always present in alloy steels. Neither did the forgings lose an unnecessary amount of heat, thus causing the necessity for more power consumption and a needlessly long time for bringing the charge to heat in the draw.

After the quench the charge was put back into the drawing furnace, whose temperature varied from 900 to 1,050 deg. F. (525 deg. C.) and raised to heat in from 2 to 4 hr. It was held at heat for 3 hr., removed to a closed pit and cooled to below 600 deg. F. (315 deg. C.) with the pit covers closed.

As stated before, the practice outlined above resulted in the passing of about 85 per cent of the forgings on the first treatment and was followed, with perhaps minor modifications for varying conditions, from the time it was evolved till the plant closed.

The accompanying chart, Fig. 5, shows the relation between the drawing temperatures and the carbon content of the steel for the three classes of material used, the forgings in all charges used in preparing the chart having passed test on the physical properties shown.

In conclusion the writer wishes to state that the above article was written before the recent rather general discussion in the technical press on flakes in nickel-steel forgings and he wishes to be understood as advancing no theories, but as merely stating facts, leaving the reader to draw his own inferences.

Lexington, Ky.

Conserving Canada's Pulp-Wood Resources

Canada produces something like 800,000 tons of paper per annum, and after supplying its own needs finds a ready market in the United States for the greater part of the remainder. The Dominion is making rapid progress with the development of its wood-pulp industry, the output of which, according to the latest available official figures, rose from 363,079 tons in 1908 to 1,464,308 tons in 1917.

Its illimitable virgin forest areas and its policy of conservation and reafforestation should in the near future make Canada one of the greatest pulp and paper producing countries in the world, but today it cannot meet anything like the demand for either commodity from the United States—which normally takes 75 per cent of Canada's output of paper—or from Great Britain, Australia, New Zealand, and South Africa. The provincial governments of Canada, in refusing to permit the export of pulp wood grown on Crown lands, are naturally unwilling to exploit their forests without regard to conservation, but are perfectly willing to continue to send to the United States most of their output of print paper.

It is extremely doubtful whether the paper consumer—large or small—will experience much relief in respect of prices within the next two or three years. While wood pulp continues to be the principal raw material for paper, conservation of the world's pulp wood areas should certainly be supplemented by a thorough investigation of the adaptability of other fibers to papermaking purposes.

The Chemical Engineer—His Functions and Training*

An English View of the Functions of Three Classes of Chemical Engineers: Those Employed in Chemical Works, Those Engaged in Manufacturing Chemical Plant, and Consultants—Suggested Curricula for Students Who Have Had Preliminary Training in Chemistry or Engineering

BY J. H. WEST

MUCH has been written at various times on this subject, and it is one of peculiar importance just now in view of the great and increasing interest which is being taken in the provision of adequate facilities for the training of chemical engineers in this country [England]. It is, however, evident that there is still much confusion of thought as to the proper functions of a chemical engineer, and until this matter is cleared up there can be no real progress in devising the correct lines upon which his training should be carried out. The recent very interesting informal discussion on "What Is a Chemical Engineer?" at the Chemical Industry Club provided a further proof of this confusion of thought, some speakers even going so far as to consider a chemical engineer as a sort of super-plant-superintendent.

The object of this article is to analyze the functions of chemical engineers in relation to chemical manufacture, to classify these functions into their various groups, and then to discuss the various sources from which the chemical engineers of the future are likely to come, thereby arriving at the nature of the training they will have had previous to entering upon the study of chemical engineering proper, and finally to offer some suggestions as to the training they will require, and how this is to be provided. The writer does not desire in any sense to lay down the law on these matters, but rather to open the way for an unbiased consideration of this subject, which is of the highest importance to the whole British chemical industry, based upon clear thinking and a practical appreciation of the actual conditions under which chemical manufacture is being carried out to-day.

The report of the British mission which investigated the German chemical factories in the occupied territory makes it clear that Germany's past supremacy in the chemical industry was not due to superior and exclusive knowledge on the part of her chemists, but rather to highly organized and well-thought-out methods of manufacture carried out in scientifically designed plants. There is still, unfortunately, a certain amount of apathy among British chemical manufacturers regarding these questions, though not nearly as much as before the war, some of the older concerns attaching far more importance to guarding the secrets of their old-time methods than to keeping in touch with new methods and new discoveries. Others, however, realize even now that a bitter fight for commercial existence may soon be upon them, and they are making their plans accordingly. It is essentially the chemical manufacturer who is chiefly interested in obtaining and utilizing competent chemical engineers, and any criticisms or suggestions regarding the points referred to in this article will be most heartily welcomed from chemical manufacturers, and also from others who are interested in the training of chemical engineers.

Functions of the Chemical Engineer

Chemical engineers may be divided into three main classes. First, those who are employed in chemical works; second, those who are engaged in manufacturing chemical plant; and, lastly, consultants. These three classes will be dealt with in turn.

THE CHEMICAL ENGINEER IN A LARGE WORKS

In order to arrive at a clear understanding of the functions of a chemical engineer engaged in a chemical works it is necessary first to consider his duties in a large works where the organization is highly developed with a large staff, and consequently there is less overlapping of duties than is inevitable in a small works with a correspondingly small staff, because such overlapping tends to obscure his true functions. These duties were fully gone into by the present writer in a previous article[1] and it is not, therefore, necessary to go all over the ground again, but there are certain points which must be emphasized, and in order to make them clear it is here necessary to make a digression.

PHASES OF CHEMICAL MANUFACTURE

The principal point, in the writer's opinion, is that there are, and must be, three distinct sides or aspects of chemical manufacture, leaving aside financial and selling considerations. These are the chemical side, the manufacturing or production side, and the engineering side. The second is by far the most important, for it is obviously the main business of the works, and the two others are merely adjuncts necessary in order that the production side can be carried on. It is becoming more and more realized by progressive manufacturers that production is a science in itself, which should be kept separate from other phases of the work and placed in the hands of trained production experts. In any manufacturing industry, whether gas-engines, boots, chemicals or anything else is being made, the production man is given certain materials to transform into certain products, and he is provided with the necessary means of doing this—viz., first, what may be termed plans of operation, for lack of a better term; second, plant; third, labor; fourth, energy; and lastly, subsidiary materials, other than raw materials.

Take the case of a works making gas-engines. The raw materials are pig iron, ingot metals for non-ferrous alloys, bar and sheet metals, and various sundries. The plans of operation consist of the designs for the gas engines prepared by the designing and drawing office staff, and the methods of manufacture which are worked out partly by the drawing office and

*Reprinted from the *Chemical Trade Journal and Chemical Engineer*, June 5, 1920, p. 727.

[1] "The Manufacturing Organization of Large Works," *Chem. Trade J.*, Feb. 9, 1918.

partly by the tool-room staff. The modern tendency is all toward working out the various processes of foundry work, machining and assembling beforehand by the joint drawing office and tool-room staffs, so that the production man gets all these matters cut and dried, and has not got to work them out for himself.

The case of chemical manufacture is almost exactly parallel. The raw materials depend upon the products to be made. The plans of operation are the chemical processes as worked out by the chemical staff, and the methods of carrying out the various chemical and physical operations as worked out by the chemical engineering staff. Here, again, the production man should be provided with all his requirements without having to bother himself about them, so that he can devote his whole time and energy to his own job, that of production. Now, production is not chemical work, and it is not engineering. It is a thing apart, calling for special knowledge of organization, the handling of labor and materials, the saving of time, and the economics of manufacture, as well as some knowledge of chemistry and engineering. There are many people who believe that a chemical plant can be run successfully only by a chemist. If that is true in the case of a given plant or process it is a sure sign that either the process has not been fully worked out by the research chemist, or that the plant and methods of operating have not been properly worked out by the chemical engineer. When a chemist says that he must run a process himself it simply means that he has turned over an incomplete process to the works and that he will complete his research on the plant itself. Now, a manufacturing plant is not the proper place for research if it can possibly be avoided, because research in such a plant inevitably means interference with production.

In the case of large firms with a well equipped semi-manufacturing scale laboratory practically every point regarding both process and plant can be worked out there, but smaller firms regard these laboratories as luxuries beyond their means, though in reality they would in most cases recoup the entire cost of such a laboratory within a year by the saving in time and money on their manufacturing plants. However, if there is no such laboratory the final stages of the process and plant research must be carried out in the manufacturing plant; but this should be placed under the control of the production man from the outset, with the chemist and chemical engineer to assist him until the initial difficulties have been overcome and the production is working smoothly. When this stage is reached the investigation of the process and plant and the methods of working should be so complete that the whole thing is practically foolproof. The production man should then, and then only, take full charge, leaving the chemist and the chemical engineer free to tackle other problems, and only needing to be recalled to give advice if and when other difficulties arise.

Production Work Not Real Chemical Work

Once the production is going smoothly by no stretch of the imagination can it be claimed that there is any real chemical work, in the highest sense of the words, involved in carrying it on. There will be routine testing of raw materials and reagents, and of the products at various stages of manufacture, including the finished article, but once these tests have been worked out and systematized a chemical student straight from college could carry them out, and how any chemist who is a real chemist can wish to have anything more to do with the plant when there is other research work—real chemical work—waiting to be done is a mystery, except that many chemists seem to prefer any sort of work almost to chemical work. There is no reason why a man who has been trained as a chemist should not take up production work in a chemical factory, provided he acquires the necessary knowledge of the science of production, and his chemical knowledge will be very useful to him; but he should frankly acknowledge when he does so that he has changed his vocation and is no longer doing the work of a chemist. The same thing applies to a chemical engineer who desires to run his plants when they are completed. Let him do so, if he has the necessary knowledge and ability, but let him also realize that by so doing he has ceased to work as a chemical engineer.

Duties of Chemical Engineer

True chemical engineering is a branch of engineering, just as much as electrical engineering or mining engineering, and it is nothing else. The real chemical engineer must be an engineer first, last and all the time, and his original training must be an engineering training, including the serving of an apprenticeship in the shops, as in the case of any other true engineer. To this must be added a real aptitude for and knowledge of chemistry, physics, and physical chemistry, particularly the two latter. It is primarily a man with such a training followed by sufficient practical experience who will be best fitted for carrying out the design and construction of original and complicated chemical plant without outside assistance. This work is the principal function of the chemical engineer, but he must be prepared, in addition, to assist and advise the various experts in other branches of engineering, such as power and steam engineers, structural engineers and electrical engineers, who will be on the staff of a large chemical works, or who may be called in from outside, regarding the special requirements of chemical works in these directions. He must, further, in order to fulfill these functions, collaborate closely with the chemical staff, the production staff, and the other engineering experts, including the repairs engineer, and he will have to deal with outside makers of plant, and select the most suitable types, arranging for any modifications of the makers' standards, if such be absolutely necessary.

Putting a Process on a Commercial Scale

The ideal method for preparing a laboratory chemical process for conversion into a manufacturing proposition would be a joint investigation carried out in the closest collaboration by the chemist, the production man and the chemical engineer, bearing in mind that the production man, as representing the commercial point of view, is the most important. The chemist would therefore have to satisfy him that the process he submitted involved no waste of materials by the use of excess reagents beyond that absolutely necessary to carry out the reactions, that expensive reagents were not to be used where cheaper ones would do, that the yields had been pushed to the highest point attainable, and that the use of power and heat had been reduced to a minimum. The chemical engineer would have to satisfy him that the plant proposed was in every way suitable and efficient, and that economy of labor, power, heat, cooling water, etc., had been fully provided for. By the production man is here meant the head man or production superintendent of the whole works. The man who

is to run the plant should be brought into touch with it during the construction period, so that he will be familiar with every detail of the plant and process before he has to begin operations. A board of directors who insisted upon the preparations for manufacturing their products being carried out in this way would feel confident that not only were they using their staff to the best advantage but were insuring commercial success as far as that can possibly be done.

The Chemical Engineer in a Small Works

So much for the works chemical engineer in a large works where his duties are highly specialized, and therefore clearly defined. We come next to the smaller works, where there is a chief chemist, with one or two research and routine chemists under him, and a chemical engineer. Here again, in the writer's considered opinion, far-seeing manufacturers who study organization and think out things for themselves will ultimately be driven to the conclusion that it is better to employ special production men to run the plants, and use the chemists and engineer to do their own proper work. In this case the methods of collaboration by chemist, production man and chemical engineer will be similar to those already considered, but if shift chemists are to run the plants the chief chemist alone will collaborate with the chemical engineer, and the onus of securing maximum economy of labor, power, heat, etc., will lie upon the latter. In either case the whole of the engineering work will have to be carried out by the chemical engineer, unless outside experts are called in, say, for instance, where a whole new works has to be laid out. It must be realized that the engineering problems connected with a chemical works cover such an enormously wide field that it is absolutely impossible for any one man to have expert knowledge of every phase, but, as before explained, the chemical engineer will assist these experts in satisfying the peculiar requirements of the chemical works.

Where the Chemist Is Also the Chemical Engineer

Lastly we come to the all too common case of the works where there is a trained chemist but no chemical engineer, his place being taken by an engineering foreman as a rule, very often an ex-sea-going engineer who has picked up a practical knowledge of chemical plant, but has no knowledge of the principles of chemical engineering. This is a state of affairs which will probably cease to exist in a few years, when there is an adequate supply of trained chemical engineers, but it is very common at present, and it has led to the idea that if the chemist in such a case studies chemical engineering he can combine his own functions with those of the chemical engineer, thus becoming a sort of hybrid. That this is the sole conception of a chemical engineer possessed by many people was evident from the remarks of several speakers at the Chemical Industry Club debate, before alluded to. In fact, it was suggested that the name for this hybrid was badly chosen, and that it ought to be engineer-chemist. There is truth in this suggestion, for how can a man without a proper engineering training be an engineer? That a knowledge of chemical engineering, even of the most empirical kind, is most valuable to such a man is obvious, and that with the aid of outside engineers or chemical plant-makers he can do farily good work in getting together plants in which to carry out his processes is not denied. There must be hundreds of chemical works in operation today which have had every bit of plant in them got out and put up on these lines, but such a man is not a chemical engineer, or an engineer at all in the true sense.

Research Should Precede Large-Scale Production

It is most probable that here we come up against the fundamental difference between British and German methods. The British manufacturer is satisfied if his staff can get together and put up a plant which will turn out a given product, and as soon as the process has been decided upon the plant is got on with and production is begun, all question of commercial efficiency and most of the snags and difficulties of large-scale manufacture being left over until the plant is working. It is not too much to say that many chemical plants in this country remain in the experimental stage for several years after they start producing, and some plants seem never to emerge from this stage at all. The result is variable quantity and quality of output, with correspondingly disappointing financial returns, due to the occurrence of difficulties which ought to have been investigated and got over beforehand. The German manufacturer, on the other hand, insists upon every phase of both process and plant being worked out in advance by highly trained specialists. In other words, the research work is carried much further than is done here, where research is usually restricted to the purely chemical laboratory-scale stage, instead of being carried right up to the manufacturing stage, both as regards process and plant. Research on the chemical engineering and production sides is just as necessary as on the chemical side.

A well-equipped semi-manufacturing-scale laboratory is exceedingly useful for this work, but much can be done with odd pieces of spare or disused plant, and the proper use of the quantitative flow sheet, on which the history of every pound of raw materials, reagents and solvents, and every unit of heat and other forms of energy, from the moment they enter the plant to the moment they leave it, is worked out as closely as possible, will throw a flood of light on the extent and exactness of the knowledge of the process and the plant which has been acquired. With regard to the hybrid engineer-chemist, while it is admitted that he can devise, put up and run plants, can he possibly have sufficient specialized knowledge of the chemical, the engineering and the production sides to do full justice to all three? Heaven knows life is all too short for acquiring adequate knowledge and experience of one small corner of one branch of one department of technology, without attempting more than one.

The Chemical Engineer as Maker of Chemical Plant

Passing next to the second class of chemical engineers, those employed by firms manufacturing chemical plant, the functions and qualifications will be very similar to those of the chemical engineer in a large chemical works. A less extended knowledge of chemical plant will be demanded, because he will only be required to deal with the special types of plant manufactured by his firm, but, on the other hand, he will have to study the application of these types to a much wider range of chemical manufactures than the works chemical engineer, who is confined to dealing with only one class of chemical products. This class of chemical engineer, again, must be a properly trained engineer, capable of

designing plant not only suitable for the purpose intended but capable of being manufactured on economical lines at competitive prices. Makers of chemical plant can be, and are, of immense assistance to chemical manufacturers, particularly those who have no chemical engineer of their own, and there are plenty of honest makers who are willing to give disinterested advice whether it results in the sale of their own plant or not. There are, unfortunately, others, happily in the minority, who are sufficiently blind to their own real interests to push the sale of their goods, irrespective of the suitability or otherwise of these for the purpose in view.

The Consulting Chemical Engineer

Finally, we have the consulting chemical engineer, who may have started life as a works chemical engineer or as a maker of chemical plant, and, provided he has had a thorough training and a sufficiently wide experience, it does not matter which. The proper functions of a consulting chemical engineer are to advise on the design and construction of chemical plant, the layout of chemical works, and, either alone, or in the case of large and important undertakings preferably in consultation with other experts, upon the other phases of chemical works engineering, such as buildings and the supply of steam and power. It is no part of his business to advise upon the purely chemical side of processes, any more than it is the legitimate business of consulting chemists to advise upon the design of chemical plant, yet consulting chemists frequently do the latter, sometimes with disastrous results, and consulting chemical engineers are often expected to do the former. Here again, in this age of specialization, overlapping of functions is greatly to be deprecated. In the consulting chemical engineer the chemical manufacturer who has no chemical engineer of his own can find an unbiased arbitrator between himself and the maker of chemical plant.

Training the Chemical Engineer

In considering the training of the chemical engineer it is necessary to differentiate carefully between the various classes of men who require training. Starting with the college student, it must be pointed out that at present, anyway, chemical engineering must be considered as more or less a post-graduate subject or as a subject to be taken up after the student has put in at least two years on either engineering or chemistry. consequently the training required will be very different in its early stages, according to the previous record of the student. The supply of students who begin with an engineering training, and later on take up chemical engineering, is likely to be small for some years, or until chemical engineering comes to be recognized as a well-defined and attractive branch of engineering, but it is probably men of this class, engineers at heart, with an aptitude for chemistry, who will make the best chemical engineers of the highest type. These men will have served their time in the shops, either before going to college or during their engineering course on the so-called sandwich system, and they will have had a thorough grounding in engineering subjects, so that they need not devote time to these subjects during their first year at chemical engineering. They should rather study as much chemical technology, physical chemistry, electrochemistry and thermodynamics as possible, plenty of laboratory work in all these subjects being included, and one day per week being devoted to the principles of chemical engineering.

On the other hand, students with a chemical training should in their first year give three days a week to engineering subjects, including applied mechanics, strength of materials, machine drawing and design, and building construction, with one day on thermodynamics, physical chemistry and chemical technology, and the remaining day on chemical engineering principles. During the second year all students would devote most of the time to the principles of chemical engineering and the design of chemical plant, the remainder of the time being spent on chemical and physical subjects by the engineering students, and on engineering and physical subjects by the chemical students. The economics of chemical manufacture should also be dealt with, and such matters as the factory law relating to chemical works, safety appliances and the handling of labor. Students who can stay on for a third year would have advanced lectures on chemical engineering principles and practice, and would be encouraged to specialize in some branch of the subject in which they would carry out original investigations. The above is merely intended as a suggested general allocation of time.

Plant Experience Essential

Works experience is most essential for all students, and is very difficult to provide for. If it can possibly be managed students should spend some months in a chemical works, or failing that in the works of a firm making a wide range of chemical plant. Possibly one summer vacation spent in each kind of works would be the best arrangement. It is greatly to be hoped that chemical manufacturers, when they begin to realize that properly trained chemical engineers will be not only valuable but essential to them, will come forward to aid the educational authorities by opening their works to students during the vacations. Chemical students who wish to acquire some knowledge of chemical engineering--and this subject is bound to be of great value to every chemist who intends to enter the chemical industry, whether on the research side or the plant side, —would take as much of the above course as they could spare time for.

Chemical Industry Seeks Highly Trained Men

In this connection it is worth referring to some remarks made by Dr. E. F. Armstrong, F.R.S., at the annual dinner of the Chemical Engineering Group, to the effect that the supply of partly trained chemists was likely greatly to exceed the demand, and that manufacturers now wanted not merely pass or honors degree men but highly trained chemists capable of undertaking the highest type of research work. Such men will certainly require a knowledge of chemical engineering. It might be added that there will no doubt be good openings for men with a chemical training who definitely propose to go in for plant or production work instead of research work, and prepare themselves for this by studying the economics of chemical manufacture, the principles of plant and works management, and chemical engineering; if necessary, abbreviating their purely chemical training in order to do this.

The training of production men lies outside the scope of this article, but it would appear that there is great need for a systematic course of training for plant superintendents and works managers, arranged on broad lines suitable to any manufacturing industry.

The Copper Industry in 1919

THE principal features of the American copper industry during the year 1919 are shown in an advance statement on the production of copper in the United States by H. A. C. Jenison, of the United States Geological Survey, Department of the Interior.

The smelter output in 1919 was about 1,310,972,000 lb., a decrease of 597,561,000 lb. from that of 1918. The production of refined primary and secondary copper from domestic and foreign ore and metal was 1,863,580,000 lb., which was 612,497,000 lb. less than the production in 1918. Refined primary copper amounting to 326,043,000 lb. was produced from ore or other material imported from foreign countries, principally Chile, Peru, Mexico and Canada.

The discrepancy between the smelter production and the refinery production is due to the fact that 562,000,000 lb. of blister copper and other material was in process of refining at smelters and refineries or in transit on Jan. 1, 1919, and though it was smelted in 1918 it was not refined until 1919.

Exports Show Great Falling Off

In 1919 the imports of copper in all forms amounted to 429,388,000 lb., and the exports of copper in all forms amounted to 516,628,000 lb., which was 231,062,000 lb. less than the exports in 1918 and 616,205,000 lb. less than those in 1917. The exports in 1919 were less than in any year since 1907.

On Jan. 1, 1919, the stocks of refined copper were 180,000,000 lb., and on Jan. 1, 1920, they were 631,000,000 lb., an increase during 1919 of about 451,000,000 lb. The stocks on Jan. 1, 1920, were several times greater than they have ever been before.

In addition to the stocks of refined copper in hand about 310,000,000 lb. of blister copper and material was in process of refining at smelters and refineries or in transit on Jan. 1, 1920. This estimate does not include blister in foreign smelters destined for the United States for refining nor material in transit to the United States from such smelters.

The apparent domestic consumption in 1919 was about 876,564,000 lb., which is 785,106,000 lb. less than that in 1918 and less than the domestic consumption in any year since 1914.

Causes of Decrease in Output

Many causes contributed to decrease the smelter and refinery production, the domestic consumption, and the exports, and to increase the stocks, but the principal cause was a poor market. The industry was working at maximum capacity when the war demand for copper ceased, and it was then, of course, forced to continue production only at the rate required to supply the ordinary commercial and industrial demand. The war demand was stopped so suddenly as to disturb greatly the trade and industrial conditions, and the prospects for the immediate future appeared so uncertain that few industries were able to continue production without first decreasing it greatly and reorganizing, to some extent, their industrial mechanism.

Prices and Costs

Under the peace-time conditions the demand for copper was small and the average price soon fell from 24.7c. to about 15c. a lb. This price was far below the actual cost of the production of a very large part of the previous year's output. All smelters and mines were forced to decrease production. Some were shut down entirely; others were operated at the minimum capacity that would keep the organization intact and the equipment in proper order. Much of the copper in stock could not be profitably held, and the placing of a large part of it on the market kept the price down, though it showed a tendency to rise when the readjustment set in.

Price Lowest Since 1915

The price during the year showed many fluctuations but averaged only 18.6c. a lb., which was about 24 per cent less than the average price in any year since 1915, though the cost of labor and supplies had risen as much as 150 per cent during that time.

The labor troubles in other industries decreased the demand for copper, increased the cost of supplies used by the copper industry, and materially increased the cost of production.

Decrease in Foreign Demand

By the time the price of copper had risen high enough to permit the industry to meet these unfortunate conditions foreign exchange began to fall so rapidly that foreign buyers were unable or reluctant to purchase American copper, and finally the exchange between the United States and foreign centers dropped so low that they could no longer buy it. These conditions almost ruined the foreign market for American copper, and the demand and the price in the domestic market were less than they had been at any time for several years. On the whole, the year was an unsuccessful one, and in view of the conditions it is remarkable that the industry remained as stable as it did.

Prospects for 1920

It is hard to foresee what improvement can be expected in 1920, but the quantity of copper sold in the early part of 1920 indicates that the year will be better than 1919. Any improvement, however, will be temporary and no stability or security can be found until existing troubles are settled and industry and trade become more stable. The prosperity of the copper industry is peculiarly dependent upon the establishment of stability in other industries, and before the industry can receive any great stimulus the condition of labor and of trade generally, not only in America but in Europe, must be greatly improved. When that time comes the industry will undoubtedly be as prosperous as ever.

Manganese Addition Increases Life of Thermit Welded Wabblers

Successful results obtained from a considerable number of welds made by several large steel mills have shown, according to a statement by the Metal & Thermit Corporation, New York City, that the life of wabblers on pinions, rolls and large shafts which have been repaired by thermit welding, after previously having been worn away or broken, can be prolonged materially by the addition of 3 per cent pure manganese to the railroad thermit in addition to the 1 per cent pure manganese already in the thermit. This will give a hard wearing surface. Wabblers should be thoroughly heated to about 1,400 deg. F. before welding; otherwise no alloying of the two metals will be obtained.

Turpentine From British Columbia Firs

IN A recent interview E. S. Oliver, an industrial chemist and specialist on wood products, who has made a study of methods of extracting the maximum amount of resin from trees without injury to the growing tree, gave some interesting and valuable information in connection with the turpentine industry, which is attracting considerable attention among persons identified with the development of the resources of British Columbia. Mr. Oliver, who has in the past conducted investigations in Mexico and Central America and in the forests of Russia, Sweden, Germany and the Mediterranean countries, states that the greatest potential source of turpentine and resin chemicals lies in British Columbia.

Government Issues "Resin Leases"

At the last session of the provincial legislature of British Columbia there was passed an amendment to the Forest Act, whereby the provincial government is authorized to issue "resin leases" and to collect a royalty of three-quarters of a cent a gallon on all resin gathered, in addition to the fees and rentals paid into the Forest Protection Fund. The amendment was passed only after demonstrations by, and reports from, forestry officials showing that tapping for resin does not injure the growing trees.

The Oliver Method of Collection

Some of the interesting history of this new industry was revealed when Mr. Oliver pointed out that the very first ship which came from England to the shores of America bore instructions, written in the hand of Queen Elizabeth herself, as to the method to be employed in securing tree resin. "And," he added, "curiously enough, on this continent the very same methods are still followed. It is an industry which has shown no improvement in its methods of collecting its raw material."

Under the old system of scarifying the barks of the trees and collecting the resin after the more volatile elements had become oxidized by contact with the air, it was not possible to secure more than 17½ per cent bulk of turpentine. In Canada the highest production in any of the eastern plants was 15½ per cent. Under Mr. Oliver's tests the lowest he has received was 33 per cent, or 1 per cent higher than in Germany, where the resin byproduct industry has been developed to an art.

Process Benefits the Trees

Without disclosing any of the secrets of the process, it may be said that Mr. Oliver achieves his results by boring a very small hole into the tree trunk and hermetically sealing it to an air-tight flask. In this way, instead of injury being done to the timber, the growth of the tree is aided. The resin being in the nature of fecal matter which the tree is seeking to rid itself of, the quality of the timber and the rapidity of its growth are aided, the small drain holes not affecting the efforts of the tree to send up sap and build up new cells.

Many Valuable Resin Products

The theory worked out by Mr. Oliver to explain why larches and pines send out resin is that the pines and conifers are the survivors of a cold epoch which swept over the northern hemisphere. The only way in which the germ of life in the tree cell could endure was by the tree evolving a non-freezable and non-swelling substance to enwrap and protect the cells. Such a substance is turpentine, which forms a large element in tree resin. "With a return of warmth," says Mr. Oliver, "these trees now find themselves with a supply of resin for which they no longer have any use. The tree is always seeking to rid itself of the substance by discharging through the roots into the ground and by forming abscesses in the tree trunk. When the tree trunk is scarified or the bark injured the resin oozes out."

Among the valuable products obtained as a result of experiments with British Columbia Douglas fir resins are turpentine, fir oils which form the base of "fruit" extracts used at soda fountains, medical oils, etc., and resins which make varnishes of the highest grade. Printing inks are also made from the resin. One of the most interesting is Burgundy pitch, which, instead of being "pitch" black, is snowy white. Its greatest value is as a white ink for use in lithographic work.

Industry a Constructive One

"The greatest satisfaction," says Mr. Oliver, "is that the industry will be a constructive one, instead of a destructive one as practiced in the southern pine forests of the United States. Every tree, no matter how small or how ill shapen, so long as it is healthy can be made revenue producing. It will help the lumber industry and will itself become the greatest single industry in the province."

A Company Already at Work on Cortez Island

A local concern has started operations in Cortez Island, at the mouth of the Campbell River, about sixty miles from Vancouver, where twenty men are employed. The men now engaged in this work are mostly ranchers residing in that locality, but it is the intention of the Vancouver company to put on about 200 workmen. The method of pursuing operations is to secure sap rights from private owners. It is estimated that a block of about 100 acres of Douglas fir gives about 800 bbl. of pitch per year, or a total of about 40,000 gal. The rancher is also provided with employment if he so desires, at $5 a day. The majority of the landowners in the Cortez Island and adjacent districts are holding their property for the ultimate timber wealth, but the establishment of this new industry is adding much to the value of the forests.

Forty Gallons at a Tapping

The company is working on trees not less than 10 in. in diameter. Some of the larger trees are said to yield upward of 40 gal. at the first tapping. The pitch comes forth in colors varying from a bright green and deep red to a milky white. The color denotes the quality of the product, the bright green being of the highest grade. One gallon of sap produces about one-third gallon of high-grade "turps," while the residue is rich in valuable byproducts.

Forestry experts declare the Douglas fir to be the most valuable tree in the world for commercial purposes, not even excepting the rubber tree. The market is also extensive, while the price obtainable for turpentine and other resin products is four times that of prewar days.

Nitrate Industry in Chile*

A Succinct Review of the Operation of a Nitrate Plant for the Recovery of Sodium Nitrate, Iodine and Potassium Nitrate—Needs of Improvements in This Industry and Some of the Technical Problems to Be Solved

BY ALEJANDRO BERTRAND

THE topography of the Chilean nitrate fields permits the installation of plants so that a great part of the handling of the nitrate material can be carried out by using gravity as motive force. A typical arrangement of a nitrate plant is shown in Fig. 1. The essential parts are:

1. Receiving hopper (buron).
2. Crushers (acendraderas).
3. Lixiviation tanks (cachucos).
4. Clarification tanks (chuladores).
5. Crystallization tanks (bateas).
6. Nitrate drier (cancha).

The accessories are:

7. Means of transporting the material from one stage of operation to the following.
8. High and low pressure steam generators.
9. Evaporators to concentrate the nitrate liquor and eliminate the sodium chloride.
10. Power generators.
11. Steam and liquor pipings.
12. Reservoirs for water.
13. Apparatus for the separate treatment of pulverized material or of the washed residue.
14. Machine shop.
15. Iodine house.
16. Installation for the separation of potassium nitrate.
17. Installations for getting and purifying the water needed during all the operations of the plant.

CRUSHING

The run of mine has to be transported to the plant from some distance—sometimes up to 30 km. (about 19 miles). The material is dumped directly from the cars into a receiving hopper located at the highest level of the plant. From here the material reaches the crushers, where it is reduced to 4 to 10 cm. size (1.4 to 4 in.) plus a varying amount of pulverized caliche, according to the hardness of the raw material.

Very few plants use any screening between the hoppers and crushers for a preliminary separation of the fines and of the part already of the desired size. In newly installed plants there is a tendency to use screens placed before and after the crushing operation, thus improving the hygienic conditions for the workmen and rendering more efficient the subsequent treatment of the classified material.

LIXIVIATION

The usual lixiviation tanks are open and rectangular, made of heavy sheet iron, the dimensions being 2 m. wide x 2.5 m. deep x 7 to 10 m. long (6.5 x 8 x 23 to 33 ft.) with a maximum capacity of eighty tons of material.

*Abstract from a paper presented, Jan. 28, 1920, before the Société de Chimie Industrielle and printed in the March, 1920, issue of *Chimie et Industrie*. For the first part see CHEM. & MET. ENG., April 7, 1920, pp. 655-659.

Each tank contains a perforated false bottom placed at 20 cm. level (about 8 in.). Low-pressure steam circulating in pipe coils serves for heating. The tanks are interconnected with siphons and provided with outlets for the liquid and means for dumping out the residues.

A 100,000-ton-per-year plant needs on the average fifty such tanks, which occupy a floor space of at least 2,000 sq.m. (21,500 sq.ft.).

The washing progresses on the counter-current principle. Generally the unscreened material from the crusher is dumped into the tanks; but in the more modern installations, when screening is used, the fines are treated separately or placed on top of the coarser materials. The complete washing of one batch of material (fondata) usually requires from 12 to 24 hr. The maximum saturation temperature of the liquid is 121 deg. C. The final washing is done with cold liquor to enable the workmen to handle the residue as soon as the liquor has been drained off.

The end of the lixiviation is usually still determined by the guesswork of the foreman. The only data which might logically indicate the actual saturation point of the wash liquor could be obtained only by chemical analysis; but the local conditions are such that analyses vary from batch to batch and therefore are of little value in actual practice. It is therefore of common occurrence to have either an incomplete washing with loss of nitrate in the residue or an excess of washing with additional heat consumption. The residue is sometimes re-treated, but usually it goes to the waste pile.

CLARIFICATION AND DECANTATION

The clarification tanks are of sheet iron, rectangular, 4 to 5 m. long x 2 to 3 m. wide x 1 to 2 m. deep (13 to 16.5 x 6.5 to 10 x 3.3 to 6.5 ft.). The bottom is inclined, the slope being 4 to 5 per cent lengthwise. The capacity of the tanks is usually sufficient to receive the saturated liquor resulting from previous 24-hr. operation.

The settling time for the liquor depends on the amount of insolubles in suspension, on the nature of these insolubles and on the temperature. All these factors vary from batch to batch, with the result that the clarification time may vary between ten minutes and many hours.

An important efficiency factor is to maintain the temperature as nearly constant as possible and at a degree which corresponds exactly to that required for the realization of a nitrate-saturated liquor. Many reagents are used to accelerate the settling of the insolubles, especially of the colloids. Among the more commonly used are: ammoniacal water, sodium carbonate, lime water, guano, manure, flour, animal glue. The action of these reagents is not yet explained in a satisfactory manner.

A symptom which is generally taken as indicating the end of the clarification period is the formation on the

surface of a thin layer of crystals of nitrate. As soon as this takes place the liquor is decanted into the crystallization tanks.

CRYSTALLIZATION

The crystallization tanks are of heavy sheet iron 4 to 6 m. x 3.5 to 4.5 m. and about 1 m. deep (13 to 19.5 x 11.5 to 14.5 x 3.3 ft.). The bottom is inclined, the slope being 2 to 4 per cent crosswise, and is provided with two to four outlets. The total capacity of the crystallization tanks is sometimes three times but usually about twice that of the lixiviation tanks; but, due to the poorer quality of the caliche now to be treated, the tendency is to equalize the capacities of the lixiviation and crystallization tanks. The liquor is kept in the crystallization tanks for five to eight days at atmospheric temperature. Theoretically the liquor ought to contain at the maximum 400 g. nitrate per liter of solvent (at the average night temperature of 10 deg. C.) and there should be no precipitation of sodium chloride, but due to the great amount of evaporation which takes place (3 to 4 per cent of the volume) there results a concentration which sometimes passes the sodium chloride saturation limit.

There are plants where the crystallization tanks are made up to 3 m. deep where the cooling take place with a smaller loss in evaporation, thus giving purer nitrates. The evaporation of the mother liquor ought to start only when there is no more precipitation of nitrate.

The nitrate crystals are separated from the walls and bottom and placed on inclined drain boards (falcas), whence the drained crystals are transported to be dried and packed for shipment.

During this operation care is taken to obtain only the deposition of nitrate, but this is seldom achieved, and the product is more or less contaminated with sodium chloride. This salt is separated by "refining," which consists simply of sprinkling the nitrate with fresh water or with water saturated only with nitrate. The water dissolves the chloride and is returned to the evaporating tanks and the refined nitrate is dried and packed for shipment.

SEPARATE TREATMENT OF PULVERIZED MATERIAL

It has been mentioned above that in some plants the crushed material is screened before it is charged into the lixiviation tanks and that the powdered material is placed on top of the coarser material in the tanks or is treated separately. This last treatment is still in the experimental stage.

The pulverized material is made up into a more or less loose mud and the insolubles are separated by mechanical thickeners, by filtration, by centrifuging, or by a combination of these agencies.

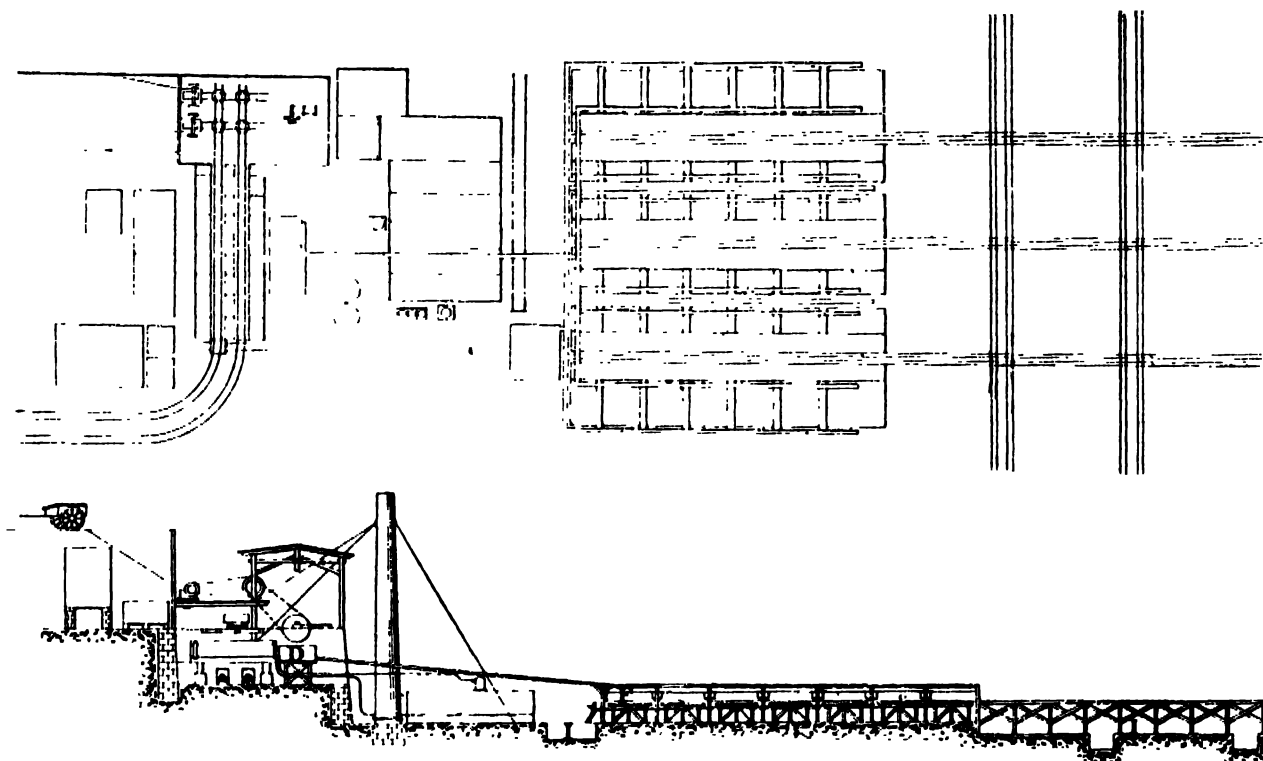


FIG. 1. TYPICAL CHILEAN NITRATE PLANT

The thickeners are of American make. The solids suspended in the liquid are submitted merely to a wet classification in cylindrical tanks with conical bottoms. The clarified liquid is decanted at the top and the thickened mud is evacuated at the bottom. This mud is generally passed through rotary filters and submitted to alternate suction and pressure. The rotation of the filter is slow (about one revolution per seven minutes with the Oliver type).

When no preliminary mechanical thickening is employed the filters used are of the "Butters" system. They consist of big leaves composed of a double layer of filter cloth which are immersed in the mud which is to be treated. The mud is heated somewhat and the space between the filter cloth layers is submitted to alternate vacuum and pressure. The results obtained with these filters are very encouraging.

Another method of treatment of the mud consists in the use of the "Burt" filter, which is a cylinder about 12 m. long (40 ft.) with an interior cylinder of filter cloth. The material to be treated is introduced in the inner cylinder and submitted to a pressure of 4 kg. per

sq.cm. and the cylinder is rotated at a speed of five revolutions per minute. The combination of pressure and centrifugal force accelerates the filtration. To clean the filter the pressure is applied to the outer side of the filter cloth, the rotation is increased, and the cake which is thus detached from the cloth is evacuated by the use of an Archimedean screw.

Of these methods the only one which gives highly encouraging results is the Butters method, first introduced in 1913. By its use it has been possible to increase the efficiency of a 15 per cent caliche from 7.5 to 10 per cent and to lower the operating cost about 20 per cent.

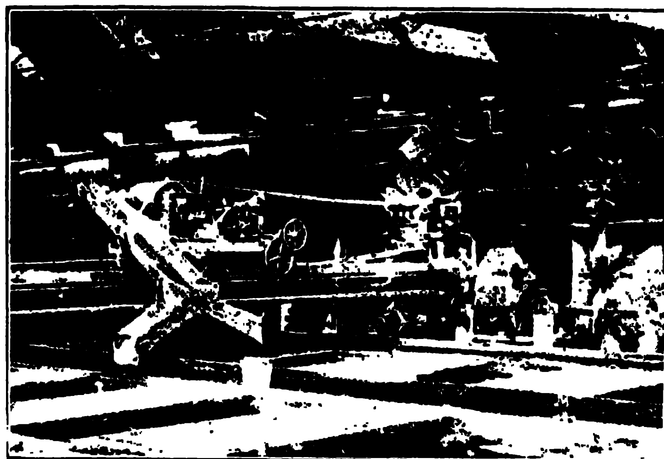


FIG. 2. WASHING, MECHANICAL DISTRIBUTION OF THE CALICHE

Production of Iodine

The caliche contains from 200 g. to 2 kg. iodine per ton in the form of a soluble salt, which during the cycle of operations outlined above is concentrated in the final mother liquor to about 8 g. per liter; but a part of the original iodine in amounts up to 250 g. per ton is found in the commercial nitrate as sodium iodate. Although the annual total amount of iodine in the caliche treated is over 5,000 tons, the actual annual iodine production before the war reached only about 500 tons, and the maximum ever produced was 1,000 tons, in 1916.

The process now used for the subtraction of the iodine is by treating the solution of sodium iodate with sulphurous acid, with the formation of soluble sodium sulphate and a precipitation of iodine. Care must be taken not have an excess of the reagent. In practice, instead of the sulphurous acid gas, sodium bisulphite is used. Here also an excess of reagent is to be avoided, otherwise soluble iodic acid is formed and lost. The bisulphite is prepared at the plant from sodium carbonate, nitrate, carbon and sulphurous acid. The last is obtained by burning the sulphur which is found in the nitrate district.

The precipitation of iodine takes place in wooden or tin sheet tanks. An excess of reagent with the resulting loss of iodine is easily discernible by a violet color of the mother liquor.

The operations subsequent to precipitation are filtration, compression and sublimation.

Potassium Nitrate

All the caliches—without exception—contain potassium nitrate from traces up to 4 per cent and some contain even as high as 10 per cent. A reasonable average would be 1 per cent.

The separation of the potassium nitrate from the sodium nitrate is accomplished by fractional crystallization. The saturation curves of these two salts cross each other at 66 deg. C. Above this temperature the potassium salt is the more soluble, but below this temperature the solubility of the potassium salt diminishes; thus at 20 deg. C. it is only a third, at zero deg. C. a sixth and at —15 deg. C. a twentieth of the solubility of that of the sodium salt. In some plants part of the potassium nitrate, amounting to 20-25 per cent of the total output, is crystallized out at the average atmospheric temperature. By a subsequent cooling to —15 deg. C. the separation of the potassium nitrate is quite complete, leaving in the final sodium nitrate only 5.5 per cent of the original total potassium salt contents.

Accessory Installations

Some of the nitrate plants are thoroughly modern in every way and the plants of the American du Pont de Nemours Co. and of the Chilean Antofagasta Co. have introduced the most modern improvements and constitute chemical plants which might well compare with the most up-to-date chemical works to be found anywhere. The same might be said about the organization and the welfare of the employees and their families.

Technical Progress in the Chilean Nitrate Industry

No substantial change in the method of working has been introduced during the last forty years, although a great many efforts are being made to find efficient improvements. More than 300 patents related to the Chilean nitrate industry have been taken out in Chile on about 500 new processes and on modifications in the old ones. About 34 per cent of all these patents deal with the stage of lixiviation, some proposing to activate lixiviation by mechanical methods (rotation, agitation, etc). Others propose preliminary classification of the raw material, to dispense with heating, to render the operation continuous, to operate in closed tanks under pressure or under a partial vacuum, to install the lixivia-

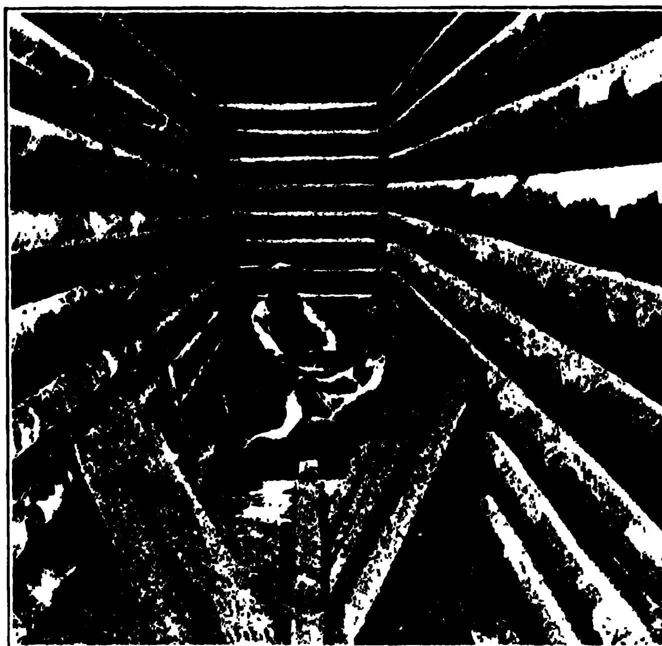


FIG. 3. INTERIOR OF AN EMPTY TANK

tion plants near the mines and instead of transporting the run of mine to the plant to pipe the saturated liquor to the plant, which might thus be located near the export harbors, etc. About 27 per cent of the patents refer to the different phases of the recuperation of the nitrate by evaporation and crystallization; about 10 per cent deal with a better use of the heat, and about the same amount of patents propose special methods for the treatment of pulverized caliche and of the residue. The remaining 19 per cent of the patents refer to the recovery of byproducts, such as iodine, potassium nitrate, etc.

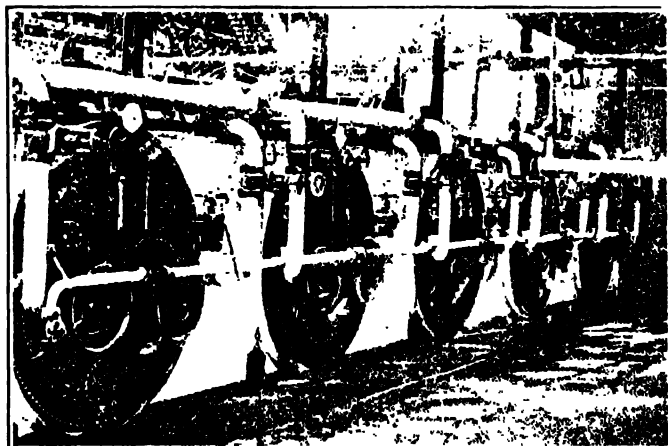


FIG. 4. MODERN OIL-FIRED BOILER INSTALLATION

Although the patents, especially those referring to lixiviation, have not proved successful in practical application, some have led the way to partial improvements.

Among the patents which have been experimented on and which promise to become practically successful, there is one which deserves especially to be mentioned. It is that of two Chileans, Messrs. Prieto and Matus. The fundamental principle of this patent is to attach to the evaporating tank a mechanical arrangement consisting of high-speed rotating horizontal shafts provided with paddles. These paddles "skim" the surface of the liquor, the skimmed liquor is "atomized" and a strong current of hot gas carries away the moisture from the atomized products, thus effecting instantaneous "concentration."

NEED OF A TECHNICAL ORGANIZATION

The main reason, and it might be said the only reason, why the great efforts illustrated by the vast amount of patents have not been more successful is that there does not exist a technical organization commensurate with the importance of the industry, to collect the useful data of past and present experience in the industry and co-ordinate them to serve as guides for further progress. Such an organization is what is most needed at present to reduce the cost, increase the efficiency and put the Chilean nitrate industry on a technical footing which could be compared with that of the competing industry of synthetic nitrogen products.

ECONOMIC IMPORTANCE OF THE DIFFERENT STAGES OF THE NITRATE INDUSTRY

The following table shows the extreme variations in the distribution of the cost from the mine to the drier per unit of nitrate produced:

	Per Cent
Mining	22-35
Transportation to the plant	10-15
Operation at the plant	60-45
General expenditures	8- 5
	100 100

If instead of figuring on the unit of nitrate the comparison is made on the basis of the caliche treated, the above figures become:

	Per Cent
Mining	29
Transportation to the plant	17
Operation at the plant	49
General expenditures	5
	100

These figures relate to pre-war costs. With the present cost of fuel the distribution of the price per unit of nitrate is about:

	Per Cent
Labor	42-25
Fuel	50-60
Water	5-10
Material, upkeep	3- 5
	100-100

A summary of the cost figures in percentages showing the economic importance of each stage of the operation is as follows:

	Per Cent
Supervision	1.5 3
Crushing, transportation	6 -10
Lixiviation	3 - 5
Ejection of refuse	6 -10
Crystallization	1 - 1
Drying, etc	1.5- 4
Fuel (total)	50 -60
Water	4 -10
Material for repairs	3 6
Shop work	5 - 7

PROBLEMS TO BE CONSIDERED IN THE FUTURE CHILEAN NITRATE INDUSTRY

Reserves of Caliche. Up to now there has not been made any elaborate survey of the nitrate zone. The following figures give what according to reliable authorities might be considered as being the total workable raw nitrate in the Chilean nitrate fields with the percentages of caliche:

Millions of Tons of Raw Nitrate	Percentages of Caliche
9	45-38
18	38-32
32	32-25
51	25-18
80	18-10
130	10- 8
320	

These figures would indicate that at the pre-war rate of consumption the reserve is sufficient to provide for the world's consumption for more than 100 years.

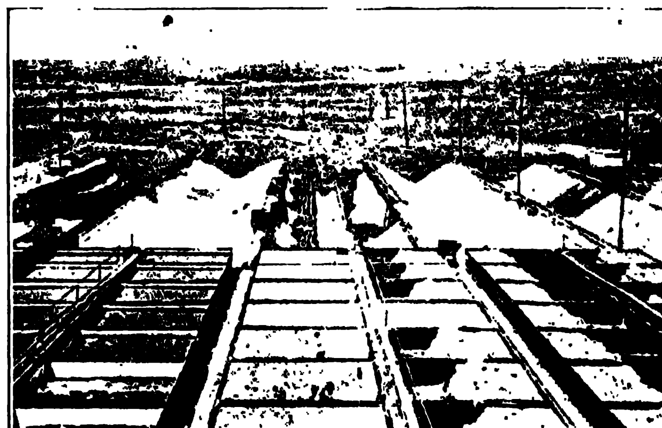


FIG. 5. CRYSTALLIZING TANKS

Water. At present from 200 to 300 l. of water are required per metric quintal of nitrate, which indicates that from 10,000,000 to 12,000,000 tons of water is needed annually to supply the nitrate industry. This amount is amply available from the Rio Loa and

especially from the underground waters which according to the exploration results are abundant in the region. But the technical problem to be solved is the purification of this underground water, because it contains 0.1 to 0.3 per cent and even as high as 1 per cent of sodium chloride besides chlorides and carbonates of magnesium and calcium, which are scale producers and very harmful to the life of the boilers and evaporators.

Fuel. The present annual consumption of fuel, including that required by the railways of the region, amounts to more than 300,000 tons of coal and 800,000 tons of oil, all of which have to be imported. A point which requires special study is that although theoretically only about 200 calories would be required for the recovery of 1 kg. of nitrate, in reality more than 1,100 calories are used now per kg. of nitrate.



FIG. 6. GENERAL VIEW OF DRIERS

Steam and Mechanical Energy. The more economical production of high pressure steam (source of energy) and of low pressure steam (source of heat), the substitution of heating by gas, the utilization of the Rio Loa hydraulic power (4 cu.m. per sec. with a head of over 1,500 m.) constitute as many problems to be solved.

With a caliche of 18 per cent nitrate, the consumption of energy is 1 kw.-yr. per 1,000 tons of nitrate.

The uses of the energy may be classified as follows:

	Per Ce
Crushing, transportatic	70
Circulation of liquids..	15
Shops	5
Light	10

Until a few years ago every plant had its own electric power house. Now there are a few central stations supplying the needs of the region. Much remains to be done in the erection of hydro-electric or thermo-electric central stations.

Substitution of Mechanical Power for Hand Labor. The substitution of mechanical power for hand labor has not shown any economical improvement, although a laborer who was paid 3 f. (about 60c.) per day in 1900 and about 6 f. (about $1.20) per day in war time gets even more now, but it may be expected that in the near future mechanical appliances instead of manual labor will find wider uses in the Chilean nitrate industry.

Other Problems. Among the other problems to be considered are: Preliminary treatment at the mine, lowering the percentage of waste, efficient evaporation in the air, making the fractional crystallization and drying operations rapid, automatic and continuous, better uses of gravity railways, shipment of nitrate in blocks or briquets instead of in sacks.

Durability of Electric Heaters for Gasoline Distillation*

By W. A. Jacobs† and E. W. Dean‡

THE petroleum division of the Bureau of Mines, in its laboratory investigations, has had occasion to develop a number of types of electrical heating equipment. It was found that electric heaters could be used to particular advantage in the standard distillation test for gasoline.[1] In order to assist in rendering this type of heater available for general use, a description of the apparatus developed by the Bureau was published.[2] Shortly after the article was printed a chemical supply house undertook the manufacture of an electric heater suitable for gasoline distillation. A preliminary model was examined and tested by the Bureau and modifications were suggested that were incorporated in the type of heater that was finally marketed.

The electric heater developed by the Bureau has an inverted conical resistance element surrounded by a layer of heat-insulating material and mounted in a metal case having a top of hard asbestos (Transite) board. The resistance element is a helix of nickel-chromium alloy wire held by a molded core of alundum. The Bureau heaters are generally of about 330 watts capacity and are used with stock types of regulating rheostats capable of reducing the effective wattage to about one third the full-load maximum.

The commercial heater has a helix of nickel-chromium alloy wire resting in a spiral groove cut in a depression in a block of heat-insulating composition. The coils of wire are held in place by a special cross of sheet mica. The combination of resistance element and heat-insulating layer is mounted in a metal case which also incloses a regulating rheostat. The full-load capacity of this heater is about 260 watts.

Comparison of the Bureau of Mines Type and Commercial Type of Heaters

Both types of heaters have been used in the Bureau laboratories, and are capable of doing about the same work. The lower apparent capacity of the commercial heater is compensated for by its greater thermal efficiency, which is due to the detail of construction involving coils held lightly by grooves in a block of heat-insulating material. The commercial heater was somewhat more satisfactory to use, because of its more rapid response to changes in current, as controlled by the rheostat, and because of the latter's convenient location.

Tests have been made to determine the life of the two types of heaters, each operated at full-load capacity. The results were briefly as follows:

	Amp.
Commercial heater:	
Initial current consumption with 110-volt alternating current..............................	2.3
Current consumption, end of 500 hr. running..	2.1
Burned out after exactly 500 hr., apparently because the insulating block had disintegrated so that the coils of wire short-circuited.	
Bureau of Mines heater:	
Initial current consumption with 110-volt alternating current..............................	3.0
Current consumption at end of 500 hr.........	2.4
Burned out at end of 505 hr., apparently because one small length of wire overheated.	

*Reports of Investigations, U. S. Bureau of Mines.

†Assistant Chemist, Bureau of Mines.

‡Organic Chemist, Bureau of Mines.

[1]Dean, E. W., "Motor Gasoline, Properties, Laboratory Methods of Testing and Practical Specifications," Bureau of Mines Technical Paper 214, 1919. 33 pp.)

[2]Dean, E. W., "A Convenient Electric Heater for Use in the Analytical Distillation of Gasoline," *J. Ind. Eng. Chem.*, vol. 10, 1918, p. 823.)

These results indicate that under conditions of the test the two heaters were practically equal in durability. The commercial heater failed evidently from deterioration of the insulating block, whereas the Bureau of Mines heater failed from destruction of the resistance wire at one spot, where overheating may have occurred or where the wire may have been defective. The slow deterioration of wire in the commercial heater, which is also indicated by a smaller falling off in current consumption, was to have been expected on account of the lighter load it had to carry.

In actual service, the commercial heater probably would have burned out in a relatively shorter time than under test conditions because disintegration of the insulating block would have been accelerated by movement and jarring. The Bureau heater, on the other hand, failed through destruction of the wire, which would not have been accelerated by movement.

Summary

A Bureau of Mines electric gasoline distillation heater and a commercial device sold for the same use were subjected to life tests at maximum current load. Each failed at the end of approximately 500 hr., the Bureau heater through deterioration of the resistance wire, and the commercial heater through disintegration of the block of insulating material holding the resistance wire.

The commercial heater probably would have failed in actual service in somewhat less time than the Bureau heater.

The life of either heating element would not necessarily be the same in actual service as under the conditions of the test described, but is sufficiently great to render the cost of replacements a negligible part of the expense of making distillation tests on gasoline.

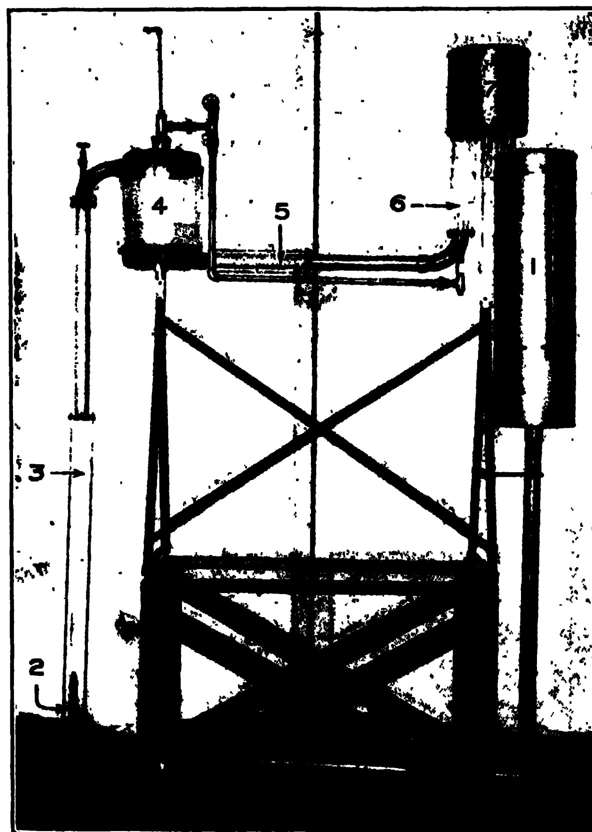
Air Lift Pumping

The wide application of the air lift pumping principle to the handling of acids and chemical solutions as well as of water from deep wells promotes a constant interest in anything regarding this system of pumping.

At the Chemical Industries Exposition in New York next month, the Sullivan Machinery Co. will show an operating model of its air lift system, illustrated by the accompanying cut.

This model is operated by a small, vertical, air-cooled air compressor, belt driven by a ½-hp. electric motor. In this model the well or other source of supply is represented by the vertical copper chamber 1. Water flows by gravity from this through the pipe at the bottom of the model, over to the riser 3, which is made of glass to show the operation of the lift. Air is introduced into this riser or eduction pipe at the base through the Sullivan footpiece or pump 2, which is a taper brass fitting with numerous holes, to permit the discharge of the water upward. In handling acid or other chemicals this part is made of resistant material such as cast iron, cast steel, hard rubber or lead. The water in the eduction pipe, being aërated by the introduction of air, rises in the tube into the chamber 4, which is a model Cyclone Booster made of glass. The air is given a swirling motion by the introduction of water at a tangent to the circumference of the chamber; this has the effect of separating the air from the water.

A certain portion of the air is permitted to escape through a vent valve, the remainder exerting a back pressure on the water in the Booster chamber and forc-



MODEL OF AIR LIFT PUMPING

ing it along the horizontal discharge line 5. Frequently in actual practice discharge above the surface is desired. The Booster is able to handle work of this sort, using the same air which raised the water or acid from the pump or well. To assist this action, particularly in cases of high discharge, an auxiliary jet or re-lift jet 6 is frequently used. In this case a portion of the air from the Booster is carried in a pipe parallel to the discharge line, as shown in the model, and introduced into the riser by means of a small pump or foot-piece, which is also shown. The tank 7 represents the storing station or collecting tank, from which the water or acid is handled by gravity or other pump to its final destination.

Dominion Oxygen Co., Ltd., Completes Initial Plant

The sensational development of Canadian industries in pre-war days was a weak and toddling growth compared to the mighty strides the Dominion is making industrially today. From 1905 to 1915 the capital invested in Canadian factories increased more than 135 per cent and the value of factory products advanced roughly from $700,000,000 to $1,400,000,000. It would be rash to attempt an estimate of Canada's industrial growth since 1915, but it is not a guess to assert that the Dominion has forged ahead industrially as never before in its history.

One of the most important recent announcements bearing on Canada's future industrial development is that of the Dominion Oxygen Co., Ltd.'s, promised erection of a chain of great oxygen plants for separating oxygen from the atmosphere. These plants will be situated in five of the Dominion's industrial centers, and service stations will be established throughout Canada to supply oxygen users wherever there is a demand for the gas, either on or off the railroad.

The first of these plants has already been completed at Toronto, and it is said to be the largest oxygen plant ever built in Canada. It will supply the Canadian market through an extensive warehousing system, pending the erection of the additional plants. The sites for these additional plants have been secured at Montreal, Winnipeg and other points, so that the work of construction may be prosecuted as rapidly as possible.

A Laboratory High-Temperature Coke-Resistance Electric Furnace

BY W. FAITOUTE MUNN

FROM time to time variously constructed furnaces heated by means of an electric current are required for laboratory research. Most of them are heated by wrapping a layer of wire, of high melting point, around the refractory substance and then passing the current through the resistor until the desired temperature is obtained. It is obvious that the maximum temperature from such a furnace depends chiefly upon two things—namely, the melting point of the wire used as the heating element and the nature and the melting point of the refractory substance with which the wire is in contact. The result is that temperatures often desired in the experimental laboratory cannot be obtained by this means or type of furnace. As the setting up of the larger and greater capacity electric furnaces usually requires special wiring and considerable expense, the work is generally abandoned and perhaps an excellent idea is set aside.

For temperatures up to 1,500 deg. C. there is not much difficulty in obtaining or making a laboratory electric furnace. For temperatures of 1,800 deg. C. and higher not much information has been given as to the construction of a furnace on a laboratory scale which will not only be inexpensive to make and to operate but also be easily raised to the maximum temperature in a minimum of time.

S. A. Tucker[1] has described a granular carbon-resistance furnace designed for 30 to 35 kw. which in general is similar to the one about to be described, but which would not be convenient for a small laboratory. The voltage, controlled by means of varying the field winding of the alternator, is excellent if the energy is produced in the immediate vicinity of the furnace, but if this is not possible, the alternative, using an auto transformer or an impedance coil for resistance, adds to the bulk of equipment and to the cost of installation.

The Borcher furnace[2] also probably belongs to this class of furnace, but instead of being heated by means of coke particles, the temperature is obtained by passing the current through a small carbon rod connecting the graphite electrodes. This arrangement would not be the proper one for heating substances in crucibles.

A convenient laboratory electric furnace for temperature up to 2,300 deg. C. is that of the granular coke-resistance type using 1-in. graphite electrodes and a 1¼-in. graphite crucible.[3] The rods, which are supported by suitable sized pipe-fittings, pass through Silocel brick and continue to within about 1½ in. of the crucible. Granulated coke is used to fill the space around the graphite electrodes and crucible. The graphite crucible is made by sawing off a length of graphite rod of desired diameter and drilling out the center by means of a lathe or with a wood bit of 1-in. diameter by hand. The entire furnace is constructed of 9 x 4½ x 2½ in. Silocel blocks.

The furnace is heated by means of an air-cooled, step-down 2.5 kva. auto transformer. The primary is wound for 220 volts, having eight different taps for connections which enable a voltage range of from 20.7 to 38 volts on the secondary. This arrangement does not require the use of any outside resistance, as the current and temperature are controlled by means of the various contacts on the primary winding and also by varying the pressure of the electrodes on the granulated coke between the electrodes and the crucible. The transformer is connected to the furnace electrodes with stranded No. 0 copper cable.

The voltage and corresponding amperage for the eight steps on the primary winding are as follows:

Volts	Amp	20 per Cent Overload, Amp	Volts	Amp	20 per Cent Overload, Amp.
38 -	65	78	27 5	90	108
35 -	71	85	25 2	100	120
32 7	76	91	22 8	109	130
30	83	100	20 7	120	144

The amperes as given in the 20 per cent overload column may be drawn for short intervals (20 to 30 min.) without disastrous results on the transformer.

Temperatures as high as 2,200 to 2,300 C. have been obtained with the above, from a cold start, in 20 min. The cost of running is not over 30c. an hr. figuring 10c. a kw.-hr.

East Orange, N. J.

[1]"A Granular Carbon Resistance Furnace," by S. A. Tucker, *Trans.*, Amer. Electrochem. Soc., vol. 11, p. 307 (1907).

[2]"The Borcher Furnace," by F. A. J. FitzGerald, *Electrochem. & Met. Ind.* (1905), p. 215.

[3]If graphite should be injurious to the substance being heated, the crucible may be lined with MgO, CaO, Al_2O_3, ZrO_2, etc., to prevent any action which might be caused by carbon.

Use of Acetylene in Chemical Laboratories

The use of acetylene in chemical laboratories is rendered convenient by the adoption of an equipment placed on the market by the Prest-O-Lite Company.

The acetylene flame is sufficiently hot to bring about chemical reactions in the most refractory of substances, is economical and is ideal for convenient handling. The equipment is very compact, comprising only the familiar Prest-O-Lite tank and flexible hose to connect it to the burner. Used with the bunsen burner, acetylene produces an intense local heat exceeded only by the electric arc and the oxy-acetylene flame, and if it were desired to use the oxy-acetylene flame it would be necessary only to add a cylinder of oxygen, reducing regulator and blowpipe. When the gas is exhausted the acetylene tank is detached and a full tank is put in its place.



LABORATORY EQUIPMENT FOR THE USE OF ACETYLENE

Synopsis of Recent Chemical & Metallurgical Literature

Manufacture of Carbon Dioxide.—Very little has been published concerning the methods used in the United States for the production of carbon dioxide. Since it is estimated that over 100,000,000 lb. of liquid CO_2 is produced annually in the United States and Canada, the following outline of the process of manufacture, from a paper by G. H. TOMLINSON in the *Canadian Chemical Journal* for July, 1920 (p. 189), will undoubtedly be of interest:

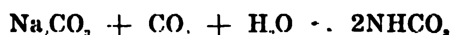
The coal or coke used in its production is burned in the usual way under steam boilers, thus furnishing not only the raw material of manufacture but also all the power required for its purification and liquefaction. The flue gases leaving the boilers are first passed through an economizer to reduce their temperature and then through scrubbers to remove dust and sulphur dioxide. From these they go to an absorption system in which contact with an alkaline carbonate solution is effected and as much as possible of the CO_2 combined. The carbonated lye is drawn from here and pumped through a heat regenerator. It is then passed to the economizer, and, following this, is used to condense the steam given off with the CO_2 during the final heating. Its temperature is thus raised to the boiling point by otherwise waste heat alone. The "boiling off" is effected by utilizing the exhaust steam from the compressors, etc., which in a properly balanced plant is sufficient to maintain the necessary heat balance. The decarbonated or exhausted lye returns through the heat regenerator, giving up its heat to the carbonated lye, before again passing to the absorption system to renew the cycle just described.

The CO_2 which is liberated from the boiling bicarbonate solution is separated from the steam as previously noted, and after further cooling is compressed into the cylinders in which it goes to the trade.

From this description it can be seen that the two main objects to be accomplished for the successful working of the process are:

1. The recovery from the combustion gases of the maximum amount of CO_2 by bringing this into combination with the alkaline carbonate.
2. The maximum dissociation of the bicarbonate thus formed with the minimum consumption of heat.

A study of the reversible reaction



$$Na_2CO_3 + CO_2 + H_2O \rightleftharpoons 2NHCO_3$$

requires measurements of the dissociation tension of CO_2 for bicarbonate solutions at various temperatures. While such data are available for pure solutions of sodium and potassium bicarbonates (see accompanying table), in the commercial process mixtures of carbonate and bicarbonate containing from 30 to 75 per cent of the latter are encountered. Complete dissociation tension-temperature curves for such mixtures have not been determined. However, it is possible to make certain general deductions on the assumption that the dissociation tension will be higher as the temperature and the proportion of bicarbonate increase.

Let x = pressure of CO_2 in combustion gases entering absorption system.
x_1 = pressure of CO_2 in waste gases.
y = CO_2 tension of exhausted lye solution.
y_1 = CO_2 tension of carbonated lye.

The best recovery of CO_2 from the combustion gases will result when x is a maximum and x_1 a minimum. Similarly, the most favorable conditions for recovering CO_2 from the lye solution are y_1 a maximum and y a minimum. Now x will normally have its greatest value when the percentage of CO_2 in the gases approaches 20 and y will have its lowest value the more completely the lye is boiled and the lower the temperature at which absorption is commenced. In order to conserve heat the volume to be boiled must be reduced as much as possible by using concentrated lye solutions. The highest efficiency will be obtained when $x = y_1$ and $x_1 = y$. In practice this results when sufficient time is provided for the absorption (which should be conducted on the counter-current principle) and when the amount of carbonate present is exactly adjusted to the amount of CO_2 available.

SSOCIATION TENSION OF BICARBONATE SOLUTIONS

Temp. Deg. C.	Dissociation Tension	
	$NaHCO_3$ mm. Hg	$KHCO_3$ mm. Hg
15	120	461
30	212	...
40	356	...
50	563	...

From the accompanying table it will be seen that y is lower for sodium bicarbonate than for potassium bicarbonate. However, the limited solubility of the sodium salt is a disadvantage and a mixture of the two salts is found to be more efficient than either alone.

Theoretically, 1 lb. carbon should yield 3.66 lb. CO_2. Commercial results vary between 1 and 1.5 lb. CO_2.

On the Oxidation of Coal.—During the last few years a number of chemists have worked on the problem of determining facts which might help to establish the constitution of coal. The theory now predominating is that coal contains three constituents; namely, compounds of lignocellulose, proteins and resins. It is also known that pyridine dissolves only the resinous constituent. It has also been determined that coal oxidizes slowly in the cold, more rapidly at 100 deg. C., and that by this oxidation the coal loses its coking property. Boudouard attributes the coking power of a coal to a substance or a group of substances which by oxidation form humic products soluble in potash and giving a brown solution. According to recent theories the oxidation is produced by the intervention of special bacteria which start the reaction.

MARCEL GODCHOT has studied the mechanism of the oxidation of coals and presented the results of this work to the French Academy of Sciences *(Comptes rendus*, July 5, 1920, pp. 32-34). He worked on Blanzy coking coal of the following composition: 37.4 per cent volatile matter, 58.6 per cent fixed carbon and 4 per cent ash. The ultimate analysis on the ash-free basis is: Carbon 83.59 per cent, hydrogen 5.78 per cent and oxygen plus nitrogen 10.67 per cent. A 100-g. sample of the coal was treated with boiling pyridine. The brown amorphous pyridine extract obtained weighed 22.63 g. and its composition was: Carbon 83.45 per cent, hydrogen 5.84 per cent and oxygen plus nitrogen 10.51 per cent. Comparing these figures with those for the original sample, it is seen that

their compositions are quite identical. An important fact is that the coal after extraction with pyridine cannot be coked, but by mixing this coal with the pyridine extract the product becomes again just as good a coking coal as the original sample.

Samples of the original coal, of the coal extracted with pyridine and of the pyridine extract were kept for one month in an oven at 100 deg. C. The increase in their weight was respectively 3.15, 1.99 and 1.22 per cent. A mixture of an extracted sample of coal with its pyridine extract submitted to the same heat for the same length of time showed an increase in weight of 3.20 per cent, which is identical with the increase in weight of the original coal. All these oxidized samples give with potash a brown coloration.

After a study of these facts it is difficult to admit that the oxidation of the coal is the result of the action of bacteria pre-existing in the coal, because pyridine is a strong antiseptic, and still the pyridine-extracted coal, the pyridine extract and their mixture are readily oxidized. It seems that pyridine has broken up the coal into two separate oxidizable parts, of which one part plays the role of an oxygen carrier because the original coal and the reconstituted mixture oxidize more rapidly and in greater proportion than the two parts separated by pyridine treatment. The coking property of the coal is due to the constituent which can be extracted by pyridine—i. e., to the resinous constituent of the coal.

Recent Chemical & Metallurgical Patents

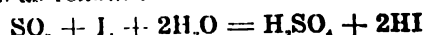
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Sulphur Dioxide.—The removal, and subsequent disposal, of sulphur dioxide from the gases of metallurgical plants is a problem which is becoming increasingly important. The production of sulphuric acid from these gases is not difficult, but sulphuric acid is a cheap and bulky commodity, the sale of which is confined to local markets; and its use, except in particular sections of the country, is limited as to quantity. The demand for liquid sulphur dioxide in manufacturing processes is increasing. Sulphur has a broader market than sulphuric acid and has the advantage of being more easily handled. Liquid sulphur dioxide is easily produced from concentrated sulphur dioxide gases by direct compression, and the direct reduction of concentrated sulphur dioxide gas to sulphur with coke is comparatively easy. For these reasons the production of concentrated sulphur dioxide gases in metallurgical operations is desirable.

FREDERICK LAIST and FREDERICK F. FRICK of Anaconda, Mont., purpose to produce concentrated sulphur dioxide gases in a practical and economical manner in such metallurgical operations as roasting, nodulizing and sintering and in blast-furnace and converter practice by supplying oxygen diluted with sulphur dioxide instead of air during these operations. The intense action of pure oxygen on sulphide materials is avoided by returning to the furnace a portion of the gases evolved in the roasting operation, the oxygen being added to the cyclic gas in a regulated quantity. Concentrated sulphur dioxide gas may be produced by this method from the usual types of metallurgical furnaces with the addition of comparatively cheap and simple equipment. (1,344,905; June 29, 1920.)

Hydrometallurgical Recovery of Copper by the Use of Iodine.—ARTURO A. OSSA, of Valparaiso, Chile, has invented a process for the recovery of copper from copper-bearing minerals with the simultaneous production of sulphuric acid. The process steps constitute a closed operating cycle in which iodine is an essential and recoverable reagent, being based primarily upon the inter-reactions between solutions of copper sulphate and hydriodic acid in the presence of sulphurous acid. In this reaction a precipitate of cuprous iodide is formed and sulphuric acid set free. The iodine is eventually recovered in a form for reuse in the process and the sulphuric acid is available for leaching oxidized copper ores for the preparation of additional copper sulphate. The sulphur dioxide is ultimately oxidized to sulphuric acid and is also available for leaching. The operation comprises three principal steps:

1. Preparation of hydriodic acid solution. This is conveniently effected by suspending pulverized iodine in water in a closed tank and subjecting it to a current of sulphuric dioxide; or a mixture of iodine vapor and sulphur dioxide may be passed upward through a tower filled with inert material and sprayed with water. The reaction is as follows:



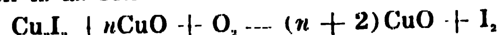
$$SO_2 + I_2 + 2H_2O = H_2SO_4 + 2HI$$

2. Precipitation of cuprous iodide. A solution of copper sulphate, preferably concentrated, is saturated with sulphur dioxide in order to prevent the precipitation of iodine during the subsequent reaction. Sufficient hydriodic acid prepared as described is added to completely precipitate cuprous iodide. The reaction is as follows:



$$2CuSO_4 + 2HI + SO_2 + H_2O = Cu_2I_2 + 3H_2SO_4$$

3. The regeneration of the iodine. The precipitate of cuprous iodide is removed by filtration, washed and then dried by gentle heating. The dried precipitate is mixed with approximately 20 per cent by weight of cupric oxide and the mixture calcined in a closed furnace under oxidizing conditions. The cuprous iodide is transformed into cupric oxide and the iodine set free. The reaction is as follows:



$$Cu_2I_2 + nCuO + O_2 = (n + 2)CuO + I_2$$

The liberated iodine sublimes and is treated for the regeneration of hydriodic acid solution. (1,343,153; June 8, 1920.)

Recovery of Copper From Oxidized Ores.—Oxidized ores of copper are not ordinarily amenable to flotation, and the presence of oxidized minerals in sulphide ores prevent the flotation of a portion of the sulphide particles. Sulphide copper minerals are not soluble in ordinary solvents such as sulphuric acid; on the other hand most oxidized copper minerals are soluble in this reagent.

W. E. GREENAWALT, of Denver, Col., takes advantage of these facts in working out a process for the recovery of copper from ores containing both oxidized and sulphide minerals, of which there are large deposits in the Western states. The ore is pulverized and treated with a dilute solution of sulphuric acid in amount sufficient to dissolve the oxidized copper. The acid pulp in which the sulphides are practically unaffected and

the oxides partly or totally converted into sulphate is agitated with flotation oil and the mixture introduced into an electrolytic cell in which it is subjected to electrolysis and flotation. The gas generated by electrolysis assists in floating the sulphide minerals and by using a high current density a non-adherent copper deposit is obtained on the cathodes; this is floated with the sulphide particles. During electrolysis sulphuric acid will be regenerated dissolving more copper and the ferric salts which are formed will be reduced by the action of the minerals in the pulp. (1,344,127; June 22, 1920.)

Potash Recovery by Metathetical Reactions.—Potash is widely distributed in combination with silica in igneous rocks such as granite, gneiss, feldspar, greensand and leucite, but is recovered with difficulty from such materials, and at an expense inadmissible for use as commercial fertilizers. A common method consists of fusion with relatively expensive chemicals. Such a method is expensive and difficult to conduct mechanically.

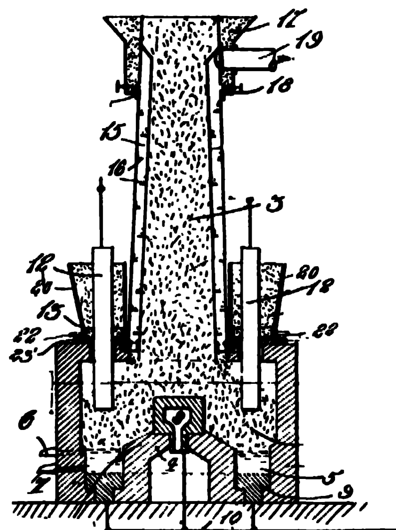
ARTHUR C. SPENCER proposes to utilize the mass action principle for the recovery of potash from potash bearing rocks by treating them with a solution of salt in excess of the potash equivalent in the material, utilizing heat and pressure to hasten the reaction, having found that the substitution of the potassium in the rock by the sodium in the salt proceeds quite readily in aqueous solution at temperatures corresponding to 150 to 300 lb. steam pressure. For instance, heating glassy basalt with a solution of sodium chloride in amount and strength so that somewhat more than two equivalents of sodium are present in the zone of reaction for each equivalent of potassium in the mineral for six hours at 200 deg. C. will result in the substitution of practically all of the potassium in the mineral. It is desirable that the rock be of an amorphous variety, otherwise it is better to heat the material sufficiently to destroy the normal molecular or the crystalline structure, or both.

Certain advantages arise by the use of ammonium chloride and ammonia to bring about the reaction: the reaction proceeds at a lower temperature and a smaller amount of ammonium chloride need be employed, only a small excess over the amount equivalent to the extractable bases being required; the unconsumed ammonia is easily recovered and the excess of ammonium chloride may be decomposed by lime; the amount of water employed can also be greatly reduced. Crude ammonia salts can be used, such as byproducts from coke-oven flues, forming an outlet for the material, which does not require such fixation reagents as sulphuric acid. The ammonia will be fixed in the mineral matter as a result of the metathetical reaction. This can be recovered by heating or the material may be used as a fertilizer. The potash recovered from the solution can be added to this material, which then requires but the addition of phosphate in some form to make a complete fertilizer.

Sodium carbonate or bicarbonate can be used if the escape of carbon dioxide be prevented, and it is possible to use natural brines. In this way such brines, if they contain small amounts of potash, may be enriched. (1,344,830; June 29, 1920.)

Devulcanizing Rubber.—CYRUS F. WILLARD, of San Diego, Cal., has developed a process for devulcanizing rubber which involves certain interesting principles of colloid chemistry. Assuming the "combined" sulphur to be adsorbed by the rubber, the inventor treats the finely ground rubber with another emulsoid colloid solution (such as wood tar emulsified in water) which has a greater affinity than the rubber for sulphur. A sulphur solvent such as turpentine is added and the mixture boiled either in an open kettle or under pressure. Under the influence of the heat and the sulphur solvent, the "combined" sulphur is liberated from the rubber and immediately adsorbed by the tar emulsion. The latter is easily removed from the remaining devulcanized rubber by treatment with 3 per cent caustic soda solution. The whole process may be carried out in one or two steps, as desired. It is claimed that over 50 per cent of the combined sulphur is removed, so that the properties of the recovered material closely approach those of the original rubber before vulcanization. Furthermore, in the case of scrap containing fabric or fiber, devulcanization takes place without destroying the fiber, which can subsequently be separated, if desired. (1,322,077; 1,322,151; 1,322,152; Nov. 18, 1919.)

Electric Zinc Furnace. — FRANCOIS LOUVRIER, of Paimbœuf, France, proposes to produce zinc from its ores in an electric furnace, the design of which is shown in the sketch. Zinc ores are fed into the furnace through the central column 3, which is sealed to prevent the inflow of air. In passing down the column the ore is dried by the heat from the liberated zinc fumes which pass up the annular passage 15 and out through pipe 19 to a condenser. Carbon in the form of powdered coal is fed into the annular passage from hopper 17, being retained on the circular shelves 16. The introduction of the coal dust into the reaction chamber in this manner affords the opportunity for the reduction of any carbon dioxide in the escaping gases. Six electrodes, 12, are provided; these enter the furnace through stuffing boxes 20, also filled with powdered coal; a valve, 22, permits the feeding of the coal into the reaction chamber and the close proximity of the coal to the electrode reduces the consumption of the latter. Beneath the electrodes, 12, is an annular hearth, 5, which is electrically connected through electrode 9. A central electrode, 8, is provided. This arrangement of electrodes provides for the uniform distribution of heat through the charge. Slag and metal are tapped through spouts 6 and 7. (1,342,636; June 8, 1920.)



Potash From Silicates.—EINAR BERGUE, of Notodden, Norway, assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab of Christiania, has been granted a patent on a process for the reduction of $K_2O.Al_2O_3.6SiO_2$ to $K_2S.Al_2S_3.6SiS_2$ or an intermediate product by heating with sulphur vapors at about 800-1,400 deg. C. These sulpho-silicons or silicates are decomposed by water under pressure, giving soluble potash. (1,346,365; July 13, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Utilizing Slag.—Relates to the utilization of blast furnace slag in the production of bricks, blocks, tiles, slabs, door and window frames, baths, sinks, pipes, conduits, and other parts of workmen's dwellings, garages, bungalows, outbuildings, &c., also electric insulators, electric main conduits, the bed-plates of electric generators, curbing, tanks, etc. The slag is broken up, graded, and filled into molds, which are then filled with molten slag so as to bind the particles of graded slag together. The graded slag may be heated, and the molten slag may be mixed with 10 to 15 per cent of silica, lime, or other binding agent, and also metallic oxides for coloring purposes; or the metallic oxides may be applied to the inner faces of the molds. The molds may also be heated and gradually cooled for the purpose of annealing the product. Instead of using molten slag direct from the blast furnace, the molds may be filled with the graded slag mixed or not with other materials such as soda-ash, cryolite, crushed waste glass, iron silicate, etc., having a lower melting point than the slag, and afterward heated to a temperature above the melting point of the slag. A mold having a double wall may be used, the space between the walls being filled with asbestos or other heat-insulating material. Or the graded slag may be placed in an inner mold surrounded by an outer mold into which the molten slag is poured while the inner mold is simultaneously removed, so that a layer of solid slag is formed around the mass of granulated slag; also molten slag may previously or simultaneously be poured among the granulated slag so as to bind the whole together. (Br. Pat. 140,874—1919. T. F. HOARE, Bradford, Yorkshire, May 27, 1920.)

Treating Wood With Liquids.—A process for lightening the color of veneers of colored wood, in imitation of the effects produced on the same wood by the prolonged action of light so that the veneers may be used for repairing or imitating old furniture, consists in treating the wood in an acid bath, preferably nitric acid, then drying the wood at as high temperature as it will stand without charring, and finally rinsing. Rosewood and purplewood are subjected to a preliminary immersion in oxalic acid and rinsed in warm water before treatment in nitric acid. In order to lessen the visibility of the grain, the wood may be immersed in alcohol for 24 hr. previous to the acid treatment. Mixtures of nitric and hydrochloric acids should be used when reddish effects are desired. Amaranth wood is treated for about half an hour in hot water before immersion in nitric acid. (Br. Pat. 141,052—1919. P. E. SIMON, Beauvais, France, June 2, 1920.

Decarburizing Iron and Its Alloys.—Iron and its alloys are decarburized by heating to a high temperature under oxidizing conditions, and then slowly cooling, for the purpose of increasing the magnetic permeability and reducing the hysteresis loss. A low carbon ferrosilicon, for example, with 4 per cent of silicon is heated at 1,050 deg. C. for 13 hr. in a current of air at a pressure 2 mm. of mercury, and has its carbon content reduced from 0.1 to 0.01 per cent or less. The article may be placed in contact with iron oxide during the treatment, and over-oxidation may be corrected by a further heating under slightly reducing conditions. After decarburizing, the article may be forged or rolled and annealed. (Br. Pat. 141,348—1919. METROPOLITAN-WICKERS ELECTRICAL Co., Westminister, June 9, 1920.)

Acrolein.—Acrolein is stabilized by the addition of minute quantities of phenols, e.g. from 0.1 to 1 per cent of pyrogallol, pyrocatechol, hydroquinone, gallic acid, tannin, etc. (Br. Pat. 141,361—1919. C. MOUREU, C. DUFRAISSE, P. ROBIN and J. POUGNET, all of Paris, June 9, 1920.)

Artificial Leather.—Artificial leather is made from paper, alone or combined with a textile fabric, by treating with a vegetable glue such as is obtained from bananas, or from the farina of *Colocasia esculadium*, mixed with water containing 25 per cent of glycerine, with or without the addition of isinglass, casein, gum damar or other agglutinant. The material is then air-dried and may be dyed. The material so treated may be waterproofed with a mixture containing a vegetable wax such as carnauba, mixed, for example, with paraffine wax and turpentine. A number of sheets may be superposed, and the material may be finished to give it the appearance of ordinary leather. (Br. Pat. 141,385--1919. G. MILLER, Meopham, Kent, June 9, 1920.)

Deoxidizing and Refining Aluminum and Its Alloys.—For deoxidizing and refining aluminum and its alloys, an aluminum cartridge containing potassium phosphide is first added to the metal heated above its melting point, to convert the impurities, silicon, iron and oxygen, into phosphorus compounds; then, at a higher temperature, a second aluminum cartridge, containing one of the metals of the alkaline earths or lithium, is added for the purpose of decomposing the phosphorus compounds, which burn at the expense of the alkaline earth metal, and the oxides formed float on the surface of the aluminum. (Br. Pat. 141,-324—1919. A. STRASSER, Borschach, Switzerland, June 9, 1920.)

Sulphuretted Dyes.—A black dye is obtained by boiling 1:2:4 dinitrophenol with sodium sulphide solution and sulphur in the presence of phenol or cresols. (Br. Pat. 141,759—1919. H. R. VIDAL, Asnières, France, June 16, 1920.)

Monoazo Dyes.—Monoazo dyes are obtained by coupling an aromatic diazocarboxylic acid with the n-methyl-ω-sulphonic acid derivative of an aromatic aminocarboxylic acid (capable of being coupled and diazotized) and finally eliminating the methyl-ω-sulphonic acid group. The products are mordant dyes, dyeing wool yellow to orange shades and giving similar tints on chrome-printed cotton, and may be used as parent materials for secondary disazo dyes. Examples are given of the preparation of 4-aminoazobenzene-3:3'-dicarboxylic acid, 4-aminoazobenzene-2:3'-dicarboxylic acid, 4-aminoazobenzene-3:4'-dicarboxylic acid, and 4-aminoazobenzene-3:2'-dicarboxylic acid.

N-methyl-ω-sulphonic acid derivatives of the aminocarboxylic acids referred to are prepared by heating a solution of the sodium salt of the aminoacid with sodium formaldehyde bisulphite solution. (Br. Pat. 141,643—1919. SOCIETY OF CHEMICAL INDUSTRY, Basel, Switzerland, June 16, 1920.)

Aluminates.—Sodium, barium, calcium and other alkali and alkaline-earth aluminates.—Calcium aluminate practically free from other oxides is produced by heating bauxite or other aluminum ore with lime and

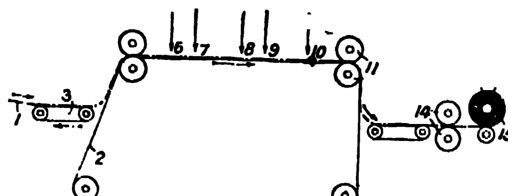
carbon or silicon, aluminum or calcium carbide in an electric furnace, whereby all the foreign oxides are reduced to the metallic state. Acidic oxides, such as those of silicon and titanium, form ferrous alloys which separate at the bottom of the furnace and are suitable for use in the metallurgy of iron. In place of lime, baryta or other alkaline earth may be used. The alkaline earth aluminates are converted into alkali metal aluminates, such as sodium aluminate, $Al_2O_3Na_2O$, by treating their hot solutions with alkali metal carbonates. (Br. Pat. 141,666—1919. ROCHETTE FRÈRES, Savoy, France, June 16, 1920.)

Recovery of Volatile Solvents.—In recovering volatile solvents evaporating during the drying of india-rubber articles and the like, an absorption agent is placed in the drying chamber, and uniformly distributed over it. The agent is preferably made to flow through the chamber, and may be conducted by means of rods, threads, wires, textile fabrics and the like. The solvent is subsequently recovered by distillation or other means. (Br. Pat. 141,739—1919. H. SCHMIDT, Cologne, Germany, June 16, 1920.)

Electrolysis—Zinc and Cadmium.—A precipitate obtained by adding zinc dust, with or without a copper salt, to sulphate solutions prepared from ores containing zinc and cadmium, with or without copper and cobalt, is treated for the recovery of cadmium, zinc, and, if present, copper, in the following manner: If substantially free from cobalt, the precipitate is oxidized and leached with sufficient dilute sulphuric acid to dissolve a maximum of zinc and cadmium and a minimum of copper. From the residue the copper is recovered by smelting or otherwise. Alternatively, the precipitate, oxidation of which is guarded against, may be leached with sufficient acid to dissolve the zinc, the residue being then oxidized and further treated to dissolve the cadmium. In either case, the solution containing the cadmium is treated with zinc dust in quantity insufficient for complete precipitation of the cadmium, which is thus obtained free from zinc. In this treatment, the solution should be slightly acid and air should be excluded as much as possible; about ½ g. of cadmium per liter should remain after precipitation. A further treatment of the solution in a second vat with excess zinc, and preferably in the presence of about ½ g. of copper per liter, gives a zinc solution which is added to the purified ore solution, and a precipitate which can be used again in the first vat. The precipitated cadmium is roasted and dissolved in dilute sulphuric acid or spent electrolyte. Copper is removed by excess of the cadmium precipitate, metallic cadmium, or cadmium oxide, and the solution, then containing about 100 g. cadmium per liter, is electrolyzed with rotating aluminum cathodes at which the current density may be 20 amp. per sq.ft. Glue may be added to the electrolyte in the proportion of 2 lb. for each ton of cadmium produced. The deposit after removal may be melted under caustic soda and potassium cyanide. After electrolysis, the solution should contain 60 g. of acid per liter. An alternative method of separating the zinc from the cadmium consists in agitating the solution with zinc oxide or hydrate at 60 deg. C. for some time, and then cooling to 35 deg. C. so as to precipitate the zinc as basic sulphate. When the original precipitate contains cobalt, it is oxidized and leached with zinc sulphate solution or just sufficient dilute sulphuric acid to dissolve out most of the cadmium and cobalt, and the residue is then treated as in the first case. The solution of cadmium and cobalt is treated with zinc dust as described above so as to obtain zinc-free cadmium, which is added to that obtained from the residue above mentioned, and a solution of zinc and cobalt, from which a pigment may be prepared, for instance by adding sodium carbonate and drying and heating the precipitate. (Br. Pat. 141,688—1919. ELECTROLYTIC ZINC CO. OF AUSTRALASIA PROPRIETARY, LTD., Melbourne, June 16, 1920.)

Color Photography.—In the interference method of color photography, the radio activity of the mercury, silver or other radio-active material used in conjunction with the film is supplemented "instantaneously and simultaneously with the eruption of the rays reflected by the object in the form of electricity, X-rays, light or other form of free energy so as to make up for the normal insufficiency of the radio-activity of these substances made by radiation in the opposite direction from these latter to aid, on the one hand, the extra rapid realization of the equilibrium of the stationary rays, the remainder of the available energy serving to effect the laminar formation of the different complementary colorations corresponding to the rays absorbed by the object, and on the other hand to aid in the prompt formation of the blacks by the process of superposition of unilateral rays in the region of the sensitive film where no ray comes from the object." (Br. Pat. 141,699—1919. P. ELMASSIAN, Paris, France, June 16, 1920.)

Imitation Leather.—In the manufacture of imitation leather, bundles or laps of fibers are led on to an endless conveyor band, and binding, softening and hygro-



scopic substances are applied to the fibers, which are simultaneously acted upon by a blower to produce a "felting" of the fibers. As shown, fibers 1 from a carding-machine pass over a conveyor 3 to a conveyor 2 and are subjected at 6 to the action of a blower, treated with binding, fatty, and hydroscopic substances at 7, 8, and 9 respectively, then subjected again to the action of a blower at 10, and pass between pressing-rollers 11 and calendar rollers 14 to a roll 15. For producing thicker fabric, the material is passed a number of times around the conveyor 2, or a drum, while fresh fibers are fed from the carding-machine. In another form of apparatus, a number of layers of fibers are fed simultaneously from rolls on to successive parts of an endless conveyor, the fibers of each layer being subjected to the action of a blower and treated with binding and softening or hygroscopic substances. The binding substance may be a solution of cellulose, cuprammonium oxide, glue, etc. (Br. Pat. 141,712—1919. N. ZIGNONE, Milan, Italy, June 16, 1920.)

Ammonium Sulphate.—Neutral ammonium sulphate is prepared by mixing the crystals removed from the saturator with ammonium sulphite or bisulphite, in solid form or in solution, either before or after the crystals have been washed, or by adding ammonium sulphite or bisulphite to the washing liquor. (Br. Pat. 141,799—1919. SOUTH METROPOLITAN GAS CO., London, and O. W. WEIGHT, Bromley, Kent, June 23, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Special Train Service to Chicago for A. C. S. Meeting

The special transportation committee of the New York Section of the American Chemical Society in charge of transportation from Eastern points to Chicago for the general meeting of the American Chemical Society, Sept. 7 to 10, finds that alternative plans can be made for a special car or cars on the New York Central and Pennsylvania lines. Members of the Society who would like to join these special parties at New York or points farther west should communicate immediately with Frank E. Dodge, care of The Barrett Co., 17 Battery Pl., New York City. Space will be reserved upon receipt of telegram or letter together with the necessary remittance.

On the New York Central a special car or cars will leave on Train No. 3, from Grand Central Station, New York City, at 8:45 a.m., Eastern standard time, Sunday, Sept. 5, arriving in Chicago Monday 7:40 a.m., Central standard time. The fares from New York and intermediate points, including extra fare, which is $5.10 from New York, together with Pullman charges, are as follows:

City	Fare	Upper	Lower	Dr Room	Compartment
New York City	$40 46	$7.78	$9 72	$34 02	$27 54
Albany	31.84	7 13	8 91	32 40	25.11
Schenectady	31 19	7 13	8 91	32 40	25 11
Syracuse	26 10	5.51	6 91	24 30	19 44
Rochester	22 98	4.86	6 10	22 68	17 01
Buffalo	20 31	4.86	6 10	22 68	17 01
Cleveland	13 19	3.24	4 05	14 58	11 34

On the Pennsylvania a special car or cars will be attached to train No. 5, leaving Pennsylvania Station, New York City, at 11:04 a.m., Eastern standard time, Sunday, Sept. 5, arriving in Chicago Monday at 9 a.m., Central standard time. The fares, including extra fare and Pullman, are as follows:

City	Fare	Upper	Lower	Dr. Room	Compartment
New York City	$41 76	$7.78	$9 72	$34.02	$27 54
Philadelphia	36 96	7.13	8 91	32 40	25 11
Baltimore	30 97	7 13	8 91	32 40	25.11
Washington	30 97	7 13	8 91	32.40	25.11
Harrisburg	27 76	6 48	8 10	29.16	22 68
Pittsburgh	18 23	3 89	4 86	17.82	13.77

These fares, figured from the existing tariff by the railroad passenger departments, may vary by a few cents when the official tariff is promulgated. Trains on either line will arrive in Chicago in time for the meeting of the directors and advisory committee at 12:30 p.m. and the council meeting at 4 p.m.

Alpha Chi Sigma to Meet in Chicago

The chemical fraternity Alpha Chi Sigma will hold a meeting in Chicago coincident with the meeting of the American Chemical Society in September. A banquet will be served at the Morrison Hotel at 6:30 on Wednesday evening, Sept. 8, and a business meeting will follow. Members of the fraternity are requested to register at a place provided for that purpose at the headquarters of the American Chemical Society, Congress Hotel.

Application of Government Research to Be Fostered

In announcing the appointment of David J. Price as chief of the office of development work in the Bureau of Chemistry, Dr. C. L. Alsberg, chief of that Bureau, makes the following statement:

> The practical application in the industries and in the arts of scientific research is quite a different matter from the doing of the research itself. It requires rather different talents and an objective point of view which the scientist in his enthusiasm may not always have. If it be a matter involving manufacturing, for example, it requires the calculation of costs, which is really usually an engineering problem, and which in many cases can best be done by someone without the bias of authorship. In short, it is rather an engineering business problem than a problem of science.

It is expected that the work to be undertaken along these lines by Mr. Price will afford both the industries and the investigators of the Bureau added facility for co-operation in the application of research conclusions that have possible industrial value. It is hoped that any industry finding valuable conclusions in the work will thus be aided to a prompt realization of the technical possibilities from an engineering as well as a laboratory point of view.

Another important aspect of this is also emphasized by Dr. Alsberg when he says: "I believe that by such an arrangement as is proposed herein much of the Bureau's work can be made effective and that the investigators of the Bureau may be made free to prosecute their researches and not waste unnecessary time in establishing industrial contacts."

It has not yet been determined what particular problems will first be attacked by this new office, but the work will go forward early in the fall.

Water-Power Rules and Regulations

The rules and regulations to be used in connection with the administration of the water-power act are being perfected. The regulations were the subject of two public hearings, at which the draft was criticized and suggestions made. The committee of the Federal Power Commission, together with a committee representing outside interests, is working out the moot points in order that the regulations may be promulgated in the near future.

The financial interests made an especially urgent plea that in framing the regulations, sight should not be lost of the fact that, at best, it is going to be difficult to interest capital, under present conditions.

Bureau of Mines Creates New Division

F. G. Cottrell, director of the Bureau of Mines, has authorized the creation of a division on non-ferrous metallurgy. A. E. Wells, who has been a member of the Bureau's staff for many years, will be in charge of the new division with the title of chief metallurgical engineer. The headquarters of the division will be maintained in Salt Lake City.

October Meeting Electric Furnace Association

The subject of Refractories has been selected for the session of the Electric Furnace Association which will be held in Columbus on Wednesday afternoon, Oct. 6.

The meeting will provide an opportunity for a discussion of their problems by the users and makers of refractories. Papers will be presented by steel men and by the manufacturers of bricks and lining materials, and considerable time will be allowed for questions and informal discussion.

Some other interesting features are being arranged for the meeting so that it should be a considerable addition to the progress of activities already planned for the first week of October in Columbus.

The Electric Furnace Association plans to hold its session in one of the buildings of the Ohio State University.

The British Paper Industry

British paper makers are making extensive plans to meet the ever-increasing demand for paper. Because of the uncertainty of business due to war conditions and the lack of raw materials, all previous measures had to be delayed till a more propitious time. Conditions, however, have very much improved since the armistice and the companies are fast recovering from the effects of the war.

The Imperial Paper Mills, Incorporated, is offering to investors £800,000 of 7½ guaranteed 15-year first mortgage debenture stock at 93 and redeemable at 103. This stock is secured by a first mortgage on mills and property at Gravesend on the Thames and on shares of a Canadian company.

The Imperial Mills was organized to supply the requirements of the Amalgamated Press, Ltd., in the production of its seventy periodicals and magazines and also the large amount of paper necessary for the printing of the *Times*, the *Daily Mail*, the *Daily Mirror*, the *Sunday Pictorial* and other papers. Originally the mills were designed with a weekly capacity of 1,500 tons. This output, however, is to be increased to 1,800 tons per week in the new plans.

Canadian Pulp Mills Purchased

The Imperial Co., together with Lord Rothermere and companies with which he is associated, has recently purchased the whole of the capital stock of the pulp mills of the Gulf Pulp & Paper Co. at Clarke City, in the Province of Quebec, on the St. Lawrence River, together with timber limits of about 625,000 acres. Under the arrangements for purchase, the Imperial Co. will acquire two-thirds of the capital, the other third being taken by outside interest.

The businesses of Edward Collins & Sons of Glasgow and Henry Leigh Slater of Manchester have been consolidated in the incorporation of the Amalgamated Paper Mills, Ltd., with a share capital of £900,000 issued at par, £400,000 of which is 8 per cent cumulative participating preferred shares.

The Kelvindale mills of Edward Collins & Sons are among the oldest paper-making concerns in the United Kingdom, having been established in 1746. The average output of the two concerns is 190 tons per week. Recently the Slater Co., in association with M. A. Berges of the Papeteries Berges (Paris), formed a new company, the Société Franco-Anglaise des Papiers Speciaux, which is erecting a new plant at Eragny, near Paris, for the purpose of coating the papers manufactured by the Berges Co.

The profits of the Collins and Slater firms combined advanced from £86,797 in 1916 to £220,219 in 1918, but dropped to £56,791 in 1919, due to war condtions. Profits for this year are estimated at the rate of £294,803 per annum.

Although only a few of the companies publish public reports, those of the following large companies will give some idea of the profits made in this industry.

PROFITS AFTER PROVIDING FOR EXCESS PROFIT DUTY

	1919	1918	1917
Edward Lloyd	£223,032	£117,940	£151,536
Ordinary dividend	13¾%	11¼%	11¼%
Alex Pirie & Sons	£105,543	£102,500	£83,833
Ordinary dividend	6 %	%	6 %
C. Marsden & Sons	£97,930	£66,180	£26,884
Ordinary dividend	9 %	8½%	6 %
A. M. Peebles & Son	£43,287	£38,349	£21,102
Ordinary dividend	9 %	5 %	....
A. E. Reed & Co.	£135,485	£111,295	£73,308
Ordinary dividend	14%	10%	10%
Spier Brothers	£236,500	£155,584	£155,345
Ordinary dividend	14%	12½%	12½%

Protective Agreements

Compared with Germany, where there were several cartels, the British paper industry is almost without organization. Every individual firm moved along in its own way. It was only under stress of war that the British makers made price agreements among themselves. Fear of foreign competition has also caused a suggestion that a duty of 15 per cent be imposed on all imports to protect home industries.

Raw Materials

The shortage of raw material is gradually becoming less acute and more stock is coming in. In the first half of the current year (January to June) the import of pulp wood, grass, rags, etc., exceeded 600,000 gross tons, compared with the import of the corresponding period of 380,000 tons and a pre-war total of 563,758 tons. The net import of pulpwood, the chief raw material, for the last six months amounted to 505,195 tons, esparto, rags, etc., amounting to only 94,830 tons, with a total aggregate value of £14,403,831.

Foreign Trade

England is still importing from abroad immense quantities of manufactured paper of all kinds, the aggregate of the six months being 346,047 gross tons, as compared with 303,638 tons in the same period during 1913. Although the imports are large, England's exports of paper manufactured in the United Kingdom made a poor showing, the total for the six months period being only 48,489 gross tons. It is this extraordinary excess of imports of foreign-made paper over the comparatively small quantity of British exports that causes the paper manufacturers anxiety. Norway and Sweden furnished England with 45 per cent of its printing and writing paper during the last half year, and 75 per cent of packing and wrapping paper, including tissue paper.

The reappearance of Germany as an exporter of approximately 8,000 tons is an interesting item. Russia exported to Great Britain 13,110 tons of packing and wrapping paper. Imports of straw board amounted to 105,900 tons and came mostly from Holland. The United States supplied England with a little more than 2,000 tons.

Corn Products Refining Co. to Build Big Factory in Kansas City

Approximately $8,000,000 will be required for an extensive manufacturing enterprise to be established here by the Corn Products Refining Co., of Chicago, New York and other cities.

The amount will be expended for branch works manufacturing sirup and various other products from corn. Seventy-five acres of land have been bought for the site and engineers are preparing plans for buildings, the construction of which will begin in September. There will be seven large buildings, all of reinforced concrete construction, the largest to have about 100,000 sq.ft. of floor space.

The manufacturing machinery to be installed will consume each day about 25,000 bu. of corn and 10,000,000 gal. pure water from an artesian well. About 1,000 operatives will be employed, most of the machinery being automatic. Prominent officials of the corporation expect to profit considerably by the increasing use of the Missouri River for the transportation of freight. Large quantities of corn are imported from the Argentine Republic by the Corn Products Refining Co. and this supply may in time come up the Missouri River when this ship transportation for the lower Missouri has been assured.

Maritime Chemists Association Holds Annual Meeting

The annual meeting of the Maritime Chemists Association was held on Aug. 3 in St. John, N. B. The chief business of general interest transacted was the formation of a Maritime Section of the Society of Chemical Industry which will function as a separate section of the Society. The program also included among others an illustrated address by H. Jermaine Creighton, D. C. S., of Swarthmore College, Pa., in "How the Nitrogen Problem Has Been Solved," and an interesting paper by Prof. H. C. Hanbon on the newly discovered salt deposits at Malagash, N. S.

Officers elected for the ensuing year were:

President, Dr. H. S. Biglow, Mt. Allison University.

Vice-presidents, Dr. H. Jermaine Creighton, Swarthmore College; I. C. Mackie, Dominion Iron & Steel Co.

Executive, Prof. H. C. Hanlon, N. S. Agricultural College; A. F. Blake, Atlantic Sugar & Refining, Ltd.

Secretary and treasurer, H. B. Vickery, Provincial Normal College.

Lack of Coal a Menace to Paper Supply

President Dodge of International Paper Co. says the Commerce Commission must modify its priority orders in allocating coal and wood cars or many newspapers will have to suspend publication because production and shipment of print paper must cease. He says over 400 newspapers of United States, directly dependent on company for their stock, are now "living from hand to mouth."

Manganese in Southern Nevada

More than twenty-five manganese mines and prospects in the southwestern part of Nevada are described in Bulletin 710F of the U. S. Geological Survey. The average content of Mn is reported as about 40 per cent. The total estimated amount of Mn runs into many hundreds of thousands of tons. The limiting factors are found in transportation and cost of production.

Milk Plants in Washington

Utility plants costing approximately $600,000, capable of handling 500,000 lb. of milk daily, with an annual output of an estimated value of $8,000,000, are being constructed by United Dairy Associations of Washington in Seattle, Wash. These plants will manufacture the raw milk into butter, milk powder, ice cream and cheese.

One of the new plants to be constructed at Lynlen will cost $150,000 and will handle 100,000 lb. of milk daily. Skagit County dairymen are building a $250,000 plant at Burlington with a daily capacity of 250,000 lb. of milk. Snohomish County dairymen purchased a modern condenser plant.

Besides these projects the dairymen in Grays Harbor County have at Satsop what is said to be the largest cheese factory in this country, if not in the world. Its output is 3,000 lb. every day in the year.

Products of these plants will be standardized, so that large orders can be filled from products of all the plants.

Dyes or Dyestuffs?

A laboratory for research on dyestuffs and explosives has been established at George Washington University, Washington, D. C. It is to be under the general supervision of Prof. H. C. McNeil and in charge of G. W. Phillips, formerly of the C. W. S. Prof. C. E. Munroe of the National Research Council will be consulting chemist of the laboratory.

Why do they call dyes "dyestuffs"? Dyes is a good old English word that means exactly the same thing. We might as well say colorstuffs. We are glad to see the laboratory established, our only objection is to its German name. The word dyestuffs indicates bulk and weight rather than tinctorial power. Dyes is better.

Glass Works for Birmingham

General glass products in the nature of bottles will be manufactured in Birmingham, Ala., in a $400,000 plant to be built by the Birmingham Glass Manufacturing Co., a new enterprise organized by New York and Alabama capitalists, who have secured a site and land containing several million tons of silica sand. The officers named for the first year are Sol W. Quinn, president; H. C. Bryson, vice-president, both of New York, and E. R. Owen, secretary, of Birmingham, Ala.

Use of Glycol as a Substitute for Glycerol

It is proposed in *Der Seifenfabrikant* (vol. 40, pp. 245-6, 1920) by H. Wolff of Berlin that glycol be used in the place of glycerol as a substitute owing to its hygroscopic and viscous nature. It is used to advantage, he says, for printing inks, for softening, cleaning and felting textiles and in pharmacy. Schlinck & Co. has patented its use (Ger. Pat. 315,222) to neutralize the acidity of oils by boiling them with glycol under reflux in order to convert the free acids into glycol esters.

New Lignite Carbonization Research Plant in North Dakota

The sum of $200,000 has been subscribed by private persons to build and operate a research plant for the carbonization of lignite at New Salem, N. D. It will be conducted by the staff of the U. S. Bureau of Mines.

The Chemistry of Churning Butter

L. S. Palmer of the Missouri Agricultural Experiment Station has made a study of the chemistry of churning butter. As the stage of lactation advances the protein concentration of the milk increases, while the size of the fat globules decreases. Therefore the difficulty in churning increases, and this factor is beyond the complete control of the butter maker. His microscopic work gave strong support to Fischer's idea that the formation of butter consists in a change of fat-in-colloid-hydrate emulsion (cream) into a colloid-hydrate-in-fat emulsion, which is butter.

June Exports and Imports of Dyes and Dyestuffs

Countries	Aniline Dyes, Value	Logwood Extract, Value	All Other, Value
Belgium	$42,627		
Denmark			$190
France	134,705	$64,508	43,183
Greece	2,787		
Italy	40,803	24,943	17,826
Netherlands	378	33	16,866
Norway	1,710		2,111
Portugal	4,235		330
Spain	110,340	10,291	34,789
Sweden	4,078		2,700
Switzerland	3,430		13
Turkey in Europe	2,150		230
England	128,353	19,584	138,878
Scotland	7,618		8,955
British Honduras			22
Canada	188,731	23,036	101,528
Costa Rica	100	64	269
Guatemala	939	14	268
Honduras			159
Nicaragua	60	5	146
Panama			146
Mexico	4,229		3,607
Newfoundland and Laborador	46		761
Jamaica			25
Trinidad and Tobago		30	
Cuba	1,792	12	7,754
Virgin Islands of U. S.	15		
Dutch West Indies	3		4
Haiti			24
Dominican Republic	45		1,272
Argentina	38,893		16,937
Bolivia	5,360		203
Brazil	43,840	60	22,363
Chile	15,845	1,300	7,396
Colombia	3,700	106	4,298
Ecuador	408	454	
Peru	12,476	1,470	11,411
Uruguay	1,145		
Venezuela	588	93	16
China	622,345	10,000	240,096
British India	199,036		134,571
Straits Settlements			101
Dutch East Indies			99
French East Indies	19,690		864
Hongkong	26,095		22,127
Japan	680,215	66,157	371,011
Siam	2,463		285
Turkey in Asia			7,012
Australia	23,128	314	11,881
New Zealand	7,023		3,011
Philippine Islands	1,090		1,160
British South Africa	6,678		2,293
Egypt	323		
Total	$2,389,515	$222,474	$1,239,191

IMPORTS

Countries From	Alizarin and Alizarin Dyes		Colors or Dyes Not Elsewhere Specified		Indigo, Natural	
	Lb	Value	Lb	Value	Lb.	Value
Denmark			441	$1,297		
France			2,702	3,991	21,116	$16,246
Germany			76,848	85,293	10	32
Netherlands			3,502	2,835		
Switzerland			144,211	256,674		
England	1,177	$961	6,413	7,015	766	750
British India					2,850	7,392
Japan			30	10		
Total	1,177	$961	234,147	$357,115	24,742	$24,420

Countries From	Indigo, Synthetic		Extracts and Decoctions for Dyeing	
	Lb.	Value	Lb.	Value
France	12,813	$8,103	13,544	$2,417
Spain			12	15
England			13,071	2,117
Scotland			5,015	1,295
Jamaica			20,930	7,116
Haiti			104,447	5,073
Japan			875	77
Total	12,813	$8,103	157,894	$18,110

Payne Hears War Mineral Plea

After listening to arguments of representatives of the Mining Congress and attorneys for claimants under the war minerals relief act, the Secretary of the Interior has stated that he has no objection to the enactment by Congress of a law giving to these claimants the right to appeal their cases to the United States Court of Appeals.

Manufacture of Paper Pulp in Congo

Papyrus, which grows in great abundance near Elizabethville, in the Belgian Congo, principally along the lower Lualaba, near the lakes of Kabuli, Sjemba, Kisali and Neaga, is to be exploited by a large company which has been granted a concession. It is planned to establish near the river a large plant, costing two and a half million francs, which will have an initial production of 20,000 tons of pulp. The material for this factory is to be sought among Belgian and, if necessary, allied manufacturers.

The papyrus of the Congo has proved on analysis to contain 37.8 per cent cellulose. After research and experiments, a process was discovered for bleaching the plants which had been vainly sought for fifty years.

June Imports of Tin Bars, Blocks or Pigs, Grain or Granulated

Customs Districts	Lb.	Value
Massachusetts	167,888	$97,702
New York	8,880,892	5,420,336
Philadelphia	56,071	28,683
Pittsburgh	56,000	43,600
Maryland	168,047	109,200
San Francisco	1,309,785	863,553
Washington	313,568	186,915
Michigan	280,074	163,582
Total	11,232,325	$6,913,571
Countries from:		
Netherlands	1,114,271	$617,813
England	4,085,504	2,271,448
Canada	33,494	52,590
Costa Rica	33,429	17,589
China	392,216	223,198
British India	65,100	27,000
Straits Settlements	4,404,278	3,078,764
Hongkong	829,556	482,598
Australia	274,477	162,571
Total	11,232,325	$6,913,571

Tin in Ore

	Tons	Value
Total	2,994	$2,239,266

Personal

Dr. JOHN J. ABEL, professor of pharmacology at the Johns Hopkins Medical School, Baltimore, Md., has received an honorary doctorate of laws from Cambridge University. Dr. Abel's numerous and distinguished researches on the chemistry of animal tissues and fluids and on the physiological and therapeutic action of various substances render him worthy of academic distinction.

Dr. H. K. BENSON, in charge of the chemistry department of the University of Washington, is spending the summer at Lake Bunsen, B. C., conducting special research work for the American Nitrogen Products Co. Dr. Benson will return to Seattle in September.

A. W. FAHRENWALD has been appointed ore-dressing engineer with the U. S. Bureau of Mines in charge of the station at Moscow, Idaho.

CHARLES H. FULTON, formerly professor of metallurgy in the Case School of Applied Science, has been appointed

director of the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., and not head of the Mining Department as given erroneously in our issue of Aug. 4. Prof. Forbes is head of the Mining Department.

H. S. GALE, who for many years has been the Geological Survey's specialist on potash and nitrate, has resigned to enter private employment.

RALPH A. GOULD and BRYANT S. DRAKE announce their association, from Aug. 1, as a partnership under the firm name of Gould & Drake, chemical engineers, with offices at 216 Pine St., San Francisco, Cal.

CHARLES S. HOWARD, formerly an instructor in the department of electrical engineering and physics at the U. S. Naval Academy, has accepted a position as junior chemist in the Quality of Water Division of the Water Resources Branch of the U. S. Geological Survey, Washington, D. C.

ERIC A. LOF has just returned from Europe, where he visited a large number of industrial plants in Sweden, Norway, England, France and Belgium.

Dr. VAN H. MANNING, director of research of the American Petroleum Institute, has returned from a trip to Europe.

E. P. MATHEWSON has gone to Arizona on a professional engagement.

PAUL MOORE, at present director of the Information Bureau of the War Trade Board, will become the secretary of the Division of Research Extension, National Research Council, on or about Oct. 1. Mr. Moore will devote himself to the promotion of research with particular reference to the industries. In this work he will be associated with Dr. H. E. Howe, who continues actively in this field as the chairman of this division of the Council.

Prof. ARTHUR M. PARDEE has resigned from the chair of chemistry at Washington and Jefferson College, Washington, Pa., to become the head of the department and professor of chemistry at the University of South Dakota, Vermilion, S. D.

Dr. CHARLES L. PARSONS, secretary of the American Chemical Society, has returned to Washington following the adjournment of the International Union of Pure and Applied Chemistry at Rome, where he acted as the American representative.

JOHN H. RAMAGE, formerly metallurgist, industrial department, U. S. Navy Yard, Norfolk, Va., is now metallurgist for the Westinghouse Lamp Co., Bloomfield, N. J.

RICHARD R. REES has resigned as chief metallurgist at U. S. Arsenal, Watervliet, N. Y., to accept a position as metallurgist with the Neptune Meter Co., Long Island City, N. Y.

R. T. READ, of the safety department of E. I. du Pont de Nemours & Co., has been appointed by the National Safety Council as permanent secretary of the Delaware local council.

J. C. TOWNSEND, foremerly safety engineer for the International Shoe Co., of St. Louis, has been appointed by the National Safety Council manager of the Grand Rapids division.

Obituary

Dr. E. Y. TITUS, a member of the technical staff of the International Coal Products Co., Newark, N. J., died on Aug. 7, as a result of blood poisoning following an accident in which he was run down by an automobile. Dr. Titus was formerly associate professor of physical chemistry at the University of Wisconsin; later chief chemist at U. S. Nitrate Plant No. 1, Muscle Shoals, Ala., and prior to his engagement with the International Coal Products Co. he was in the U. S. Fixed Nitrogen Research Laboratory. He had been married about a month at the time of his death.

Book Reviews

IRON AND STEEL. By *Erik Oberg* and *Franklin D. Jones*, editor and associate editor of *Machinery*, in collaboration with prominent metallurgists and steel-makers. 328 pp. New York: The Industrial Press.

In the rather limited space of 300 pages of pica type, the authors present "A Treatise on the Smelting, Refining, and Mechanical Processes of the Iron and Steel Industry, Including the Chemical and Physical Characteristics of Wrought Iron, Carbon, High-Speed and Alloy Steels, Cast Iron, and Steel Castings, and the Application of These Materials in Machine and Tool Construction." Obviously the words "brief outline" would be better than "treatise." Thus in the very sub-title the authors exhibit that defect of non-precise diction which will blast their hopes that their volume will find favor as a text-book for technical students. The casual reader may not mind, but the budding engineer or technician should not be told that "wrought iron" and "bushelled scrap" are the same thing (p. 72) nor think of "ingot iron" and "wrought iron" as the same type of material (p. 79).

It is too bad that the prominent metallurgists collaborating in this work did not revise the chemical terminology. When discussing bessemer steel (p. 139) it is said that "the graphitic carbon is burned into the combined form," whatever that action may consist in. Also on page 140 the statement is made that "manganese . . . burns the sulphur (which is in the form of iron sulphide) into managanese sulphide." At the bottom of page 147 is a simple explanation of rephosphorization in acid steel which will attract those metallurgists who are delving into the mysteries of balanced reactions for light.

Had the authors confined themselves to the mechanical processes involved in the manufacture of steel products, a happier result would undoubtedly have been attained. Their chapter on Rolling and Drawing contains an unusually full and well-illustrated account of the operations involved in the cold drawing and rolling of shafting, strip and wire. Forty pages are devoted to this matter, a disproportionate amount in a general survey, but fortunately so in this case. Doubtless by experience and intimate contact the authors could have presented an authoritative yet concise account of non-metallurgical operations in modern steel mills which have filled a vacant spot in American technical literature, rather than merely another book, of which there are already far too many. E. E. THUM.

Current Market Reports

The Iron and Steel Market

Pittsburgh, August 20, 1920.

The iron and steel market has not established any general or definite trend, but rather is displaying even more confusing features than a few weeks ago. For instance, semi-finished steel prices are showing a distinct downward trend and pig iron is not merely showing an advancing tendency, it actually has advanced, and in the case of valley foundry iron by no less than $4 a ton in a week. The influence of improving transportation conditions is not defined. There does not seem to be any increased consumptive demand for steel in consequence, while there are heavier deliveries of steel, yet this does not seem to make steel more plentiful.

IMPROVED TRANSPORTATION

The improvement in transportation, as regards the movement of steel products, has been continuous for several weeks. Taking the steel industry as a whole, the rate of

accumulating of steel began to decrease several weeks ago, while the increase in shipments has proceeded far enough so that no more steel is accumulating, the present situation being that while some mills have added to their accumulations in the past week or two others have moved some of the steel accumulated many weeks ago.

Hopes had been entertained that the Interstate Commerce Commission would allow the coal-car preference order to expire Aug. 19, at the end of its two 30-day periods, thus releasing many flat-bottom gondolas from coal movement to pig iron and steel movement, but the commission has extended the order for another thirty days, to Sept. 18, and has not relaxed the provision that gondolas 38 in. and higher inside measurement are to be considered coal cars. Apart from this, the Pennsylvania system has made an order on its own account that cars classifiable as coal cars may no longer be loaded with other freight when destined to travel toward the coal mine, and thus shipments of some valley producers to the Pittsburgh district are impeded. On the whole, however, car supplies at furnaces and mills are increased by reason of there being a more rapid movement of cars all around, the total quantity of transportation having increased. The point has not yet been reached at which coal mines are able to load all the cars furnished, but that time may come soon, and then some cars would automatically be released for use by the iron and steel and other industries.

A noteworthy improvement in transportation is seen in connection with placement of cars for coke loading in the Connellsville region. For several months the production there has been regulated by the car supply. The Connellsville *Courier* reports production of coke in the Connellsville and lower Connellsville region in the past three weeks as having been as follows, successively: 172,870 tons, 194,140 tons, 219,440 tons. A labor shortage has not yet been uncovered in the region, although a continuation of increasing car supplies would eventually make labor the limiting factor. The better car placements are due solely or chiefly to quicker movement of the cars that have been in the coke service right along. The quantity of coke en route to furnaces has been reduced, and thus the receipts have increased even more than the shipments.

Advancing Pig Iron

The advances in pig iron are rather a curious phenomenon, considering the fact that any trend observable in steel products is downward, while pig iron was already too high relative to steel prices. The buying of pig iron is not heavy, but it is so insistent that when furnaces ask higher prices enough consumers pay the advance to establish the market at the higher figures. In the past week sales have established foundry pig iron, valley furnaces, at a $4 advance, while transactions in steel-making grades have scarcely been sufficient, with conservative market reporting, to establish higher levels distinctly. In foundry iron the transactions, though totaling only a few thousand tons, have established $50 valley as the market, a few of the sales being for delivery to the end of the year. Former quotations were: bessemer, $47; basic, $46.50; foundry, $46. If foundry iron does not recede from $50 it is quite probable that within a few days the other grades will be clearly established at a $50 level. As the market has never before advanced even by a dollar or two on such light transactions, there are naturally misgivings in some quarters as to what the end of this curious movement will be.

Semi-Finished Steel

It is learned that in a number of recent transactions in sheet bars $70 Pittsburgh was shaded slightly, and this figure represents absolutely the top of the market, though three weeks ago the market seemed clearly established at $75 as minimum. There are reports of a number of transactions in standard billets, particularly in the East, on the basis of $60 Pittsburgh. Obviously $50 pig iron and $60 billets are not properly aligned. Again, however, bars and shapes can be bought for forward delivery at about 3c., or $60 a net ton, and this does not agree with $60 per gross ton for billets.

Many statements are now being made that the decline in automobile building is not as great as has been reported in some quarters, and it seems evident that there is a good bit to explain away, if possible. The steel industry feels much less pressure from the majority of automobile factories for steel deliveries, but the loss in tonnage is a small item compared with the total steel productive capacity, since at capacity for both industries the automobile industry would not absorb more than 6 or 7 per cent at the outside of all the steel. In such items as hot and cold rolled strips, however, the decrease in demand is important.

As to railroad buying, it is quite improbable that there will be any buying of cars and locomotives to amount to anything for delivery before early next year. Car and locomotive repair work will continue and will absorb considerable tonnages of steel. A little interest is beginning to be shown in rails for next year.

In steel for large construction jobs there is very little demand and it does not look as though there would be much activity along this line until some changes occur in fundamental conditions.

The general demand for steel, for a wide variety of uses, continues good and it remains the marvel of the trade that so much steel can be absorbed when there do not appear to be heavy consumptive operations in progress.

The Chemical and Allied Industrial Markets

New York, August 20, 1920.

Considering the season of the year, there has been considerable price activity during the week. The movement in general has been upward, with a noticeably firmer undertone to the market, although the volume of business transacted does not seem to be very much more than the usual amount. The increases, where they have occurred, have been made by producers who are finding it impossible to meet existing prices with the increased labor costs and transportation difficulties.

Among the items that came up is *calcium chloride*, fused lump, formerly listed at $25@$30 per ton as low price and now difficult to obtain under $33. With it the *granulated* grade also advanced to a low mark of 2@2½c. per lb. The average price for *formaldehyde* is between 40@50c. per lb., although it is possible to get small lots of from one to five tons at a figure slightly under the market, from second hands who are finding it difficult to find purchasers at 40c.

The newly arranged schedule of prices on *sal soda* issued by producers ranges between $2@$2.25 per cwt.; this represents an increase of 75c. per cwt. and is evidently due to the increased cost of production and is also a move in preparation for the coming buying season. In comparison with the rise of *sal soda* is the sharp decrease of *caustic soda*, which is down as low as $5.60, against recent quotations of $6.25@$7 per cwt. There is no doubt the demand for this item has greatly fallen off and with the banks calling in notes holders are making concessions to get rid of the material on hand.

Coal-Tar Products

The absence of buying interests is felt in the coal-tar products market and prices are at about the same levels as previously reported. Both *aniline oil* and *salts* have fallen off, the former being listed at 30@33c. and the latter at 35@40c. per lb., with very little activity displayed. *Benzidine sulphate* has also been affected and current quotations are 85@90c., against the recent 90c.@$1 per lb. level. In contrast with these comparatively small drops, *dimethylaniline* came down from $1.35@$1.45 to $1@$1.05 per lb. The looked-for increased interest caused by the expected return of textile mills to their former activity has not strengthened this market to any extent and whereas the drops are not numerous there is not one actual increase in the list.

Ortho-toluidine and *paranitraniline* are both slightly under last week's listing, the former being quoted at 30@35c. and the latter $1.10@$1.20 per lb., representing a drop of 25c. per lb. for this material.

In line with the other allied markets the *waxes* continue weak, as demand is practically at a standstill. Through a mistake in the price table of the Aug. 18 issue, *Carnauba*, No. 2, regular, was quoted at 55@60c. per lb., whereas the correct price is 85@86c., a 5c. difference between that and No. 1, which is now being sold around 90@95c. per lb. *Montan*, crude, is weaker at 25@26c. than it was last week and business has been very dull as a result.

Vegetable Oils

	Today	Week Ago	Month Ago	Year Ago
Cottonseed oil, crude	$0.10	$0.10@.11	$.015½	$0.22
Cottonseed oil, summer yellow	.12½	.13½@.13½	.18½	.27
Cottonseed oil, winter yellow	.17½	.19	.21	.27

The above table shows the decline in cottonseed oil during the past year. The principal reason back of this downward movement is the persistent lack of demand on the part of consumers, with a resulting accumulation of supplies in the hands of the crushers. To remedy this situation the farmer is being urged to withhold his supply of seed, thereby causing a scarcity on the market of this commodity and boosting the price back to former war levels. The present price is the lowest it has ever been since this commodity had its first sensational rise immediately after being introduced on the market, when the crude could be obtained for 5@6c. per lb. Previously it had been thrown away as useless until the discovery was made that it could be used in cattle feeding and as a fertilizer. During the war the peak was reached when it sold as high as 24c. per lb., but since then owing to slackening of demand the price has been steadily falling off.

Miscellaneous Materials

Feldspar remains very scarce and $17@$20 is the nominal quotation, although all contracts are being written with a provisional clause making the price subject to "prevailing quotation at time of shipment." All grades of *shellac* have strengthened and although it is possible to obtain small quantities of this material slightly under the current quotations, it would be only the cheaper grades on which concessions would be granted. The fall crop, while there is no surplus, promises to meet requirements, and with the present heavy inquiry it is expected these prices will prevail for some time.

The St. Louis Market

St. Louis, Mo., August 17, 1920.

The chemical market for this district continues quiet and prices remain firm. With the settlement of the railroad rates and wages many large buyers are coming into the market for future needs and producers are booking orders for 1921 delivery. An increase in prices for nearly all lines is predicted in the near future, as the increase in freight rates will in many cases materially affect the cost of raw materials.

The local supply of chemicals is now normal and ample to meet present demands, with the following quotations, based on car lots unless otherwise noted, holding firm. The market for *sulphuric acid* continues good with prices unchanged. The 60 deg. grade is quoted at $16 per ton and 66 deg. at $24 per ton. *Oleum* remains unchanged at $27.50 per ton.

Muriatic acid is quiet and prices unchanged at $25 per ton and 2@2¼c. per lb. in carboys.

The supply of *sodium bisulphate* is now ample and prices are quoted at from $5 to $6 per ton, a slight reduction from previous quotations.

Nitric acid remains unchanged and is quoted at $7 per cwt. for the 36 deg. and $10 per cwt. for the 42 deg. *Standard mixed acid*, consisting of 36 deg. nitric and 61 deg. sulphuric, is unchanged at 11¼c. per lb. of nitric and 1¼c. per lb. of sulphuric acid.

Zinc chloride, 50 per cent solution, is quoted at $4 per cwt., an increase of 25c. due to rise in cost of raw material.

Phenol is plentiful due to a local firm disposing of surplus Government stocks, and prices are unchanged at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.. -	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	21 - .22
Acid, acetic, 28 per cent	cwt.	3 50 - 3.75	4 00 4 50
Acetic, 56 per cent	cwt.	6 50 - 7.50	8 50 9 50
Acetic, glacial, 99½ per cent, carboys	cwt.	14 00 - 16 00	16.25 -
Boric, crystals	lb.	.15½ - 16	16½ - 19
Boric, powder	lb.	.15½ - 16½	17 - .20
Citric	lb.	78 80	.82 84
Hydrochloric (nominal)	cwt.	2 00 3 00	3.10 - 4 00
Hydrofluoric, 52 per cent	lb.	13½ .14	14½ - .15½
Lactic, 44 per cent tech	lb.	.11 .11½	12 .16
Lactic, 22 per cent tech	lb.	04½ - 05½	06 .07
Molybdic, C. P	lb.	4.00 4 50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).		.	.. .
Nitric, 40 deg	lb.	06 07	07½ - .08½
Nitric, 42 deg	lb.	07½ 08	08½ - .09½
Oxalic, crystals	lb.	55 57	60 .65
Phosphoric, Ortho, 50 per cent solution	lb.	14 - 23	24 25
Picric	lb.	.28 - 35	.40 - 50
Pyrogallic, resublimed	lb.	2 [illegible] 2 55	2 60 2.65
Sulphuric, 60 deg., tank cars	ton	[illegible] 00 16 00	. . .
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	16 00 - 17 00	18 00 - 20.00
Sulphuric, 66 deg., drums	ton	26 00 - 28.00	-
Sulphuric, 66 deg., carboys	ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27 00 30 00	37 00 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 30 00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	[illegible] 35 00	40 00 - . .
Tannic, U. S. P.	lb.	1.45 1 50	1 55 1.65
Tannic (tech.)	lb.	60 - 70	80 .90
Tartaric, crystals	lb.		74 .77
Tungstic, per lb. of WO	lb.		1 20 1.40
Alcohol, Ethyl (nominal)	gal	5 10 5 50	6 00 7.00
Alcohol, Methyl, 95%	gal	-	3 25 - 3.30
Alcohol, Methyl, pure	gal		3 50 - 3.55
Alcohol, denatured, 188 proof (nominal)	gal.		1 10 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	-	1 05 1.10
Alum, ammonia lump	lb.	05 05½	.05½ .06
Alum, potash lump.	lb.	08 08½	.09 09½
Alum, chrome lump	lb.	17	18 - 19
Aluminum sulphate, commercial	lb.	.04½	.
Aluminum sulphate, iron free	lb.	06	
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	09½ - .10½	11 - 12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	34 35	35 - .40
Ammonium carbonate, powder	lb.	16 16½	.17 18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	16 16½	17 - 18
Ammonium chloride, granular (gray salammoniac)	lb.	13 13½	13½ - 14½
Ammonium nitrate	lb.	09 10	.11 - 14
Ammonium sulphate	lb.	07 07½	08½ .....
Amylacetate	gal		5 00 ..
Amylacetate tech.	gal.		4 75 - 5 25
Arsenic, oxide, lumps (white arsenic)	lb.	15½ - .16	.16½ - 17
Arsenic, sulphide, powdered (red arsenic)	lb.	20 - .21	22 - .25
Barium chloride.	ton	150 00 160 00	-
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .12	.12½ - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	04½ - 05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		. ..	.... - ....
Blue vitriol (see copper sulphate)		. ..	.... - ....
Borax (see sodium borate)		. ...	..... - ....
Brimstone (see sulphur, roll)		. - .	..... - ......
Bromine	lb.	70 - 90	1 00 - 1.05
Calcium acetate	cwt	3 50 3 55	.. . ..
Calcium carbide	lb.	04½ 04½	04½ - .05½
Calcium chloride, fused, lump	ton	33 00 34 00	35 00 - 45 00
Calcium chloride, granulated	lb.	02 02½	[illegible] 03½
Calcium hypochlorite (bleaching powder)	cwt.	6 50 - 7 50	8 00 8 50
Calcium peroxide	lb.		1 50 1 70
Calcium phosphate, monobasic	lb.	-	75 .80
Calcium sulphate, pure	lb.		25 - .30
Carbon bisulphide	lb.	08 09	10 - .11
Carbon tetrachloride, drums	lb.	14 15	16 - 17
Carbonyl chloride (phosgene)	lb.	.	80 1 05
Caustic potash (see potassium hydroxide)		.	. . .
Caustic soda (see sodium hydroxide)		. .	. - . . .
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	09 .09½	10 - .10½
Chloroform	lb.	.40 - 43	.44 - 47
Cobalt oxide	lb.	-	2 00 - 2 05
Copperas (see iron sulphate)			. .
Copper carbonate, green precipitate	lb.	27 28	29 31
Copper cyanide	lb.	- .	65 .70
Copper sulphate, crystals	lb.	08 - .09	09 .09½
Cream of tartar (see potassium bitartrate)		-	. - . . .
Epsom salt (see magnesium sulphate)		-	- . .
Ethyl Acetate Com. 85%	gal	1 10 1 30	1 40
Ethy Acetate pure (acetic ether 98% to 100%)			1 75
Formaldehyde, 40 per cent (nominal)	lb.	40 45	.48 - 50
Fusel oil, ref	gal.		5 25 6 00
Fusel oil, crude (nominal)	gal		-
Glauber's salt (see sodium sulphate)		. . -	-
Glycerine, C. P. drums extra	lb.	. .	26½ - .28½
Iodine, resublimed	lb.	4 30 4.35	4 40 - 4 45
Iron oxide, red	lb.	. - . .	03 20
Iron sulphate (copperas)	cwt	-	2.75 - 3.00
Lead acetate, normal	lb.	. -	13½ - .16
Lead arsenate (paste)	lb.	11 12	13 - 17
Lead nitrate, crystals	lb.	. -	90 1 00
Litharge	lb.	14 - 15	15½ 16
Lithium carbonate	lb.	.. - ..	1.50
Magnesium carbonate, technical	lb.	.12½ - .13½	15 - 16
Magnesium sulphate, U. S. P.	100 lb.	3.50 - 3.90	4 00 - 4 50
Magnesium sulphate, commercial	100 lb.	... -.. .	3.50 - 3 60
Nickel salt, double	lb.	. . . - .	14 .16
Nickel salt, single	lb.	. . . . -.	.13 .14
Phosgene (see carbonyl chloride)		....	. . .
Phosphorus, red	lb.	.50 - .55	.60 .65
Phosphorus, yellow	lb.	... -	.35 - .37
Potassium bichromate	lb.	.36 - .38	39 - 40

	Unit	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0 52 -$0 56	$0.57 - $0 58
Potassium bromide, granular	lb.	-	.70 - .73
Potassium carbonate, U. S. P.	lb.	50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .25	.26 - .28
Potassium chlorate, crystals	lb	.16 - .17½	.18 - .20
Potassium hydroxide (caustic potash)	lb.	.27 - 28	.29 - .33
Potassium iodide	lb.	-	3.35 - 3.60
Potassium nitrate	lb.	.17 - .17½	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.90 - 1.00	1.05 - ......
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$225.00 -240.00	......-.......
Rochelle salts (see sodium potas. tartrate)		......-......	......-.......
Salammoniac (see ammonium chloride)		......-......	......-.......
Sal soda (see sodium carbonate)		......-......	....
Salt cake	ton	......-.. ...	40.00 - 50.00
Silver cyanide (nominal)	oz.	......-......	1.25 -.......
Silver nitrate (nominal)	oz.	......-......	.60 - .62
Soda ash, light	100 lb.	.....-......	3.20 - 3.50
Soda ash, dense	100 lb.	-......	3.55 - 3.65
Sodium acetate	lb.	10 - .15	.20 - .25
Sodium bicarbonate	100 lb.	2.50 - 2.75	3.00 - 3.50
Sodium bichromate	lb.	22 - .24	.26 - .27
Sodium bisulphate (nitre cake)	ton	7.00 8.00	9 00 - 11.00
Sodium bisulphite Powered, U S.P.	lb.	08¾	10 - .11
Sodium borate (borax)	lb	09 - .10	.11 - 12
Sodium carbonate (sal soda)	100 lb.	2 00 - 2.10	2.15 - 2.25
Sodium chlorate	lb	11 - 12	.12½ - .14
Sodium cyanide, 96-98 per cent	lb.	25 - .30	.32 - .35
Sodium fluoride	lb	18 -......	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	5.60 - 5.70	5.75 - 6.00
Sodium hyposulphite	lb.	......	.03 .04
Sodium molybdate	lb	2.50 -......	3.25½-.....
Sodium nitrate	100 lb.	3 00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	16 - 18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03¾- .04½	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb	- ...	.39 - .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg)	lb.	.01½- .01¾	.02 - .02½
Sodium silicate, solution (60 deg)	lb	.02½- .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 - 1.70	1.75 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½- .10	.10½- .11
Sodium sulphite, crystals	lb	.04 0 4½	.04½- .05
Strontium nitrate, powdered	lb	.15 - 18½	.19 - .20
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	16.00 -20.00	......-.......
Sulphur dioxide, liquid, cylinders	lb	.09 -......	.10 - .12
Sulphur (sublimed), flour	100 lb	....-......	3.80 - 4.35
Sulphur, roll (brimstone)	100 lb.	....-......	3.40 - 3.90
Tin bichloride (stannous)	lb.	.42½- .44	.45 - .46
Tin oxide	lb.	.......-......	.55 - .65
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb	.13 - .13½	.13½- .17
Zinc cyanide	lb	.45 - .49	.50 - .60
Zinc dust	lb.	.11 - .12	.12 - .13
Zinc oxide, U. S. P.	lb	17 - .25	......-......
Zinc sulphate	lb.	.03½- .03¾	.04 - .06

Coal-Tar Products

NOTE The following prices are for original packages in large quantities:

	Unit			
Alpha naphthol, crude	lb.	$1.40		$1.50
Alpha naphthol, refined	lb	1 60	·	1.70
Alpha naphthylamine	lb.	.50	—	.52
Aniline oil, drums extra	lb.	.30	—	.33
Aniline salts	lb.	.35	—	.40
Anthracine, 80% in drums (100 lb)	lb.	.90	—	1.00
Benzaldehyde (f f c)	lb.	2 00	—	2.10
Benzidine, base	lb.	1 35	—	1.40
Benzidine, sulphate	lb.	1.15	—	1.25
Benzoic acid, U S P	lb.	.85	—	.90
Benzoate of soda, U.S P.	lb	.80	—	.90
Benzol, pure water-white, in drums (100 gal)	gal	.38	—	.40½
Benzol, 90%, in drums (100 gal)	gal	.36½	—	.38½
Benzyl chloride, 95-97%, refined	lb	.35	—	.40
Benzyl chloride, tech	lb	.25	—	.35
Beta naphthol benzoate (nominal)	lb.	3 50	—	4.00
Beta naphthol, sublimed (nominal)	lb	..	—	...
Beta naphthol, tech (nominal)	lb	.85	—	.95
Beta naphthylamine, sublimed	lb	2.25	—	2.40
Cresol, U. S P, in drums (100 lb)	lb.	.18	—	.19
Ortho-cresol, in drums (100 lb)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal	1 05	..	1.15
Cresylic acid, 95-97%, dark, in drums	gal	1.00	--	1.05
Cresylic acid, 50%, first quality, drums	gal	.65	—	.75
Dichlorbenzol	lb.	.08	—	.10
Diethylaniline	lb.	1 50	—	1.60
Dimethylaniline	lb	1 00	—	1.05
Dinitrobenzol	lb.	.30	—	.37
Dinitroclorbenzol	lb.	.32	--	.35
Dinitronaphthaline	lb.	45	—	.55
Dinitrophenol	lb.	.40	—	.45
Dinitrotoluol	lb.	...	—	.40
Dip oil, 25%, tar acids, car lots, in drums	gal	.38	—	.40
Diphenylamine (nominal)	lb.	80	—	.85
H-acid (nominal)	lb.	2 00	-	2.25
Metaphenylenediamine	lb.	1 25	..	1.30
Monochlorbenzol	lb	.18	—	.20
Monoethylaniline	lb	2.00	—	2.40
Naphthaline crushed, in bbls. (250 lb)	lb	....	—	...
Naphthaline, flake	lb	...	—	.19
Naphthaline, balls	lb.	....	—	.19
Naphthionic acid, crude	lb.	.75	—	.85
Nitrobensol	lb	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.50
Nitro-toluol	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-bensol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	.85
Ortho-nitro-to[illegible]	lb.	.25	—	.40
Ortho-toluidine	lb.	.30	—	.35
Para-amidophenol, base	lb.	2.50	—	3.00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlor-bensol	lb.	.08	—	.12
Paranitraniline	lb.	1.10	—	1.20
Para-nitro-toluol	lb.	1 35	—	1.50
Paraphenylenediamine	lb.	2.50	—	2 65
Paratoluidine	lb.	2.00	—	2.25
Phthalic anhydride	lb.	.60	—	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridin	gal.	2.00	--	3.50
Resorcin, technical	lb.	4.25	-	4.50
Resorcin, pure	lb.	6.25	--	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	—	.52
Salicylic acid, U. S. P.	lb.	.50	—	.60
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	—	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.35	—	.....
Toluol, in drums	gal.	.38½	—	.40½
Xylidine, drums, 100 gal.	lb.	.50	—	.65
Xylol, pure, in drums	gal.	.47½	—	.50½
Xylol, pure, in tank cars	gal.	.45	--	.....
Xylol, commercial, in drums, 100 gal	gal.	.32½	—	.35½
Xylol, commercial, in tank cars	gal.	.30	—	.....

Waxes

Prices based on original packages in large quantities.

	Unit			
Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.37	—	.38
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1 (nominal)	lb.	.90	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.86
Carnauba, No. 3, North Country	lb.	.35	—	.36
Japan	lb.	.17	—	.18
Montan, crude	lb.	.25	--	26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¼	—	.10
Paraffine waxes, refined, 118-120 m p.	lb.	.11	—	.11½
Paraffine waxes, refined, 125 m.p	lb.	.12¾	—	
Paraffine waxes, refined, 128-130 m p.	lb.	.13	-	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	--	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	--	.18½
Stearic acid, single pressed	lb.	.20	—	.21
Stearic acid, double pressed	lb.	.22	—	.23
Stearic acid, triple pressed	lb.	.24	—	25

NOTE--Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based carload lots. The oils in 50-gal. bbls, gross weight, 500 lb.

	Unit	Price
Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2 15
Pine oil, pure, dest. dist	gal	1.80
Pine tar oil, ref, sp. gr. 1.025-1 035	gal	.48
Pine tar oil, crude, sp.gr. 1.025-1 035 tank cars f o b. Jacksonville, Fla.	gal.	35
Pine tar oil, double ref., sp gr 0 965-0 990	gal	.85
Pine tar, ref, thin, sp. gr., 1 080-1.960	gal.	.36
Turpentine, crude, sp gr., 0.900-0 970	gal.	1 75
Hardwood oil, f.o b. Mich., sp. gr, 0.960-0 990	gal	35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots

	Unit			
Rosin B-D, bbl	280 lb.	$14 00		$16 25
Rosin E-I	280 lb.	16 60	--	16 75
Rosin K-N	280 lb.	17.00	—	17.20
Rosin W G.-W. W	280 lb.	17.25	—	17.50
Wood rosin, bbl	280 lb.	15.00	—	
Spirits of turpentine	gal.	1 60	--	
Wood turpentine, steam dist.	gal.	.....	—	
Wood turpentine, dest dist.	gal.	.....	-	
Pine tar pitch, bbl.	200 lb.	.....	--	8 50
Tar, kiln burned, bbl. (500 lb)	bbl.	14.50	-	15.00
Retort tar, bbl	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.72	—	
Rosin oil, second run	gal.	.75	—	
Rosin oil, third run	gal.	.92	--	

Solvents

	Unit	Price
73-76 deg., steel bbls. (85 lb)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

	Unit			
Para—Upriver fine	lb.	$0.32½	--	$0.34
Upriver coarse	lb.	.20½	—	.22
Upriver caucho ball	lb.	.21	—	.21½
Plantation—First latex crepe	lb.	.33	--	
Ribbed smoked sheets	lb.	.29¾	-	
Brown crepe, thin, clean	lb.	.27	—	
Amber crepe No. 1	lb.	.29	—	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

	Unit			
Castor oil, No. 3, in bbls	lb.	$0.16½	—	$0.18
Castor oil, AA, in bbls	lb.	.19	—	. .
China wood oil, in bbls	lb.	.17½	—	.18
Cocoanut oil, Ceylon grade, in bbls	lb.	.15	—	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.16½	—	.16½
Corn oil, crude, in bbls	lb.	.14½	—	.15½
Cottonseed oil, crude (f.o b. mill)	lb.	.10	—	.11
Cottonseed oil, summer yellow	lb.	.12½	—	.13½
Coteonseed oil, winter yellow	lb.	.17½	—	18½
Linsed oil, raw, car lots (domestic)	gal.	1.50	—	..
Linseed oil, raw, tank cars (domestic)	gal.	1.40	—	..
Linseed oil, boiled, car lots (domestic)	gal.	1.56	—	.....

Olive oil, commercial	gal.	3.00	3.10
Palm, Lagos	lb.	.10½	
Palm, bright red	lb.	.10½	
Palm, Niger	lb.	.11	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.40 —	1.50
Rapeseed oil, blown, in bbls	gal.	1.60 —	1.70
Soya bean oil (Manchurian), in bbls N.Y.	lb.	.14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ —	.11

FISH

Winter pressed Menhaden	gal.	$0.90 —	$1.05
Yellow bleached Menhaden	gal.	0.95 —	1.05*
White bleached Menhaden	gal.	1.00 —	1.25
Blown Menhaden	gal.	1.00 —	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	—$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	— 20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	— 10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	— 25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	— 19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	—
Barytes, floated, f.o.b. St. Louis	net ton	26.50	— 28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	— 11.25
Blanc fixe, dry	lb.	.05½	— .06
Blanc fixe, pulp	net ton	60.00	80.00½
Casein	lb.	.15	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	.06
Chalk, English, dense	lb.	.04½	— .05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	— 12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	— 15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	— 22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	— 40.00
China clay (Kaolin), imported, lump	net ton	25.00	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	— 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	— 8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	— 10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	— 23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	— 20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	— 20.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00	— ...
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00	—
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	—
Fuller's earth, imported, powdered	net ton	35.00	— 40.00
Graphite (dust polish grade 30%) Ashland, Ala	lb.	......	— .01
Graphite (dust facing grade 50%) Ashland, Ala	lb.	......	— .02
Graphite, crucible, 80%, carbon Ashland, Ala	lb.	......	— .05
Graphite, crucible, 90%, carbon Ashland, Ala.	lb.	......	— .10
Graphite, crucible, 85%, carbon	lb.	......	— .08
Graphite, crucible, 88%, carbon	lb.	......	— .09½
Graphite, crucible, 90%, carbon	lb.	......	— .10½
Pumice stone, imported, lump	lb.	.04	— .50
Pumice stone, domestic, lump	lb.	.06	—
Pumice stone, ground	lb.	.04	— .07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	......	— 10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	......	— 14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	......	— 17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7.50
Shellac, orange fine	lb.	1.35	— 1.40
Shellac, orange superfine	lb.	1.40	— 1.45
Shellac, A. C. garnet	lb.	1.10	1.15
Shellac, T. N.	lb.	1.15	1.20
Soapstone	ton	15.00	— 25.00
Talc, paper-making grades, f.o.b. Vermont	ton	10.00	20.00
Talc, roofing grades, f.o.b. Vermont	ton	9.00	— 15.00
Talc, rubber grades, f.o.b. Vermont	ton	10.00	— 15.00
Talc, powdered, Southern, f.o.b. cars	ton	20.00	— 25.00
Talc, imported	ton	60.00	— 70.00
Talc, California Talcum Powder grade	ton	20.00	— 35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90— 100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90 95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50— 55
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45— ...
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75— ...
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45— 55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100 110
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90— 100
Silica brick, 9-in. and 9 in. sizes, Chicago district	1,000	55 ...
Silica brick, f.o.b. Birmingham	1,000	51— 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	55— 60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18 —	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20 —	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	200.00	— 225.00
Ferro-manganese, 76-80% Mn, English	gross ton	195.00	— 220.00
Spiegeleisen, 18-22% Mn	gross ton	75.00	
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.75 —	2.75
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3, f.o.b. Atlantic Seaboard	unit	77 -	.85
*Coke, foundry, f.o.b. ovens	net ton	20.00	...
*Coke, furnace, f.o.b. ovens	net ton	18.00	20.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	...
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	- 27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	- .02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.70	- .80
Manganese ore, chemical (MnO_2)	gross	75.00	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.75 —	.85
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½—	....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.00 -	7.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	...
Zircon, washed, iron free	lb.	.10 —	.....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	7.50
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	9.50
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8.5
Zinc, spot, E. St. Louis	7.90@ 8.40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@ 1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@ 3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	110.00@115.00
Iridium	oz.	350.00
Palladium	oz.	100.00@ 110.00
Mercury	75 lb.	88.00@ 90.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@ 40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@ 23.50
Aluminum, sheet scrap	23.00@ 23.50
Copper, heavy machinery comp	14.50@ 15.00
Copper, heavy and wire	15.25@ 15.75
Copper, light and bottoms	13.00
Copper, heavy cut and crucible	16.25
Brass, heavy	9.50@ 10.00
Brass, light	7.25@ 7.75
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp turnings	12.50@ 13.50
Lead, tea	4.75@ 5.00
Lead, heavy	7.25@ 7.50
Zinc, scrap	5.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3.97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.47	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.47	4.12	3.37		3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25	...	...	...
Plates, ¼ to 1 in. thick	4.67	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SAN FRANCISCO—The Amer. Can Co., 120 B'way, New York City, is having plans prepared for the construction of a factory. Estimated cost about $500,000.

Connecticut

MONTVILLE—Robert Gair & Co., 50 Washington St., Brooklyn, N. Y., has awarded the contract for the construction of a 2-story, 200x500-ft. manufacturing building and power house to the Austin Co., 217 B'way, New York City. Estimated cost, $600,000. Noted June 30.

NEW HAVEN—Della Valle & Vece, archts., Exchange Bldg., will soon award the contract for the construction of a 2-story, 50x70-ft. factory on Olive St. for the Tuttle Color Printing Co., 30 Crown St. Estimated cost, $20,000

STAMFORD—The Petroleum Heat & Power Co., Selleck St., is building a 1-story foundry. Estimated cost, $15,000. A. W. Steele, mgr. Noted July 28.

District of Columbia

WASHINGTON—The Vasil Steam Systems Co., 314-318 Washington Loan & Trust Bldg., plans to build a foundry and machine shop.

Illinois

DE KALB—Arthur Foster, archt., 155 N. Clark St., will soon receive bids for the construction of a 3-story, 40x179-ft. hospital for the Rev. J. A. Solon. A chemical laboratory will probably be installed. Estimated cost, $150,000.

EAST ST. LOUIS—Darling & Co., 4201 South Ashland Ave., Chicago, has awarded the contract for the construction of a fertilizer plant, including a 1 story, 50x80-ft. acidulation plant, to the Austin Co., 208 South La Salle St. Chemical equipment will be installed in same. Estimated cost, $500,-000.

EAST ST. LOUIS—The Excelsior Tool & Machine Co., 32d St. and Ridge Ave., has awarded the contract for the construction of a 1-story foundry addition to the Stupp Bros. Bridge & Iron Co., Frisco Bldg. Estimated cost, $35,000.

HILLSBORO—The Bd. of Educ. has awarded the contract for the construction of a 2-story, 150x150-ft. high school to Jesse Gedney, Arcade Bldg., St. Louis, Mo. A physical and chemical laboratory will be installed. Estimated cost, $201,214.

MELROSE PARK—The Heppes Nelson Roofing Co., 4500 Filmore St., has awarded the contract for the construction of a roofing manufacturing plant including a 1-story, 80x140-ft still and gas building, etc., to the Austin Co., 208 South La Salle St., Chicago. Estimated cost, $100,000.

Indiana

HAMMOND—The Metals Refining Co., Inc., Edison Bldg., Chicago, plans to build a lead smelting plant. W. Schoenbach, vice-pres.

SOUTH BEND—The George Cutter Wks. of the Westinghouse Electric & Mfg. Co. plans to build a 64x112-ft. foundry.

Kansas

ELDORADO—The City Comm. voted $25,000 bonds to install a new filter system at the city water plant.

PITTSBURGH—The Pittsburgh Builders' and Pavers' Brick Co. is having plans prepared for the construction of a brick plant to include four new kilns. Estimated cost, $60,000.

Louisiana

NEW ORLEANS—The Union Paper Products Co., 109 Tchoupitoulas St., has awarded the contract for the construction of a 1-story factory to Jos. Frombers, 302 Title Guarantee Bldg. Estimated cost, $112,743.

Maryland

BALTIMORE—The Bd. of Awards, c/o City Register, will soon award the contract for the construction of a sludge digestion tank, pipe lines, etc., at the sewage disposal works on the shore of the Back River here. A. E. Christholf, Highways Engr.

Massachusetts

CAMBRIDGE—The Suffolk Engraving & Electrotyping Co., 394 Atlantic Ave., Boston, has awarded the contract for the construction of a 6-story, 100 x 100-ft. manufacturing building on Main St. to the Simpson Bros. Corp., 166 Devonshire St., Boston. Estimated cost, $225,000.

GREENFIELD—The School Bd. will soon receive bids for the construction of a 3-story high school at Federal and Sanderson Sts. A chemical laboratory will be installed in same. Estimated cost, $400,000. Patton & Blair, 579 5th Ave., New York City, archts.

Missouri

ST. LOUIS—The G. J. Fritz Fdry. & Machine Co., 20185 3d St., has awarded the contract for the construction of a 1-story foundry addition to the Stupp Bros. Bridge & Iron Co., Frisco Bldg. Estimated cost, $40,000.

New Jersey

NEWARK—The Amer. Can Co., 120 B'way, New York City, is having plans prepared for the construction of a factory. Estimated cost, about $500,000.

North Dakota

MARMARTH—The Bd. Educ. will receive bids until Sept. 7 for the construction of a 2-story, 61x91-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000.

Pennsylvania

ALLENTOWN—The Allen Tire & Rubber Co., 510 Hamilton St., has awarded the contract for the construction of a 2-story rubber factory to the Allentown Constr. Co., 5th and Hamilton Sts. Estimated cost, $2,500,000.

CHESTER—Allison & Co., Law Bldg., has awarded the contract for the construction of a 1-story, 30x65-ft. paint shop and dipping tank to the John R. Wiggins Co., Inc., Otis Bldg., Philadelphia.

COALDALE—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. John T. Simpson, Essex Bldg., Newark, N. J., archt.

NEW CASTLE—The Johnson Bronze Co., South Mill St., has awarded the contract for the construction of a foundry, etc., to the Moore-Lamb Co., Starrbaugh Bldg., Youngstown. Estimated cost, $125,000. Noted Aug. 11.

Rhode Island

PROVIDENCE—Brown University is having plans prepared for the construction of a 3-story, 50x200-ft. chemical laboratory. Chemical equipment will be installed in same. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., archts. and engrs.

Texas

EL PASO—The Atlas Brick Co., Dallas and Cotton Sts., plans to construct a lime hydrating plant, etc. Estimated cost, $60,-000. Clarence L. North, pres.

PHARR—The city received bid for the construction of a sewage disposal plant including a septic tank from R. O. Langworthy, $20,000.

SAN ANTONIO—H. D. Kellar, Coldwater, Mich., plans to build a cannery and sirup mill here to include an ice factory, etc., for the manufacture of cane sirup, citrus preserves and marmalades.

Virginia

EAST RICHMOND (Richmond P. O.)—The Jefferson Tire & Rubber Co., Central Bank Bldg., is having plans prepared for the construction of a 3-story, 80x240-ft. factory. Estimated cost, $150,000. Akron Eng. Co., Akron, O., archt. and engr.

West Virginia

SCHINISTON—The Paquet Glass Co. is building an 80x120-ft. illuminating glassware factory. Estimated cost, $25,000. P. J. Paquet, pres.

Wisconsin

CAMPBELLSPORT—The White House Milk Products Co., West Bend, had plans prepared for the construction of a 2-story, 50 x 110-ft. condensed milk plant. Estimated cost, $75,000. M. Tullgren & Sons, 425 East Water St., Milwaukee, archts. Noted Aug. 11.

DURAND—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. H. Miles, secy.

Quebec

QUEBEC—The Standard Pulp & Paper Co., Ltd., will soon receive bids for the construction of a pulp and paper plant. Estimated cost, $1,250,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, on Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS 1920 annual meeting will be held in the Engineers Societies Building, from Dec. 7 to 10 inclusive.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

CHEMICAL & METALLURGICAL ENGINEERING

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Chemistry to Be Represented On Super-Power Survey

THE acceptance by ARTHUR D. LITTLE of an appointment as member of the advisory board on super-power investigations of the United States Geological Survey will be noted with pleasure by all chemists. CHEMICAL & METALLURGICAL ENGINEERING has urged that the problems of chemistry be carefully considered in connection with these investigations, and it is a great pleasure, therefore, to note this striking assurance that the ideas for which we have stood are agreed to by the Government departments in charge of the work.

The coking of coal and development of byproducts therefrom promises to be one of our greatest chemical industries. Byproduct gas affords a means for transportation of energy from the mine field to the districts where fuel and power are required that does not in any sense interfere with simultaneous transportation of solid fuel by railway and electric current over high-tension power lines. The technology of such gas transfer is well known. It remains to determine the circumstances under which this medium of energy movement is most advantageous.

If gas is used as a medium of energy transfer, the production of byproducts of great value is assured. The chemist is vitally concerned, and chemical industry will watch these investigations with the utmost interest. To be assured that a prominent chemical engineer will be continuously available to advise regarding these problems is most satisfying.

The chemical industries must also be considered by the super-power investigators as important consumers of electric energy. Electrochemical developments afford an excellent supplement for other industrial power requirements, because the load can be so distributed as to make more uniform demand, filling up the hollows and reducing the relative heights of the peaks in the load curve. Chemical engineering attention is, of course, vital for the most advantageous use of this possibility.

Chemistry In the Kitchen

THE chemistry of cooking, so far as its practical application is concerned, is easy. The co-ordination of fats, proteins and carbohydrates into a balanced ration may be learned in a short course in domestic economy, and thousands of young aspirants to the dignity of the distaff in households of the future are studying it in fresh-water and salt-water colleges. How much of it they are learning is open to question. They may take the subject as a thing apart and apply their chemistry to "nutrition," but forget all about it when they think of a feast. The art of cooking is, indeed, much more subtle than the chemistry of rationing, and while the two are seldom wedded they are, indeed, parts of the whole and should never be separated.

With all the immense sums that we pay for eating we are not very intelligent in the preparation of our food. In an essay lately published in *Harper's Magazine* it was suggested that if a committee of intelligent persons from another planet were to visit the earth for the purpose of reporting on social conditions obtaining among its inhabitants they might well declare to their celestial authorities that, so far as we Americans are concerned, we miss more than is reasonable in the selection and preparation of what we eat. The imaginary high commission noted that, generally speaking, men and women differed in their attitudes toward food, in that men care more for its taste and odor than for its appearance, while women care more for its appearance than for its taste and odor. Nevertheless the preparation of food is assigned chiefly to women. Few women like to cook, and wherever it is possible they employ other women to do the work for them; and these other women have learned what little they know as a trade and not as a science or an art. The kitchen, they observed, is usually placed in the least desirable part of the house, and combined with it in the same room is the scullery, so that all the gross work of cleansing, peeling and cutting up is made part of the cooking, whereby the least agreeable and the most honorable duties of the household are combined in one. Distinction and honor accrue to the art of the cook because what he or she prepares becomes part of our very selves.

One of the reasons why living is so expensive is because competent persons have addressed themselves rather to discrimination in the selection of things prepared than to the selection of things to eat and the subsequent preparation of them. There is so little imagination and invention among cooks that they can make savory dishes only out of certain cuts of meat, while other cuts which cost much less could be made to taste better than the conventional expensive viands with the aid of a little intelligence and imagination. When we consider what the Chinese have done with the soy bean we should hang our heads in shame over our own stupidity with vegetables.

We know a man of science engaged in research whose salary was not increased in accord with the increase in living costs, and the problem of maintaining himself, his wife and four children became a serious one. Fortunately his wife had a scientific turn of mind and had been through a course of "domestic science," so together they began to balance their rations from a chemical standpoint. They prepared the amount actually needed, and found that it was less than had been their custom, and at first they felt themselves on short rations. A few weeks' experience taught them, however,

that they were eating all they needed, and this soon became all they wanted, while the family health improved.

Then came the development of the art as such, the use of herbs, many of which were unfamiliar, a happy diversity of flavors, and a much broader field from which to keep up a constant change in things eaten than before. The result is a complete rationing of the family at no greater expense than before the rise in prices, and with it the greater satisfaction of every member. The man and wife are, it is true, persons of rare and even unusual intelligence, and the results are what we may expect from the application of brains and intelligence to any problem. By thought and experiment they live better today at no greater expense for food than five years ago.

We believe it would pay the proprietors of large hotels and restaurants to retain the services of chemists of the first rank; men of imagination and culture as well as of laboratory technology, to engage in research in the preparation of foods. There are bakery and flour-testing and butter fat laboratories by the score, but these are not what we mean. We have in mind research and development in cooking, which includes baking and frying and broiling and steaming and roasting, with the use of imagination rather than the kitchen conventions in the selection and treatment of raw materials.

Soy Beans and The Chinese Character

IN THE *National Medical Journal* of China W. A. ADOLPH and P. C. KIANG tell at length of the nutritive value of the soy-bean products, and give information as to their preparation. The leading foods seem to be soy-bean milk, cheese, oil, and sauce. The cheese or bean curd has been the chief source of Chinese protein diet for centuries, and we can commend from experience the excellence of a good chop suey made with it. It is white, has about the consistency of calf's brain, and a delicate agreeable taste. Four methods of making it are given, and when the process involves the coagulation of bean milk with salt bittern, a curd is produced which is rich in all the inorganic essentials that are lacking in the bean proper. The authors suggest that some of the racial characteristics of the Chinese people may be traced to their dependence to so great an extent on this vegetable protein.

If they are right, and if the habits of industry and the disposition to mind his own business that distinguish the Chinaman are due to his diet of soy-bean cheese, let's have more of it in this country. Let's make it by the thousand tons and feed it to the millions.

If our present indisposition to work and our tendency to quit and then blame somebody else for our laziness is due to too much beef and pork and mutton let's give the bean-eaters a chance. Economics is not the main thing in life, and economics alone does not make or mar nations. Dietetics plays an important role. Better far a thousand years of beans than a century or so of too much meat if it is to be followed by collapse. The Chinese dallied with this ubiquitous and excellent vegetable as far back as B.C. 2838. They should have some experience with it by this time, and we have yet to learn of an anti-bean bill in the legislative halls of that country.

Resistance Between The Cup and the Lip

IN OUR issue of July 28 we published a paper by DR. ALVIN J. COX on Philippine industrial material, products and resources available to the United States. It was an illuminating catalog of supplies. It showed that the islands offer immense quantities of the following materials, subject, of course, to proper development: Manila hemp, sisal and maguey, tobacco, sugar from cane and palm coconuts, including copra and coconut oil; alcohol from molasses, nipa palm (from which 5,000,000 gallons or 10,000,000 proof gallons are made annually) and from cassava, arrowroot, yams and sugar palm; buri palm fiber for buntal hats which we call "Bangkok" and are so light that whoever can afford to wear them in summer at present high prices will wear no other if his wife will let him; rattans, coir fiber for brushes, ropes and doormats; tree cotton or kapok, which is an oily, short fiber, susceptible to many uses; resins, terpenes, perfumes, edible nuts, and a large variety of vegetable oils; coffee, cacao, papaya gum, strychnine, the leaves and seed of *Datura alba*, which, on extraction, produce a valuable remedy for asthma; rubber, lumber and tanning materials, paper pulp from bamboo (especially *Canabojo*), abaca or Manila hemp waste, rice straw and other paper stock; honey, silk, and a large variety of products of the sea. In minerals there are silver, gold, copper and well-located deposits of iron, the ore being workable, high in iron content and well located. And there is manganese in abundance. The petroleum outlook is very favorable. Coal is imported but is present in large quantities, unmined. Cement material and limestone are plentiful; so are asbestoform materials and so is bat guano. There are resources in fireclay, abrasives and sulphur. There is great need for island-made caustic soda, bleaching powder, lime, sand-lime brick, salt, chloroform and glass, to mention but a part of the list.

'Tis a grand bill of fare, if we, who published it, do say it. If this country were industrially organized the speedy development of many industries would follow. This would add to the sorely needed stores of manufactured materials both here and abroad and bring down the cost of living and of things required in the practice and arts of civilization.

American capital is ready to go abroad and afield, American management in industrial affairs has proved itself as competent as British or German management; in some countries it bears a superior reputation. The trouble seems to lie between knowing that the stuff is there and knowing just how to go about to get it. We need, however, to qualify the statement that American capital is ready to go abroad. It is shy about taking the first step and that is—to pay for *all* the information needed. By far too often it has rushed in—and we lay no stress on Philippine development in this respect—without adequate knowledge. In the islands referred to, for instance, there are great holdings in possession of religious orders, and while these associations are not averse to profits it is necessary to negotiate with them and to understand their points of view and habits of mind. More important still is the industrial survey which, in the making, must be backed by scientific proficiency and acumen, engineering competence in the calculation of costs, as well as in the ability to design and construct, together with keen business common sense and honesty.

Occasionally a technical man is sent out to give a proposal the "once over" and the chances are that he will miss the key to the situation, and then whichever way he decides is likely to be wrong. What is needed is a promotion organization that is in no hurry to make money; the profits of which, beyond costs for services rendered, are to come from industries after they have been established. And such an institution must have modest ideas of bankers' commissions. It requires also better administrative ability than is easy to find, because the diversity of requirements is coupled with the diversity of opportunity.

We believe the best method for such development would be for a kind of organization to be formed between some high-class promotion corporation (and there are a few such) together with selected representatives of such industries as cordage, tobacco, sugar, oil, industrial alcohol, straw hat, furniture, drug, rubber and others, and always including transportation. Competitors are still shy of joint conferences, or of letting one another know what they are doing; and since they will not change their natures it would be better to take them separately. The main thing to pay for would be information, for complete industrial surveys which should be made by the most competent men available. Then the promoting company could coordinate the information, and provide for the mutual aids and conveniences to be enjoyed by the various pioneers. The sugar man and the straw hat manufacturer may not have much in common, and yet they might find themselves indicated as neighbors by the survey.

In short, we should like to see organized research applied to the international and overseas business of the United States.

It would be a great help.

The Right Chain And the Right Sprocket

USUALLY when a link gives way in a chain drive the plant mechanic hooks in a new one and turns on the power again. If any attempt is made to account for the accident, nine times out of ten it is laid to overloading the conveyor, pump, mixing machine, etc., and to avoid a recurrence the charge to the machine is materially cut down to suit the power delivered by the drive. The lack of good design seldom comes into consideration, probably because very little is known about the subject. General rules are applied, usually, such as: For durability a short pitch is better than a long one; the sprocket centers should not be closer than forty times the pitch of the chain; the under side of the chain should be the slack one; large sprockets and a large number of teeth give less wear; the ratio of sprockets should not be less than 5 to 1 and sixteen teeth should be the minimum used; adjustable shafts should be used to take up wear. But no concrete conception of the phenomena involved is presented.

In printing a Study of Chain Driving in this issue we are making Mr. LAWSON'S article in *Engineering* available to our readers, many of whom have more than a remote interest in this branch of machine elements. Attention is directed especially to the subject of impact and the effect of an oil film on chain elasticity. The formula on the life of chain is ideal engineering computation. It involves the selection of the right chain and the right sprocket.

Pig-Iron Statistics Are Informing

STATISTICS usually are considered rather "dry," but the statistics of pig-iron production are quite illuminating as to the proportions of the iron and steel industry. The American Iron and Steel Institute has just issued its midsummer pig-iron statistics, showing the production in the first half of this year. The total shown for the output, 18,435,602 gross tons, is one of the least interesting things in the presentation. The trade knew in advance approximately what output would be reported.

As a matter of record, however, it may be mentioned that the maximum half year's output was the 20,826,914 tons made in the second half of 1918, while in the past three half-years output has been as follows: First half 1919, 16,278,175 tons; second half, 14,737.189 tons; first half 1920, 18,435,602 tons. With reference to capacity, under reasonably favorable working conditions, such as obtained in 1916 except for the last two months of that year, the furnaces can probably turn out about 46,000,000 tons of pig iron in a year, so that production in the first half of this year was at 80 per cent of commercial—not rated or theoretical—capacity. That was a good showing considering the great difficulties encountered, particularly in the matter of transportation.

The statistics show that coke is practically the universal fuel in making pig iron. A little bituminous coal is used raw, less than 0.25 per cent of the coke used. A still smaller quantity of anthracite is used, less than 1 per cent of the pig iron having been made with use of any anthracite, and even with that pig iron coke was used largely in mixture with the anthracite. In 1890 2,186,411 tons of pig iron was made with anthracite.

In the first half of this year 155,612 tons of pig iron was made with charcoal as fuel, that being 0.8 per cent of the pig iron output.

Of the pig iron made in the first half of this year 46 per cent was basic iron, while 32 per cent was bessemer and low-phosphorus iron, making 78 per cent for the two "steel-making irons." The comparison is accurate enough, but it is not exact, because on the one hand some of the bessemer iron was produced primarily for making ingot molds, the subsequent use of the worn-out molds in making steel being incidental, while on the other hand in the 22 per cent of "all other" are included spiegeleisen and ferromanganese, which are employed chiefly in steel making. In the year 1907 the production of bessemer iron was more than double the production of basic iron, while in the year 1913 basic iron took first place.

Marketwise, however, the grades of pig iron stand in altogether different relations. Of the total pig iron made, 29 per cent was made for sale, the other 71 per cent being made by consumers. Of the iron made for sale only 20 per cent was basic iron, while only 10 per cent was bessemer and low-phosphorus. Foundry and ferrosilicon comprised 54 per cent while malleable contributed 12 per cent more. No small part of the bessemer, low-phosphorus and basic iron sold was for making steel castings. It may be estimated that of all the "merchant pig iron" made about 80 per cent goes into steel, gray iron and malleable iron castings, including ingot molds, whereas of all the pig iron produced fully 75 per cent is used for making rolled steel.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, August 9, 1920.

BUSINESS at the moment is somewhat stagnant, partly owing to the holidays and mainly, perhaps, on account of the serious international situation. Prices of imported chemicals are somewhat higher, but the home chemical trade is dull, with values falling slightly. It is thought, however, that the next month will show a very considerable improvement, especially on export account.

CHEMICAL COMPANIES' RESULTS

Recent reports of progress in chemical undertakings are of a disappointing nature. Thus the dividend on the preference shares of the British Cellulose & Chemical Manufacturing Co. has been postponed, the reasons given being delay in obtaining machinery and plant and the after effects of strikes, etc. It will be remembered that this company is to manufacture artificial silk and "celluloid" products made from acetyl cellulose, and while it is stated that production on a large scale is to commence shortly, the general impression seems to be that the plant has been inefficiently and too lavishly planned and that considerable reorganization will be necessary before remunerative results are obtained. The Alby United Carbide Factories has also failed to declare a dividend owing to shortage of raw materials such as coal and on account of serious losses caused by strikes. The history of the company is a very interesting one and it appears to have been universally successful until it took an interest in the Nitrogen Products Co. with its attendant share manipulations.

An interesting feature of the report is the statement that it is now possible to manufacture carbide on a commercial scale from inferior carbon material using an "agglomerate" patented by the company. Ultimately a committee of inspection was appointed by the shareholders to assist the Board and to watch the shareholders' interests. Brunner Mond & Co. have allocated $400,000 in furtherance of scientific and industrial research, the resolution giving effect to this proposal of the directors having now been carried after it had previously been rejected by the shareholders at the recent annual meeting.

DEVELOPMENTS IN NITROGEN FIXATION AND RUBBER VULCANIZATION

Preliminary details of the Claude process previously referred to have now been published in the *Chemical Age*, London, of July 17, and results of large-scale working will probably be forthcoming before the end of the year. Meanwhile it is understood that the nitrogen fixation process via barium cyanide of the British Cyanides Co. has proved commercially successful and an announcement in this connection is to be made shortly. The chief difficulty seems to have been the question of temperature and suitable refractories for the furnace lining. Similarly, Dr. Calvert's process, which is being developed by the Cyanides Trust, Ltd., was rendered possible only by the use of a new resistant nickel : chromium alloy, "Cronite," and it is understood that while not yet on a commercial scale, manufacture on a large laboratory scale is proceeding with very satisfactory results. An interesting patent is that of Peachey, No. 146,734, for the cold vulcanization of rubber, the process having been developed at the Manchester College of Technology. A company with a capital of $1,000,000 has recently been formed to develop the process, which is somewhat revolutionary in character.

SOCIETY OF CHEMICAL INDUSTRY'S ANNUAL MEETING

In spite of the presumed considerable influx of American visitors to this country at the present time, Americans and Canadians were conspicuous by their absence at this meeting, probably because Newcastle is a relatively long way from London. The conference on filtration promoted by the Chemical Engineering Group disclosed the fact that there is shortly to be an amalgamation of the various interests developing centrifugal filters such as that of Gee and Sturgeon, while the company developing the Sharples centrifuge will probably also be included. The difficulties of continuous operation and of washing the precipitates can be best overcome by such amalgamation and as regards washing, it is probable that the principle of "steeping"—i.e., filling the machine with water to soak into the precipitate—will be adopted. Other interesting features of the meeting were discussions on the increased rate of subscription, the general question of increased publicity and the advisability of forming a British Institute of Chemical Engineers. As regards subscriptions, the point was raised that the interests of American and Colonial members, as well as those of the Society, would be best served by preferential treatment as against British members, while the formation of a British Institute of Chemical Engineers was considered informally, not with a view to separation from the Society of Chemical Industry but to enable chemical engineers to have a voice in the proposed general registration of practicing engineers in this country and to provide facilities for qualifying chemical engineers as and when education in this important subject has been adequately developed. The cinematograph was used for the first time in illustrating one of the papers read before the Chemical Engineering Group, Mr. Kestner, the recipient of the Society's gold medal, being in the chair.

PERSONAL NOTES

Lord Moulton was presented at a dinner held on July 21 with a Georgian loving cup in recognition of his personal and national services, and while his services were really called upon at a time when he "was really too old for his job," there is no doubt that his magnetic personality was the source of inspiration to those who worked under his general direction and that it required a man of his character and achievements to bring about that degree of co-operation among chemical manufacturers which was so lamentably lacking before the war and which is now proving of inestimable benefit to the industry. Dr. T. M. Lowry, F.R.S., has been appointed professor of physical chemistry at Cambridge, G. O. Banister professor of metallurgy at Liverpool University and Dr. R. V. Wheeler to the new chair of fuel technology at the University of Sheffield. The latter's researches in the constitution of coal are classical, while Dr. Lowry's work at the Ministry of Munitions has received full recognition. Sir John Cadman, Director of Petroleum to the British Government, has been appointed a member of the Advisory Council for Scientific and Industrial Research.

Lake Superior Meeting of the A.I.M.E.

Report of the 122d Meeting of the American Institute of Mining and Metallurgical Engineers, Giving Short Descriptions of the Lake Superior Milling and Smelting Practice and of Some of the Papers Presented

LAKE Superior region was the scene of the 122d meeting of the American Institute of Mining and Metallurgical Engineers, their technical sessions starting at Houghton, in the "copper country," just twenty years from the date of their last visit. Over a hundred members of the party had been gathered together since the previous Friday morning on board one of the lake passenger steamers, en route from Buffalo. On this journey the usual pleasures of a water voyage were experienced, ranging from "rubber-neck" wagons at the ports of call to a strong north wind on Lake Huron, either of which was well calculated to disturb the equanimity of the dignified.

That storm so delayed the boat's arrival at Houghton that no inspection trips were possible Monday afternoon, except for those members who had foregathered by rail. Tuesday, however, the Engineers grouped themselves in small parties and were motored over any route which their interests suggested, examining geologic formations, mining methods, surface plants, mill, smelter, refinery or reclamation plant as they desired. Luncheon brought them together at a little bay on the extreme northern end of Kewenaw peninsula, where a picnic full of local color was enjoyed by visitors and hosts. The visitors dissected the anatomy of a "pasty," and enjoyed a four-cornered wrestling bout done in true "Cousin-Jack" manner, while the hosts were able to get impressions of Mr. Hoover from many angles.

Visitors Provided With Every Comfort

Mining men who have acquired tender feet from prolonged use of subways and golfing togs certainly have nothing to complain of the many thoughtful attentions given by those in charge of their entertainment in Houghton. Visitors were housed in a rolling hotel composed of Pullman and dining cars, complete enough in itself, but given the finishing touch by the early morning arrival of a road engine, which furnished steam heat and hot water, a comfort well appreciated by anyone who can remember the morning chill in northern woods.

Sightseeing and Social Events Take Precedence

Sightseeing and social events took more marked precedence at this 122d meeting than for many past occasions. Relatively few technical papers describing details of local mining and metallurgical operations were read, this deficiency being atoned for by the presentation of a 260-page "Handbook of Mining in the Lake Superior Region," prepared by Alexander N. Winchell, professor of mineralogy, University of Wisconsin, and by the engineers clubs of northern Minnesota and Duluth. Personal inspection also shows improvements in many important operating details, many of which are well worth attention in technical literature. Possibly in no other region could a visitor see Collom tappet jigs and low-pressure steam turbines operating in the same mill, nor a blast furnace making block copper close neighbor to an ammonia leaching plant.

Lake Superior Milling and Smelting Practice

Lake Superior milling and smelting practice is distinctly an adaptation to local needs. Primary crushing is done in steam stamps because that is the only high-tonnage machine which will not be "frozen" by the occasional piece of mass copper which slips through. After stamping through $\frac{3}{8}$ in. the ordinary practice, as illustrated by the Quincy mill, was to get a little copper by launder jigs before the [illegible] or $\frac{3}{16}$ in. material (oversize crushed by rolls) was jigged in Collom tappet jigs. The hutch product of these was classified and fed to more jigs, the middlings of which joined the classifier overflows, were settled and cleaned on tables. Such practice—what with the peculiar association of gangue and native copper—gave a recovery of approximately 15 lb. of copper and a tailing of 7.5.

Recent improvements made by Ralph Hayden at this mill have cut the tailing in half, with a corresponding recovery. He substituted real jigs of ample capacity for the "oversize" launder jigs, and sized the roll product so that three separate banks of machines are handling material of certain limiting dimensions. This was in an effort to catch as much mineral in the coarse form as possible, and relieve the machines handling finer products of just that much duty. All jig tailings are then reground in ball mills and passed over a system of primary, middling and cleaning tables.

Older practice at the Calumet & Hecla mill has produced a tremendous volume of much higher-grade tailings than the various amygdaloid ores produce. This is now being reclaimed, reground and settled and the values in the sands leached by ammonia solution,[1] while the slimes are cleaned in flotation machines. This new plant is a model in many ways, and thoroughly in keeping with modern engineering advance.

It contrasts sharply with the primitive 10-ton melting and refining furnaces used to profusion in the smelters. Not that this plant is devoid of improvements, for it has one battery of three large furnaces equipped with every improvement: charging machine, casting machine, pulverized fuel and waste heat boilers. Necessity for keeping various ore receipts separate and the impracticability of accurate sampling have prevented the more widespread installation of modern labor-saving devices. Studies and complete plans have lately been made by the C. & H. staff, working in conjunction with C. H. Repath, involving radical changes in this layout, an improvement which is now held up by unfavorable market conditions. A feature of the new plant will be the separation of the melting from the refining stages—now done successively in the same furnace.

Large reverberatories similar to those in use in Western plants will melt the mineral, delivering practically pure molten copper to the refining furnaces, there to receive the finishing touches.

[1]Process devised by C. H. Benedict (see *Eng. & Min. J.*, July 14, 1917, p. 48), similar to that described in CHEM. & MET. ENG., vol. 20, No. 7, April 1, 1919, p. 328.

On Tuesday, Aug. 24, the party went to Marquette, Mich., and inspected the plant of the Cleveland-Cliffs Iron Co.

The original Pioneer charcoal furnace, the first in Michigan, was built in the City of Negaunee in 1857, and was operated almost continuously until 1895, when it was abandoned. In February, 1890, the Pioneer Iron Co. was acquired by the present owner, the Cleveland-Cliffs, Iron Co. This was the beginning of the furnace and chemical department of this company. In 1903 the Pioneer furnace at Marquette was completed and went into blast in connection with the chemical and byproduct plant, and has operated continuously since that time. It is 70 x 13 ft. with a 7 ft. hearth. To supply this furnace with charcoal under normal running conditions, eight acres of hardwood is cut over daily, making about 200 cords of wood. Its capacity is 130 tons of pig iron per day.

In addition to the basic products (methanol, methyl acetone, acetate of lime), the chemical plant produces c.p. acetone, acetic acid, formaldehyde, flotation oils, insulating pitch, sodium acetate, sulphuric acid, iron liquor, methyl acetate, special solvents, hexamethylenamine and pure creosote.

The methanol and acetone are used principally for solvent purposes and in the production of dyes; acetic acid for the cutting of lead, production of vinegar and dyes; formaldehyde as a disinfectant, preservative, treatment of seeds to prevent smut, scale, etc., and in the production of insulating material, such as bakelite, etc. Hexamethylenamine is chiefly used as a drug, largely in cases where internal disinfection is required.

The wood is prepared mechanically, coming in as logs and going through the splitting and block mills, coming out in 8-in. lengths, where it is put into pre-driers, which are heated by the waste gases from the retorts. By this means charcoal can be put in the blast furnace within seven days from the time the tree is cut.

The furnace and also the chemical plant are thoroughly modern. The furnace is equipped with self-dumping device for the charcoal, has steel ore bins, motor-driven scale cars, skip hoist and revolving top.

Technical Papers Presented

Surface Changes of Carbon Steels Heated in Vacuo

E. Heaton Hemingway and George R. Ensminger described some experiments made at the Watertown Arsenal on "Surface Changes of Carbon Steels Heated in Vacuo." After heating a highly polished piece of 1.01 per cent carbon steel at 1,000 deg. C. for six hours there appeared on the cooled surface, when examined at 500 magnifications, very delicate pearlitic grains outlined by ragged continuous markings, lightly depressed, the whole probably representing the structure stable below the transformation. Clearly independent of these figurings, deeply marked polygonal crystal outlines, with straight elements, represented the gamma boundaries. A third system, suggestive of broad shallow valleys, more or less independent of either, was thought to represent the boundaries of former gamma crystals that have been absorbed by crystalline growth.

This outside layer of carbon-free iron was very thin—a moderately heavy polishing, followed by the usual etching, would exhibit the original hypereutectoid structure. Similar markings remained on lower carbon steels after a similar heating, but in this case the depth of the pure iron was considerably deeper, although not so deep as found by Rawdon and Scott.[1]

Study of the deposits formed on the inside of the vacuum tube led the present authors to the conclusion that the outside layer containing the characteristic markings consists of a ferrite volatilized at the high temperature and redeposited below the temperature at which solid solution exists. Any iron oxide existing on or in the steel would also tend to cause decarburization by breaking down cementite with formation of corresponding amounts of carbon oxides.

Utilization of Titaniferous Iron Ore

An interesting paper on "Utilization of Titaniferous Iron Ore," as practiced in New Zealand, was presented by J. A. Heskett. Large quantities of titanium-bearing iron beach sands are available; these, however, contain large quantities of ferrous oxide. Accepting the established opinion that such an ore would smelt slowly, the author made a mixture of equal parts of the sand and coking coal, coked the combination, producing a ferrocoke having 36 per cent metallic iron and 40 per cent carbon. This was then charged with limestone into a 3 ft. x 8 ft. cupola, and produced ten tons per day of very close-grained gray iron. However, the coke broke up into very fine particles and gradually plugged the furnace.

Briquetting and coking a 1 coke : 3 sand mixture, using sodium silicate for binder, and then smelting with coke and limestone gave no fines and a free-running slag, yet the iron was white. The briquet evidently contained sufficient carbon to deoxidize the ore, yet the time in the coking process (30 min.) was insufficient, resulting in direct reduction immediately above the tuyeres at comparatively low temperature.

Using a 45-ft. blast furnace (8 ft. bosh, 4 ft. hearth) with 20-oz. blast at 1,000 deg. F., the charge consisted of briquets containing 50 per cent iron. These were made by grinding eight parts sand and one part coal to an impalpable powder, pressing and carbonizing. Slags were very fluid, but coke consumption was high, and the hearth gradually built up with a mixture of coke, ferrotitanium and cinder. By tapping at short intervals (2 hr.) this high-titanium mixture was flushed out of the furnace between iron and slag. It appeared that approximately 85 per cent of the TiO_2 content in the ore was accounted for as a slag constituent. The remainder was divided, 5 per cent into a high TiO_2 cinder, and the rest in ferrotitanium.

Their experience is that their pig iron will not "grain out" as will other irons of similar analysis. It has a ready tendency to chill to a depth of less than $\frac{1}{16}$ in., even in sand castings, and despite the fact that the iron contains 2.5 per cent Si and 0.04 per cent S. This is usually accompanied, however, by an excellent surface appearance and a strength about 25 per cent higher than expected.

Nitrogen in Steel, and the Erosion of Guns

When studying the structure of failed steel bottles which had contained nitrogen and hydrogen at high temperatures and pressures (in the Haber process), H. E. Wheeler observed a decarbonized inner case, structureless under normal etching agents, and permeated by cracks. Its scleroscope hardness was 20, but a small amount of cold work increased it to 75. Under

[1]Chem. & Met. Eng., vol. 22, No. 7, April 28, 1920, p. 787.

the microscope no pearlite was evident, although chemical analysis showed from 0.05 to 0.58 carbon, depending upon the alloy steel under examination—chromium-vanadium steel being the most resistant. No satisfactory method for determining nitrogen in this metal was available at the Watertown Arsenal, where the investigation was conducted.

Normalizing at 1,000 deg. C. in vacuo closed the cracks, and caused the reappearance of considerable pearlite in the affected zone, the latter change not occurring if the sample was heated in the air, while the former change was due to relief of internal stresses.

Small cylinders of various analyses were then heated in ammonia for 20 hr. at 650 deg. C. and cooled in the same atmosphere. Nascent nitrogen from such treatment forms Fe_2N, this compound being stable below 450 deg. C. Carburization also occurs in low-carbon irons by pyridine or hydrocarbon impurities in the gas, while decarbonization takes place in hypereutectoid steels. Washed metal is apparently unaffected, while white cast iron becomes coated with solid iron nitride ⅛ in. deep, a layer easily removed and analyzing Fe_2N plus about 1 per cent carbon. Many alloy steels were studied in this way, and it was concluded that the alloying elements did not combine with the nitrogen, but affected the penetration only as they affected the carbide. Nickel steel, for instance, heated above the critical for 12 hr. gave, when cross-cut, polished and etched, a deep white case, grading into martensite, and thence into a central zone showing pronounced dendritic structure, which latter is reverted to the normal pearlite grains by vacuum treatment. Cold work greatly assists the penetration, the work apparently shattering the cementite so that it is more easily taken and retained in solid solution by the combined action of heat and nitrogen.

These effects were so similar to the oft-described phenomena accompanying gun erosion that Mr. Wheeler proposes a new hypothesis for the cause of this deterioration. Briefly it is that the hard white layer on the inside of an eroded gun is a locally cold-worked (and therefore hard) austenitic case due to penetration of nitrogen at the high pressure and temperature during the course of an explosion.

Casting and Molding Steel Ingots

EMIL GATHMANN presented a brief paper on "Casting and Molding Steel Ingots," in which he classified steel into three divisions: *A*, non-effervescing, killed, or solution steel so made that the lower portion of the ingot is free from blowholes, segregation or pipe: *B*, effervescing gassy or evolution steel, making an ingot containing deep-seated blowholes without pipe or shrinkage cavity; and *D*, a midway class of less commercial importance and ease of definition. Division *A*, comprising only one-eighth the American production, is used for superior-quality material, ordnance, rails, and high-strength materials. *D* cannot be used where surface finish is important. *B* and *D* are usually squared on the ends only, total discard amounting to 20 per cent. Division *A* must be cast big end up to prevent concealed pipe by crystals bridging across the molten center; easy commercial methods for stripping such ingots have been devised, and approximately 1,000,000 tons is made in this manner each year. Killed steel should possess 0.20 residual silicon, while effervescing steel obviously must have silicon and other deoxidizers in very small quantity. When cast properly at low temperature into hot molds, piping steel can be made with only 5 per cent discard. The molds must have large mass near the base, and be devised so that the top is kept molten to the last, preferably by auxiliary heating.

Type *D* steel cannot be improved by any known mold-design short of fluid compression. Best results in type *B* are had when ingots are bottom cast, although superior results regarding deep-seated blowholes and freedom from "snakes" have been effected by so-called top-bottom casting, where a large volume of very hot steel enters the mold at low pressure and velocity. One large unsolved problem in this type of steel yet remains, however, which is the prevention, or rather reduction, of segregation.

Note on Pro-Eutectoid Ferrite

When studying the structure of a cast-steel runner (0.35 per cent C, 2.69 per cent Ni) CHARLES V. CLAYTON noted a peculiar occurrence in the pearlite kernels. Ordinary reticular structure was observed at low power, but on higher magnifications the very fine, almost sorbitic pearlite granules exhibited white ferrite markings arranged like Widmanstättian bands ordinarily, but often as swirls or rosettes.

The author supposes that a whirling motion in the liquid steel rounded the tips of dendritic branches, upon which low-carbon austenite would be precipitated, due to the selective freezing or differential crystallation noted by Foley,[3] which upon passing the transformation range would give birth to the bent ferrite plates.

Variation in Length of Wood Fibers

A new conception of wood fibers is given by the great number of measurements that the Forest Products Laboratory in Wisconsin has made. The length of the fibers, instead of being uniform and characteristic in each species, has been found to vary more in a single tree than in the average for different species. One Douglas fir had fibers ranging from 0.8 to 7.65 mm. in length, though several thousand measurements showed the average for the Douglas fir to be 4.41 mm. and for the long leaf pine 3.76 mm.—a difference in the average for the two species of less than 1 mm., or one-twenty-fifth of an inch. In early growth, up to twenty to fifty years, the fiber length increases strikingly from the center outward, but after the maximum has been reached the variation is small, even though the tree live to 400 years or more. There is also some increase in fiber length from the butt of the tree upward for about two-thirds of the distance to the top. Each annual ring shows variation, the wood of early spring having longer fibers than that formed last in summer.

Develop Bonding Clays

Blends of bonding clays for use in crucible manufacture, which have been in process of development at the Ceramics Station of the Bureau of Mines at Columbus, Ohio, have reached a point where the Bureau is confident that the entire sufficiency of domestic clays has been proved. Since bond clay must possess a variety of properties, such as plasticity, bonding strength, slight shinkage and a tendency not to slag, no one clay has been found entirely adequate. Requirements for all uses are being met, however, by the blends which are being developed. A number of domestic clays have been developed which have been found to be superior to the clays imported before the war.

[3]CHEM. & MET. ENG., vol. 22, No. 3, Aug. 1, 1919, p. 140.

Convertion of Walnut Shells Into Poultry Charcoal in a Rotary Kiln

By Harry L. Glaze and Raymond B. Stringfield*

To convert walnut shells, a waste product, into poultry food, a salable commodity, seems at first glance a difficult problem, but in reality it is quite simple. The solution of the problem brought out several features capable of rather wide application.

Briefly, the problem was this: From the walnut crop of southern California there are produced many tons of nuts which are scarred or otherwise off grade. These were formerly discarded or sold for next to nothing. With the development of a cracking machine, the meats from the cull nuts were made to yield a profit, but there remained as a waste product a thousand tons or more of shells per year. These were expensive to handle and bulky to dispose of. Used as a fuel, they proved to be unsuitable when burned loose, and were difficult to briquet. The available tonnage was too small to permit of the profitable operation of a retort process for the production of charcoal, acetic acid and creosote. Several attempts made to develop a profitable outlet for the shells had proved unsuccessful.

Upon investigation it was found that many tons of willow charcoal were brought into southern California each year to supply the large poultry ranches; it was also found that walnut charcoal was even better than willow for this purpose. Experience with the incineration of kelp in a rotary kiln for the recovery of its potash content convinced the authors that charcoal could be produced economically in a similar type of apparatus, and operation of the completed installation proved this surmise to be correct.

Description of Plant

The feature of the installation is its extreme simplicity resulting in low power and labor costs. Incoming shells from the walnut cracking plant are fed into the hopper of a No. 2 Sprout-Waldron corn grinder, the hopper being set flush with the unloading platform. The grinder reduces the shell to approximately 4 mesh, with the production of very little dust and fines. The product weighs about 31 lb. per cu.ft. A bucket elevator delivers the ground shell to a storage bin of five tons capacity. The bin has a 45 deg. hopper bottom, closed by an adjustable vertical gate, through which a reciprocating slide feeds a regulated quantity of ground shells into the kiln at each revolution.

The kiln is a steel shell 20 in. in diameter and 19 ft. long, lagged on the outside with asbestos felt 1 in. in thickness. This is mounted on trunnions and has a slope of 1 ft. in 10. There is a special arrangement of lifters and baffles designed to secure agitation of the shells during charring. It has been found that proper agitation is especially important, as it was almost impossible without it to control the conditions of charring. A chain drive rotates the kiln at 10 r.p.m. The regulated discharge from the storage bin flows into a hopper from which it is fed into the kiln by a rotary scoop such as is commonly used on ball mills. Through an 8-in. hole in the center of the scoop pass three 1½-in. ordinary type gas burners. These have atmospheric mixers and $\frac{1}{32}$-in. openings and burn 3 cu.ft. of gas per minute each.

*Mechanical and chemical engineers, Arthur R. Maas Laboratories.

As the ground shells enter the kiln, they pass through the flame and into a zone of high temperature. Active decomposition begins immediately and is accompanied by the complete combustion of the dust formed in grinding. About 6 ft. from the inlet end of the kiln an exorthermic reaction sets in, the burning ceases and energetic distillation takes place. This is accompanied by dense clouds of creosote-bearing smoke. In the last few feet, distillation is completed, and the thoroughly charred shells are cooled. The charcoal discharges into a hopper and is quenched by a water spray. From the hopper it is conveyed to a rotary screen yielding 4-, 6- and 10-mesh products, which are sacked. The product is of excellent quality, free from dust, and of slightly higher gas-absorbing power than ordinary willow charcoal. The yield is slightly over one ton of charcoal per three tons of shells.

The flue gases are blown by means of a 10-in. fan into a scrubber, where practically all of the tar and creosote is removed by means of sprays. About 40 lb. of tar is recovered per ton of shells. The tar is suitable for use as a timber preservative. On distillation it yields excellent grades of creosote, heavy oil and pitch. No attempt is made at present to recover the acetic acid and other soluble constituents of the spray water.

Cost of Operation

The plant has proved simple and economical to operate. The feed is easily regulated and the shells are thoroughly charred without ashing. The grinder can be so regulated that practically the entire product is between 4 and 10 mesh. A 10-hp. motor furnishes ample power, drawing only about 4 hp. average load. Four men operate the plant—one per shift, with an extra man on the day shift to sack charcoal and do repair work. The chief source of trouble is the flue connecting the kiln with the scrubber, which catches considerable tar and burns out occasionally, making it necessary to clean out the flue every few days.

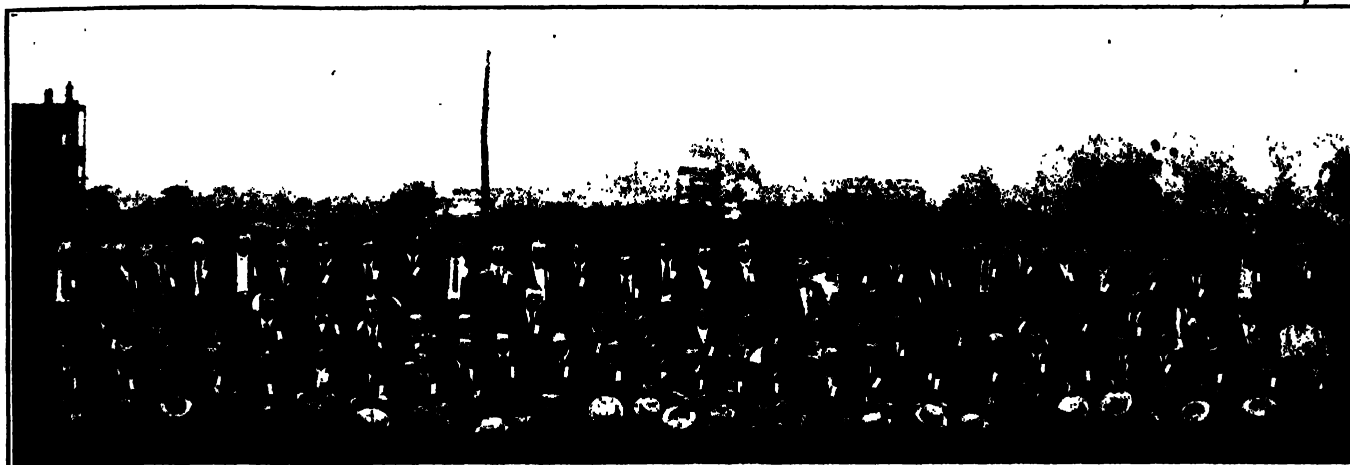
The plant has a capacity of three tons of shells per 8-hr. shift, yielding slightly over three tons of finished charcoal per twenty-four hours. Neglecting overhead and the cost of shells, the present cost of operation is:

Capacity:	
Twenty-four hr. operation, 18,000 lb. shells, 6,000 lb. charcoal	
Operation Cost per Day:	
Three men at $5	$15.00
One man at $4	4.00
Gas at $1 per ton of shells	9.00
Electricity at 6c. per Kw.-hr. for 4 hp	4.56
Water	1.50
	$34.06
Cost per Ton of Charcoal:	
Operation	$11.35
Sacking at 20c. per sack	4.00
Cartage on 3 tons of shells	3.00
	$18.35

Since poultry charcoal is selling on the Pacific Coast at $50 per ton and up, it will be seen that the plant is a profitable venture, even neglecting the value of the tar and creosote recovered as a byproduct.

Test runs have been made on apricot, peach and prune pits and on ordinary sawdust and shavings, and excellent results have been obtained in each case; the charcoal, of course, varies with the raw material. As the initial cost of the equipment is low, this type of plant with its flexibility and small operating cost may solve the waste disposal problem of other industries, even of those operating only a few months in the year.

Los Angeles, Cal.



Chicago Meeting, American Ceramic Society

Abstracts From President Minton's Remarks on His Investigations of the Economic Situation of the Ceramics Industry and Business Conditions in Germany—Short Notes on the Visits to Some Chicago District Industrial Plants

THE summer meeting of the American Ceramic Society, in accordance with the usual custom, followed a program of inspections of manufacturing plants, no papers being presented. The opening feature was the banquet at the Hotel LaSalle on Monday night, Aug. 16.

W. D. Gates, the dean of Chicago ceramists, presided at this function. Secretary Binns and Mr. Gates, charter members of the society, indulged in reminiscences of former times to the delight of the guests.

The chief address was delivered by President Minton, who had just returned from an extended trip through Germany investigating the ceramic industries and business conditions. His remarks covering general conditions are given in brief below.

President Minton's Address

"My journey was by way of England and Holland to Berlin, thence to Essen, Cologne and the Rhine cities. I found conditions very bad, the food supply being inadequate with nothing but black bread and potatoes available in the smaller cities. At the large hotels in principal centers there is plenty of food at fabulous prices, which accounts for the optimistic reports of some travelers. Everything is issued on cards as during the war and 100 g. of bread per person is the daily allowance. Importation of other than gift food is not allowed by the authorities, who are desirous of conserving the supply of available cash. Some food is smuggled in through Coblentz, as no frontier is recognized and consequently no inspectors are in evidence at this point. There are 550,000 children being fed by the German Government. These are on the average two years undersize for want of proper nourishment.

"The economic situation is exceedingly bad. Transportation equipment is particularly depreciated. Every car in Germany has a flat wheel. Upholstering has been ripped from the car seats to be used for clothing. This is also true of household furniture. I did not see any of the paper suits in evidence, but paper belting is being used in factories and is said to be as efficient and long lived as leather belting.

"I visited twenty-seven clay plants and three chemical plants during the period. The Krupp works at Essen employ about 38,000 persons engaged in manufacture of typewriters, sewing machines and similar peace-time products. Many ceramic plants are burning wood for fuel. All are operating at about 50 per cent capacity because of lack of fuel.

"The attention paid to detail in these industries is remarkable. Clays are floated in order to segregate the finest material and classify the remainder. One plant is using the ultra-violet rays over the clay solutions to kill the bacteria which would otherwise exert action to collect the iron particles and subsequently speck the wares.

"Several companies are engaged in making large quantities of stove tiles, a business entirely ignored in America. These artistic tile stoves are lined with refractory materials which hold the heat in the room. The tiles are pressed very soft in aluminum molds, insuring perfect cast pieces."

Plant Inspections

Chicago industrial plants were visited as outlined below. The Western Electric Co. gave a complimentary luncheon on Tuesday and the Chicago Hardware Co. entertained the members in like manner on Wednesday.

Bach Brick Co.

This plant is a typical example of distinctive methods employed in the manufacture of common brick in the Chicago district. The clay from the pits contains from 8 to 14 per cent combustible matter, and coal dust is sometimes added to assist in the burning. The clay comes from the cutter with practically no previous working, is stacked on iron cars and put through the waste heat driers. The cars are then run out to an open area, where the overhead crane with special hoisting grapples lifts the mass of brick from a car in one

operation and transfers it to the huge rectangular pile. Large quantities are stacked in a short time; the outside of the pile is walled over with a layer of burned brick and mud; oil burners are inserted in eyes near the bottom and the burning operation started. The finished brick are loaded directly from the pile to wagons and cars.

NORTHWESTERN TERRA COTTA CO.

This manufacturing plant involves methods of procedure combining the skill of artist and scientist to produce commercial wares. It is a huge art studio employing numerous designers and clay modelers on one hand and demanding application of the exact science of chemistry to finishing glazes on the other. This is immediately evident in the fact that 35,000 tons of clay is molded to special shapes each year. No stock pieces or molds are kept. Each order calls for new designs. And the glazes used require all the colors of the spectrum with all the infinitely delicate shadings and blendings so essential for an appeal to the artist's eye. Here the ceramist is in his glory.



FIG. 1. PARTLY FINISHED ORIGINAL DESIGN FOR THE WRIGLEY BUILDING, CHICAGO

The raw clay is brought in from the Indiana coal district by rail and mixed with suitable grogs depending on the ware desired. The clay sculptor with the aid of architect and pen artist produces the original design from which plaster of paris molds are made; these molds are sent to the casting room, where the required number of pieces are cast. Then the finishers tool out the imperfections by hand and work the finer clay to the surfaces.

The drying is carried on in ten Carrier Engineering Corporation chambers, where the air is conditioned from a temperature of 130 deg. F. and a relative humidity of 70 at the start to a temperature of 180 deg. F. at the finish. Taylor Instrument Co. instruments are installed for the proper control of the driers.

The glazes are sprayed on in some instances, but a large amount of work is done with the brush.

A spacious ceramic laboratory is equipped to control the scientific features and prepare new glazes. Fig. 2 shows an Isko refrigerating machine used for freezing a piece in the laboratory. When this is thoroughly chilled it is removed and subjected to a steam bath on one side and protected with an ice bath on the other—a rigorous test of glazes against climatic conditions. Abbe mills are used in preparing the glazes.

The burning operations employ thirty-five periodic kilns of the muffle type and eleven days is required for the burning cycle. Maximum temperature of about 1,050 deg. C. is reached. In addition a 320-ft. Dressler tunnel kiln has just been installed, increasing the capacity of the plant about 50 per cent. This kiln continuously turns out about eighteen industrial cars of ware per day and burns oil for fuel, reaching a temperature of 2,100 deg. F. in the hot zone. The estimated efficiency of fuel consumption is 75 per cent, against 10 per cent efficiency in the periodic kilns. The waste heat is conveyed overhead to the Carrier driers.

LINDSAY LIGHT CO.

The production of gas mantles from oxides of cerium and thorium nitrates burned to oxides is carried on after the method of the Welsbach Co. of Philadelphia, which was described in detail in the Oct. 15, 1919, issue of CHEMICAL & METALLURGICAL ENGINEERING, page 497. The monazite sands from Brazil are passed through an electro-magnetic separator to remove the iron and thence to the digesters, continuing through the same process as the Welsbach, with slight modifications.

COONLEY MANUFACTURING CO.

The production of enameled kitchen ware in this plant involves two distinct departments, namely, the fabrication of the metal shape, involving punching, drawing and annealing of sheet steel to shape, and the application of the enamel or "granite" coating to the piece. The first department is a series of large machine shops with a variety of presses and continuous annealing furnaces arranged to anneal the metal between drawing operations. Rapidly operated electric spot-welding machines are employed to attach handles and lugs to the various utensils.

The enamels are prepared dry in a battery of Abbe mills and subsequently mixed with water in the tanks

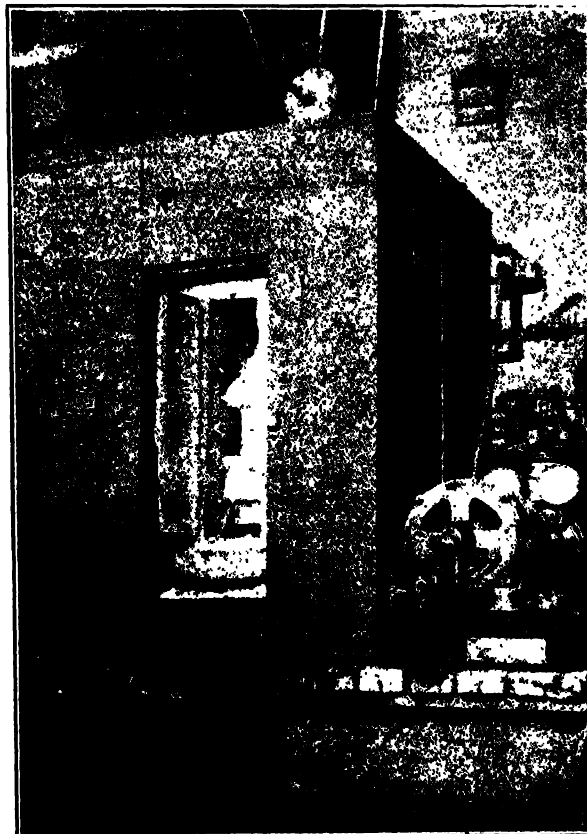


FIG. 2. TESTING GLAZE BY FREEZING

at the dipping benches. Women are employed for the dipping room work, which is done by hand. The mottled effect on granite ware is obtained by throwing a second color on with a coarse stipple brush and turning the piece in the hand while the splotches are still wet. Various trimming coats are given by brush or dipping.

The ware is placed in movable racks, which are later wheeled to the drier. The burning on is accomplished in a short space of time by introducing into coal-fired muffle kilns and removing almost immediately. Though most of the coating operation is hand work, the production is enormous.

The company is erecting a large steel and brick building which when equipped will double the plant's capacity.

WESTERN ELECTRIC CO.

Some idea of the extent of this mammoth Chicago concern may be gathered by an inspection of the power house which generates 150,000 kw. from steam turbogenerators. An increased capacity to a total of 200,000 kw. will be available when the new General Electric turbine goes into service. The total factory space is 3,000,000 sq.ft., devoted entirely to the manufacture of telephone equipment. There are 22,000 employees engaged in turning out 100,000 telephones per month, 400,000 switchboard lines per year of central office equipment and other commercial systems. The work is particularly rushing at this time due to the change over of the entire Bell telephone system to automatic central station control, which requires new apparatus with the present system maintained in operation during the period.

The cable plant turns out 250,000,000 conductor ft. of telephone cable, or 98 per cent of all the telephone cable produced in America.

The visitors were provided with a sufficient number of guides to give one guide to each four men—quite a departure from the ballyhoo usually attempted. Space will not permit an adequate description of this trip, but should manufacturers in general organize inspection trips as the Western Electric did in this instance the educational benefit to visitors would equal many months of study and be of inestimable value in our industrial development.

AMERICAN STEEL & WIRE CO.

This factory, like the Western Electric Co., conducts operations on an enormous scale. Billets 4 in. x 4 ft. of high- and low-carbon steel are received from the mills of the Chicago district as raw material. These are heated in furnaces and rolled to rods about $\frac{5}{16}$ in. in diameter which are handled as coils of wire. After pickling in muriatic acid and neutralizing with lime solution, they are annealed and ready for the drawing operations.

The company makes fence wire, copper, zinc and tin finished fine wire, wire fence, springs of all sorts, wire nails and baling wire. An interesting feature of the drawing operation is the use of a fermented rye meal solution for lubricating the wire just before it enters the dies. Details of the chemical control will be presented in a subsequent issue of CHEM. & MET.

CHICAGO HARDWARE CO.

This plant produces small castings and white glass table tops. It is the most successful manufacturer of small iron castings in the Chicago district and has an elaborate department for making small and intricate cores.

After an evening at the outdoor opera in Ravinia Park, the meeting was concluded. The Chicago Section's hospitable entertainment was deeply appreciated by the visiting members.

Canada's Sugar Industry

There are three sugar plants in the Province of Ontario, two in Quebec, and one each in British Columbia, New Brunswick and Nova Scotia.

The amount of capital invested in the industry in 1918 for the whole of Canada was $37,256,851, apportioned by items as follows: Land, buildings, and fixtures, $17,733,990; machinery and tools, $6,108,445; materials, stocks in process, finished products, fuel, and miscellaneous supplies on hand, $6,511,626; and cash, trading and operating accounts, and bills receivable, $6,902,790. The capital invested in Ontario plants was $11,407,382; in Quebec, $5,869,592; and in the remaining provinces, $19,979,877.

The quantity and cost value at the works of the material used during 1918 are shown below:

Classes of Materials	Tons	Cost Value at Works
Beets	204,017	$2,593,715
Raw sugar	313,651	39,991,144
Bone black and other materials	....	529,059
Boxes, bags, other containers	..	2,289,119
Total cost		$45,403,037

The quantity and selling value at the works of the various products are shown in the following table:

Kinds of Products	Quantity	Value
Sugar, granulated, pounds	651,940 965	$57,080,353
Molasses or sirup, gallons	1,559,694	1,016 626
Beet pulp, tons	11,069	411,645
Lime, bushels	22,590	6,250
Fertilizers, tons	1,284	43,075
Cattle food		151,776
All other products		102,494
Total value		$58,812,219

"Colloiditis" Prevalent in Britain

FROM OUR LONDON CORRESPONDENT

London, August 9, 1920.

The use of the word "colloid" is at present being made an excuse and a catchword in the chemical industry and elsewhere, the uninstructed public having heard so much recently of progress in colloidal chemistry that any new project connected or presumably connected with it attracts undue attention. Even in the realm of "colloidal" fuel methods in which the fuel and oil are merely blended without the aid of a peptizing agent are being exploited by companies under names such as the Colloil Trust. Dr. Searle's recent book on "The Use of Colloids in Health and Disease" also suffers from the craze of applying the term "colloid" indiscriminately and the book was trenchantly and amusingly criticised in the *Journal of the Society of Chemical Industry* of June 30, p. 211R, by Dr. H. H. Dale. Thus Dr. Searle states that all products of digestion are essentially colloidal and, after previously stating that solutions of colloids do not pass through membranes, assumes that in the presence of common salt their passage is considerably increased. From this Dr. Searle deduces "the advisability of eating salt with so typical a colloidal gel as a boiled egg," but to quote Dr. Dale's criticism, "if salt will get a boiled egg through the alimentary mucous membrane, digestion becomes a mere hobby."

Program of Chicago Meeting, American Chemical Society

THE following is the final program of the general meeting, entertainment, industrial excursions and Industrial, Rubber, Fertilizer and Leather Divisions:

Monday, Sept. 6

4 p.m. Council meeting in Parlor B, University Club.

6:30 p.m. Councillors' dinner given by Chicago Section in College Hall, University Club.

8 p.m. Council meeting reconvenes in Parlor B.

Tuesday, Sept. 7

10 A.M.—GENERAL MEETING, GOLD ROOM, CONGRESS HOTEL

Address of welcome by Prof. Julius Stieglitz, honorary chairman, in behalf of Chicago Section.

Address of welcome by Joseph R Noel, vice-president of Chicago Association of Commerce, in behalf of Chicago business men.

Response for Society by Prof. William Albert Noyes, president American Chemical Society.

"The Value of Technical Training in the Reconstruction of Industries," by Thomas E. Wilson, president Wilson & Co., packers.

"Chemistry's Contribution to the Life Sciences," by Dr. A. S. Loevenhart, University of Wisconsin.

The directors of the Chicago Chemists' Club will entertain the directors and the advisory committee of the American Chemical Society at luncheon, club headquarters, 315 Plymouth Court.

The Association of Harvard Chemists will meet in the Green Room, Congress Hotel, for luncheon and the semi-annual meeting.

1:15 p.m. Take special elevated trains at Adams St. Station for Noyes St., Evanston. Badge admits to trains.

3 p.m. General meeting reconvened in Patten Gymnasium, Northwestern University campus, Evanston.

"The Relation of Educational Institutions to the Industries," by Prof. H. P. Talbot, Mass. Inst. of Tech.

"Some Uses of Silica Gels," by Prof. W. H. Patrick, Johns Hopkins University.

ENTERTAINMENT PROGRAM

4:30 to 7:30 p.m. Chicago Band concert on the campus.

4:45 to 5:30 p.m. Swimming exhibition in gymnasium pool.

5:30 to 6:30 p.m. Swimming in pool for men only. No suits required.

4:45 to 5:45 p.m. Organ recital in Fisk Hall by Hugo Goodwin.

5 to 6 p.m. Indoor-outdoor baseball game between Chicago section and the World. Captain—Chicago Section, L. V. Redman; the World, Charles H. Herty.

5:30 to 7:30. Dancing in the gymnasium.

4:45 to 5:30. Committee of Evanston women headed by Mrs. L. V. Redman and Mrs. W. Lee Lewis will serve punch at various stands on the campus.

6 to 7 p.m. Supper served on the lawn south of the gymnasium near the Shakespeare Gardens. Registrants are furnished with tickets.

4:30 to 7:15 p m. Outdoor smoker.

7:15 to 9:30 p.m. Evening entertainment.

8 to 10:30 p.m. Observatory will be open for inspection of the universe.

Special trains start for the city from Noyes St. at 9:40 p.m., but regular trains run all night.

Wednesday, Sept. 8

DIVISIONAL MEETINGS, 9 A.M. AT UNIVERSITY OF CHICAGO

Copy of the *Chemical Bulletin* furnished to all registrants will give explicit directions for reaching this and other locations.

DIVISION OF INDUSTRIAL AND ENGINEERING CHEMISTRY

Session opens with a symposium on "Cellulose Chemistry," which will be led by Dr. J. J. Esselen of A. D. Little, Inc.

"The Constitution of Cellulose," Harold Hibbert.

"Economics of the World Pulp Situation," Hugh P. Baker.

"The Regeneration of Book Stock," Charles Baskerville and Clarence Joyce.

"Recovering of News Print," Charles Baskerville and Reston Stevenson.

"On the Cellulose Content of Certain Compound Celluloses," Louis Kahlenberg.

"A Comparison of Wood Cellulose and Cotton Cellulose," S. A. Mahood and D. E. Cable.

"Acid Hydrolysis of Sugar Cane Fiber and Cottonseed Hulls," E. C. Sherrard and G. W. Blanco.

"The Preparation and Analysis of a Cattle Food Consisting of Hydrolyzed Sawdust," E. C. Sherrard and G. W. Blanco.

"Supply and Preparation of Wood for the Manufacture of Pulp," Hugh P. Baker.

"Parchmentizing Paper and the Reaction of Mordants," J. E. Minor.

"Is It Feasible to Form a Section of Cellulose Chemistry?" G. J. Esselen, Jr.

"Solvents for Phosgene," Charles Baskerville.

"Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel," (Lantern), Edward G. Mahin and R. F. Brewer.

"Soda-Lime for Industrial Purposes" (Lantern), Robert E. Wilson.

"Flow of Viscous Liquids Through Pipes" (Lantern), Robert E. Wilson and M. Seltzer.

"New Solvents for Rosin Extraction," H. K. Benson and A. L. Bennett.

"Comparative Study of Vibration Absorbers," H. C. Howard.

"Catalysis in the Manufacture of Ether," Hugo Schlatter.

"Use of Platinum Crucibles in Electro-Analysis. Copper Determination," Harold Van Doren and J. R. Withrow.

"Use of Platinum Crucibles in Electro-Analysis. Rapid Copper Determination," Rufus D. Rud and James R. Withrow.

"Estimation of Benzene in Admixture With Paraffine Hydrocarbons," H. McCormack.

"Preparation of Manganates and Permanganates," H. McCormack.

"Permanganate Determination of Sulphur Dioxide," H. S. Coith and James R. Withrow.

"Action of Permanganate Upon Sulphur Dioxide and Sulphides," F. C. Vilbrandt, Samuel L. Shonefield and James R. Withrow.

"Idiometric Determination of Sulphur Dioxides," Gordon D. Patterson and James R. Withrow.

"Uniform Packages for Reagent Chemicals," W. D. Collins.

"Uniform Specifications for Chemical Thermometers," R. M. Wilhelm.

"Recovery of Industrial Gases With Activated Charcoal," O. L. Bannebey.

"A Comfortable Dust Respirator," H. V. Main.

"Evidences of Auto Catalysis in the Hydrogenation of Cottonseed Oil," O. R. Sweeney and Joseph Elbert.

RUBBER DIVISION PROGRAM

Discussions, "Shall the Rubber Division publish an annual volume of reprints and lengthy abstracts of interest to the rubber chemists and the public during the year?"

W. B. Weigand, "Rubber Energy."

Research Laboratories, New Jersey Zinc Co., "The Aging of Some Rubber Compounds."

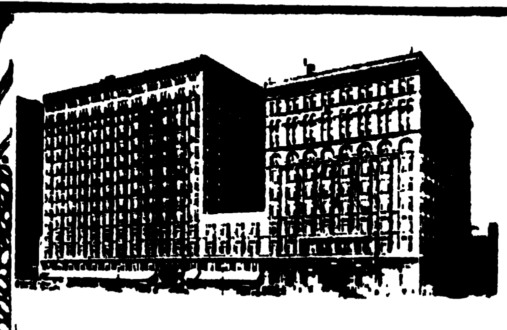
Research Laboratories, New Jersey Zinc Co., "Some Microsections Cut From Vulcanized Rubber Articles."



KENT LABORATORY UNIVERSITY OF CHICAGO



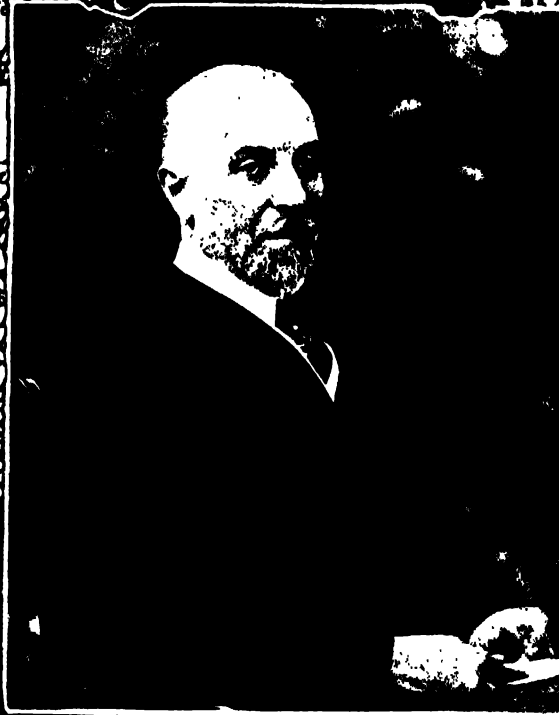
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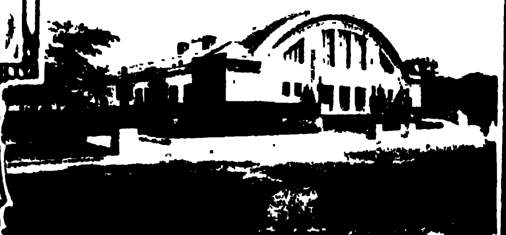
HENRY P TALBOT



NORTHWESTERN CAMPUS



A. S. LOEVENHART



PATTON GYMNASIUM NORTHWESTERN UNIVERSITY

G. D. Kratz, A. H. Flower and B. J. Shapiro, "The Action of Certain Organic Accelerators in the Vulcanizing of Rubber (II)."

G. D. Kratz, A. H. Flower and B. J. Shapiro, "The Action of Certain Organic Accelerators in the Vulcanizing of Rubber (III)."

J. F. Schufter, "Method for the Determination of Free Sulphur and Antimony Tri- and Penta-Sulphides in Golden Antimony."

J. B. Tuttle, "The Action of Heat and Light on Vulcanized Rubber."

Symposium, "The Analysis of Rubber," led by W. W. Evans.

Round table discussion of recent developments.

There will be samples on exhibition of rubber, vulcanized by Peachey's nascent sulphur method.

FERTILIZER DIVISION

"Kelp as a Basis of an American Potash Industry," J. W. Turrentine.

"Relationships of Chemistry and the Fertilizer Industry," C. H. MacDowell.

"A Perfect Fertilizer Law," E. G. Proul.

"Boron in Relation to the Fertilizer Industry," J. E. Breckenridge.

"The Quantitative Estimation of Borax in Mixed Fertilizers," J. M. Bartlett.

"Note on the Determination of Nitrogen in Fertilizers Containing Both Organic and Nitric Nitrogen," by F. B. Carpenter.

"Injurious Effects of Borax on Field Crops," F. B. Carpenter.

"The Changes Taking Place in Cyanamide When Used in Mixed Fertilizers," Rolla N. Harger.

"Dicyanodiamide. A Rapid, Direct Method for Its Determination in Cyanamide and Mixed Fertilizers," Rolla N. Harger.

"Some Results of Determination of Potash by the Lindo-Gladding Method of Using Alcohol of Various Strengths in the Presence of Sodium Salts," R. D. Caldwell and H. C. Moore.

"The 'Blank' in the Kjeldahl Process, Its Analytical and Commercial Significance," B. F. Robertson.

LEATHER SECTION

"Nature of the Hide-Tannin Compound and Its Bearing Upon Tannin Analysis," John Arthur Wilson and Erwin J. Kern.

"The Mechanism of Bating," John Arthur Wilson.

"Chemical Control of the Tannery," F. C. Orthmann.

"A New Method for the Recovery of Nitrogenous Fertilizer Material From Tannery Waste Sulphide Liquors," V. H. Kadish.

"The Influence of Acids on the Tannin Content of Tan Liquors," Alan A. Claflin.

"On the Swelling and Falling of White Hide in Vegetable Tan Liquors," George D. McLaughlin and R. E. Porter.

"Dyestuffs as Used in the Leather Trade," P. R. Roberts.

"The Effect of Concentration of Chrome Liquors in the Adsorption of Its Constituents by Hide Substance," A. W. Thomas and Margaret W. Kelly.

"The Determination of Hydrochloric Acid and Neutral Chlorides in Leather," A. W. Thomas and A. Frieden.

"Comment on Wilson and Kern's Recent Contribution to the Knowledge of Vegetable Tanning Agents," A. W. Thomas.

Luncheon arrangements have been made at the Edelweiss Gardens during the scientific meetings.

PLANT VISITS

1:15 p.m. Entrain at Van Buren and Randolph Stations, Illinois Central R. R., on special train, or catch same train at 57th and 60th St. stations at 1:30.

Doehler Die-Casting Co., maker of aluminum and white metal castings.

Pullman Car Works. Freight and assembly plants, where the "Ford plan" produces one every few minutes.

Sherwin-Williams Co. Visit the Dutch Process White Lead plant.

Carter White Lead Co. Making white lead by Carter process.

Libby, McNeill & Libby, Blue Island Cannery. Packing jelly, jam, mustard, olives, apple butter and catsup.

SOCIAL FEATURES

6:30 p.m. Alpha Chi Sigma fraternity dinner at Hotel Morrison.

8 p.m. "Chemical Publications," by President W. A. Noyes, Gold Room, Congress Hotel.

Thursday, Sept. 9

DIVISIONAL MEETING, UNIVERSITY OF CHICAGO

9 a.m. to 12 noon and 2 p.m. to 5 p.m. Division of Industrial and Engineering Chemistry will hold a Fuel Symposium arranged by A. C. Fieldner, Pittsburgh Station, Bureau of Mines, as follows:

"Low-Temperature Carbonization of Coal," S. W. Parr, University of Illinois; T. E. Layng.

"Carbonization of Canadian Lignite," Edgar Stansfield, chemist, Canadian Department of Mines.

"Efficiency of Various Fuels for Heating Houses," Henry Kreisinger, fuels engineer, Bureau of Mines.

"Byproduct Coking," F. W. Sperr, Jr., chief chemist, Koppers Company.

"Relation of Byproduct Recovery to Fuel Utilization and Economy," C. E. Lewers, Semet-Solvay Co.

"Use of Charcoal in the Extraction of Gasoline From Natural Gas," G. A. Burrell, president, Island Refining Co.

"Colloidal Fuels, Their Preparation and Properties," S. E. Sheppard, chemist, Eastman Kodak Co.

"Gasoline Losses Due to Incomplete Combustion in Motor Vehicles," A. C. Fieldner, supervising chemist, Bureau of Mines; G. W. Jones; A. A. Straub.

"The Enrichment of Artificial Gas by Natural Gas," J. B. Garner, Peoples Gas Co., Pittsburgh, Pa.

"Commercial Realization of Low-Temperature Carbonization of Coal," Dr. Harry A. Curtis, chief chemist, International Coal Products Corporation.

"Fuel Conservation, Present and Future," Horace C. Porter, consulting chemical engineer.

7 p.m. Semi-annual banquet, Gold Room, Congress Hotel. Evening dress optional. Tickets to registrants, $4. Toastmaster, W. Lee Lewis. Speeches and music.

Friday, Sept. 10

INDUSTRIAL EXCURSIONS

Illinois Steel Co., South Works, blast furnaces, bessemer converters, electric furnaces, open-hearth furnaces, rolling mills and gas-engine plant operating on cleaned blast-furnace gas. Train leaves Randolph St., Illinois Central R. R., at 8:19 a.m. and Van Buren St. at 8:20 a.m.

The following trip which includes plants listed below starts from the LaSalle St. Station from 8:10 to 8:27 a.m.

Albert Schwill & Co., maltsters.

American Maize Products Co., maker of cornstarch and byproducts therefrom, corn oil, dextrose, dextrin, glucose, etc.

Steel & Tube Co. of America, operator of Semet-Solvay byproducts coke plant and large tube mill.

American Steel Foundries Co., Indiana Harbor plant, maker of steel castings.

International Lead Co., electrolytic refiner of lead and electrolytic white lead.

Assemble at Congress Hotel at 1:30 p.m. for the following excursions:

The Fleischmann Co., maker of cider vinegar, malt vinegar, white wine vinegar and yeast.

National Malleable Castings Co., malleable iron castings.

Northwestern Terra Cotta Co., terra cotta and art decorations.

Fansteel Products Co., maker of pure tungsten and molybdenum.

Sears, Roebuck & Co., wallpaper and color plants. Leave at 1 o'clock and have luncheon at plant.

Heath & Milligan Co., manufacturer of pigments and mixer and grinder of paint.

Legal Notes

By Wellington Gustin

Seymour Mfg. Co. Obtains Large Judgment—Agreement Not in Restraint of Trade

The $180,296.63 judgment in favor of the Seymour Manufacturing Co., of Seymour, Conn., against the Derby Manufacturing Co., of Derby, Conn., has been set aside by the Supreme Court of the state, for the purpose of correcting numerous errors, thereby changing the judgment, though such change is not substantial in the amount.

The case is involved, arising out of contract between the companies for the manufacture of copper bands for projectiles. The Derby company, with the financial aid of the Seymour company, built a plant adapted to the manufacture of these bands, and began operations with orders turned over to it by the Seymour company. It also attempted to go into business on its own account, but was unable to finance the purchase and carrying of copper, and turned to the Seymour company for assistance. The contract in question was entered into Jan. 29, 1917, and was terminated April 20, 1917, by mutual consent. At this latter date the Derby company was indebted to the Seymour company. The judgment was obtained by Seymour and Derby appealed. A number of questions arising out of the business relations of the parties were presented to the Supreme Court.

Question of Legality of the Contract

The first question was whether the contract was illegal on its face or because it was entered into for the purpose of restraining competition. It purported to be a contract to co-operate in the construction of copper driving bands on the basis of the Seymour company providing the copper and the Derby company manufacturing the bands therefrom. Each party engaged to fully inform the other of any impending business, and if it is proposed to bid for or accept any such business, and if the Seymour company can furnish the copper, and the parties agree on the market price of the copper and on the contract price for the bands, then the Seymour company is to make the bid or acceptance in its own name, and turn over one-half of the tonnage orders so taken to the Derby company for production. The Derby company agrees to take the Seymour company's copper, use it and to account for the scrap. The difference between the market price of copper per pound and the contract price of bands per pound is called the "toll" in the contract, and is to be divided in proportion of eleven parts to the Derby company and four parts to the Seymour company.

Defendant Claimed Restraint of Competition

Defending the suit, the Derby company claimed that this contract was illegal as restraining competition because the parties proposed to agree on the price of bands. The Supreme Court said this contract contained no present agreement on prices for any purpose. Though it does contain an agreement to agree on the price at which some bands shall be sold, this is not for the purpose of preventing one party from underselling the other in the open market. It relates only to orders or contracts brought within the contract by the specific agreement of the parties in each case; and therefore applies only to orders which must be or may be, according as the contract is construed, turned over in part to the Derby company for production. Of course, said the court, the Derby company cannot bid against the Seymour company for any contract and at the same time agree to act as its bailee for hire in assisting to fill it. But this does not make such illegal at common law or under the Sherman anti-trust act.

The Derby company further contended that the contract is illegal because it agreed not to make any bid or take any order for bands. But the court failed to find anything in the contract prohibiting the defendant Derby company from accepting business on its own account. The contract goes no further than to provide that, so far as the parties may be able to agree on prices, the Derby company is to co-operate in production, and the bid or acceptance is to be in the Seymour company's name. It must follow, said the court, that if the parties cannot agree on the price at which any order will be accepted for co-operative production, either party may compete for it on its own account.

The claim that the contract was entered into for the purpose of restraining competition between the parties is refuted by the findings of the court that the Seymour company did not have productive capacity to fill its orders, and that the Derby company had surplus capacity for production, but did not have the funds or credit enough to carry on the business on its own account.

Minor Errors in the Judgment

There were numerous minor errors in calculating the amount of the judgment. The Derby company reported that it had made 288,283 bands under the contract. In making these it used not only the 500,000 lb. of copper furnished by the Seymour company at the agreed special prices, but also used 180,499 lb. of other copper belonging to Seymour, which was in the Derby company's possession. Acting on the theory that the Seymour company was bound to furnish copper for 500,000 lb. in bands at the specified prices, it credited the Seymour company with 30.5c. only for this copper, although its market value when appropriated was 35c. a lb. Defendant appropriated the plaintiff's copper to the contract without agreeing on its price, and the plaintiff relied on the implied promise of the defendant to pay what the copper was reasonably worth. The court said the copper was reasonably worth its market value at the time it was taken.

Again, one order, known as the "Chase contract" was to be carried out by the Derby company shipping and billing the bands direct to the Chase company, and reporting to the Seymour company the number of bands so shipped and paid for. There was an option in the "Chase contract" calling for an additional quantity of bands. The Derby company concealed the fact that the option had been exercised. It failed to report 73,830 bands which were delivered to the Chase company and paid for. Now, the Seymour company did not furnish the copper for these unreported bands, but it was at all times ready and willing to do so. The Chase contract was a co-operative transaction. The court said the Seymour company had the right to assist in its performance by furnishing the copper at agreed prices and the right to receive its agreed toll on all bands delivered and paid for. Conversely the Derby company had no right to resort to other sources of copper supply in order to make itself the sole beneficiary of the con-

tract. The Derby company claimed the agreed toll was payable only in case the Seymour company furnishes the copper. But the answer is that the latter's readiness and willingness to furnish copper is in law a sufficient performance of its agreement to furnish it, as against the defendant who has wrongfully prevented it from doing so.

Another important element of the case was the special damages claimed by the Seymour company in the delay of returning the copper scrap to it at the termination of the contract. The court held the Derby company was liable for the loss to plaintiff by its being compelled to buy additional copper through this delay in returning the copper scrap.

Court Holds Invention by Employee Not Within His Contract Assigning All Invention Rights

The White Heat Products Co. sought to compel its employee Charles W. Thomas to disclose certain inventions and assign to it an application for patent on such devices, pursuant to the terms of a written agreement between the parties. The case was heard before a referee, who found for the products company, holding that the invention was within the terms of the contract. After argument the trial court reversed the finding of the referee and dismissed the company's case, and now the Supreme Court of Pennsylvania has affirmed this decision.

The White Heat company is described as being organized for the purpose of making and selling products from silica and other materials, and at time of entering into the contract with Thomas it was engaged in the manufacture of bricks for wainscoting, etc., from white silica rock mixed with glass as a binder. Thomas was an expert in matters of this character and owner of certain patents, and, in consideration of the agreement of employment, assigned to the company all his interests in certain specified patents, together with the exclusive right to make, use and sell the design under another patent relating to a furnace "in so far as the same relates to the business of making bricks, stone products, earthenware products or analogous and collateral products," together with his "entire right, title and interest in and to every invention, interest therein, or claim thereto relating to the manufacture of bricks, stone products, earthenware products, and analogous and collateral products which he now has or may hereafter make or acquire during the period of his employment by said stoneworks and for one year after the termination thereof."

Worked on Abrasive Wheel Invention

For a period of two years and ten months Thomas continued experiments in the manufacture of bricks and all patents secured by him were assigned to the White Heat Products Co. In 1914, the company's plant being idle owing to its operations proving unsuccessful, Thomas began of his own accord experimenting with a process for making an abrasive wheel to be used for grinding iron, steel and other hard metals. The experiments were at first conducted in a separate shop, but later the matter was discussed with P. M. Sharpless, president of the White Heat company, with a view to their engaging in business together, and it was agreed that experiments be continued at the company's plant and at its expense. The experiments proved successful and samples were put on the market.

Agreement over the manufacture of abrasive wheels was not concluded and the company then first claimed the invention was within the original contract of employment.

The first question presented to the Supreme Court was, Is a wheel used for grinding an invention "relating to the manufacture of bricks, stone products, earthenware products or analagous and collateral products" within the meaning of those words as used in the contract? Its answer was that it was not such an invention.

Agreement Must Be Clear and Unmistakable

The rule of law is that in cases of this kind, where the product of an inventive mind is sought to be appropriated under an agreement to assign to another, the language of the agreement must be clear and show an unmistakable intention that the particular matter covered by the invention or patent is within the intention of the parties at the time of agreement.

The court said that measured by this rule the contract as viewed by the company falls down. It is as susceptible to one construction as another. The court was of the opinion that the contract provisions were limited to inventions relating to the manufacture of earthenware products and do not apply to or require the assignment of patents for the manufacture of all articles made of earth or clay; consequently a tool in the nature of an abrasive wheel, although composed principally of bauxite clay, is excluded from its terms as not coming within the meaning of the words "earthenware products."

There is another rule of law that where a person in the employ of another devises a new invention and uses the property of his employer and the services of other employees to put the device in practical form and assents to the use of the perfected invention by his employer, he thereby gives to such employer an irrevocable license to use the device. This was urged in favor of the company.

But the court said it did not apply, since the invention was conceived and the preliminary work done outside of the employee's working hours and in a plant not connected with his employer's plant. While the article was subsequently perfected and manufactured in the plant of his employer, still this was done under and subject to the completion of negotiations for a proper compensation to Thomas through the profits to be derived from the manufacture and sale of the patented article.

Judgment was therefore affirmed against the company.

Contract Where "Ton" Means 2,000 Lb.—Rule May Be Changed by Agreement or Custom

In an action by the Chemung Iron & Steel Co. against the Mersereau Metal Bed Co. on a sales contract in New York, the court there construed the term "ton" as used in the contract to mean 2,000 lb. and not a long ton of 2,240 lb., where the contract called for "tons" merely and not long tons and neither by proof of trade customs nor otherwise was it shown that long tons were intended. In the circumstances, section 4 of the General Business Law must be held to govern. It reads in part: "The hundredweight consists of one hundred avoirdupois pounds, and twenty hundredweights are a ton." And where there is no agreement to the contrary, or a general custom of the trade does not change the rule, same must be applied.

A Study of Chain Driving

Report of Investigation and Tests on Chain Driving — Variable Factors Involved — Some Mathematical Relationships—Effect of Impact on Life of Chain —Economic Calculations

F. M. LAWSON has made notable progress in the development of a chain driving theory in his recent contribution to *Engineering*, July 2, 1920, which, on account of its interest to the engineering profession, we are reproducing in full:

To a commercial mind, perhaps the first appeal of any proposition in engineering is with regard to the practical issues which are likely to result from its direct application. The commercial mind is not so much concerned with the theories involved, but prefers to examine them in the light of actual practice. The true theorist, on the contrary, prefers to commence from first principles, adopting as his base a point as in Euclid. From this beginning he sets down his proposition and deduces the facts which may be inherent although not always self-evident. He is content that the theory shall be subjected to the most careful scrutiny in its smallest detail, and is not satisfied unless the test of actual practice be applied in order that his conclusions may be proved to be sound.

Twenty Variable Factors

Research work connected with chain driving is undoubtedly difficult, since in any chain drive there are at least a score of variable factors, the alteration of any one of which may involve alteration of several others. The following gives twenty variable factors: (1) Number of teeth in wheels; (2) revolutions per minute of wheels; (3) ratio of reduction; (4) inclination of drive; (5) material wheels made of; (6) steadiness of load; (7) speed of chain; (8) pitch of chain; (9) lubrication of chain; (10) pull on chain; (11) center distance; (12) inclination of chain; (13) type of chain; (14) design of chain; (15) length of chain; (16) tension on slack side of chain; (17) bearing pressures; (18) weight of chain; (19) accuracy of manufacture of chain; (20) accuracy of manufacture of wheels.

Looking at the above list, it will be observed that if one factor is altered and a different result obtained it will be impossible to say whether the difference is due to the original factor being altered or to one of those factors which is affected by its alteration. For instance, increasing the number of teeth in a driver wheel may give a longer life, but is this longer life due entirely to the number of teeth being altered? Is it not also due to the fact that by increasing the number of teeth the pull in the chain is decreased and the bearing pressure reduced? Or, again, would not the life have been increased still further if the alteration had not affected the speed of the chain?

Tests would have to be carried out *ad infinitum* to establish any definite theory, which in itself is an absurdity, so that if any theory can be outlined which will enable those engaged on practical research to direct and concentrate their energies along defined paths their time will be saved and progress made.

Now, to follow in Euclid's footsteps, what is the point common to all chain drives?

In considering a chain drive the simplest form may be stated to consist of a driver wheel, a driven wheel, and a length of endless chain, the utility of the chain being to transmit power from the driver wheel to the driven wheel. The chain consists of a series of links connected by studs, so that the center of all studs in the chain travel along the same path; consequently if the path of one stud can be definitely located, the paths of all studs at any position in the chain drive are located, and this stud path in its relation to the wheels is common to all chain drives and consequently may be considered as the starting point, for it is a line generated by a point.

Now a stud in a chain 1-in. pitch running at 500 ft. per minute moves a pitch length in $\frac{1}{100}$ second, so that it is impossible to see the path of any one stud although the light wave of the path of all studs may be observed under favorable conditions. The practical value of this light wave cannot be exaggerated, but it has one drawback for research in that it is not capable of measurement, and consequently a method had to be adopted to obtain actual stud paths at high speeds which could be measured. The method the author adopted, and it is a method which has the advantage of being simple, is as follows:

To one of the studs in a chain a stiff pointer was fixed extending about $\frac{3}{8}$ in. beyond the width of the chain. When the chain was running a board covered with beeswax was moved toward the chain so that the pointer scratched the path in the wax. In order to simplify the mechanism, records were taken separately at four different places:

(1) Entering the driver wheel; (2) leaving the driver wheel; (3) entering the driven wheel; (4) leaving the driven wheel.

In this paper the author has concentrated on the first division, knowing that if this is solved the three remaining divisions can be solved in the same way. Before dealing with these practical results it is necessary to investigate the theory, for, although chain drives have been on the market over thirty years, no satisfactory theory has yet been published, so far as the author knows, and consequently the following is the result of research:

Mathematical Relationships

The "true" pitch circle diameter of a wheel may be calculated from the formula:

$$\text{Pitch circle dia.} = p \operatorname{cosec} \alpha \text{ inches} \qquad (a)$$

where p = pitch in inches

Tr = number of teeth in driver wheel (or driven wheel Tn),

$$\text{and } \alpha = \frac{180}{Tr}.$$

The speed in feet per minute on any point on the pitch circle is equal to:

$$\frac{\pi pN \operatorname{cosec} \alpha}{12} \text{ feet per min.} \qquad (b)$$

Where N = revolutions per minute

If the chain is running toward the wheel the "straight" speed is equal to:

$$\frac{pNTr}{12} \text{ feet per min. or } \frac{180pN}{12\alpha} \text{ feet per min.} \qquad (c)$$

It must be noted that the speed (b) is always greater than the speed (c) since the linear measurement of the circumference of the "true" pitch circle is always greater than the linear measurement of a polygon composed of Tr sides of length p. Or expressed otherwise:

$$\text{Speed } (b) : \text{speed } (c) :: \alpha : \frac{180}{\pi} \sin \alpha \qquad (d)$$

and α is always greater than $\frac{180}{\pi} \sin \alpha$

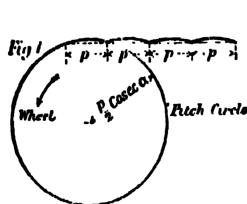


FIG. 1. PITCH CIRCLE

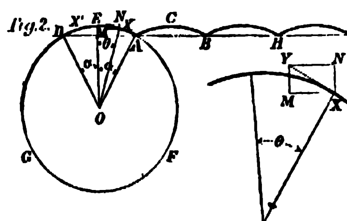


FIG. 2. HORIZONTAL AND VERTICAL VELOCITIES

At first sight there appears to be a difficulty in accounting for two speeds because the center of one stud may be traveling circumferentially at a higher speed than the center of a stud behind it, which is traveling in the straight line. It is accordingly necessary to analyze the straight speed and see what is meant by this.

Firstly at dead slow speed it is obvious that the path of a stud traveling toward the driver wheel is composed of arcs of the "true" pitch circle, the chord of the arc being equal to p, see Fig. 1. (For convenience these arcs are afterward referred to as "pitch arcs.")

Take the case of a wheel which is traveling without cyclic variation; the speed at any point on the arc is constant. In Fig. 2, let

EFG = pitch circle

DA = pitch = AB = BH.

The velocity at any point X in the pitch circle may be resolved into horizontal and vertical velocities—the horizontal velocity being proportional to XM, the vertical velocity proportional to XN, when XY represents the velocity at the point X which may be found from formula (b).

Hence XM = horizontal velocity at point X.

= $XY \cos MXY$.

= $XY \cos \theta$, where θ = XOE.

And XN = vertical velocity at point X.

= $XY \sin MXY$.

= $XY \sin \theta$.

Now XY from formula (b)

$$= \frac{\pi pN \operatorname{cosec} \alpha}{12} \text{ feet per min.}$$

Hence horizontal velocity at any point X

$$= \frac{\pi pN}{12} \operatorname{cosec} \alpha \cos \theta \text{ feet per min.} \qquad (e)$$

And vertical velocity at any point X

$$= \frac{\pi pN}{12} \operatorname{cosec} \alpha \sin \theta \text{ feet per min.} \qquad (f)$$

It follows that the horizontal velocity at the point A, where $\theta = \alpha$

$$= \frac{\pi pN \cot \alpha}{12} \qquad (g)$$

which, when α is acute, is always less than speed (c).

And since (c) is always less than speed (b), which is the horizontal velocity at the point E, there must be some point between A and E at which the horizontal velocity equals speed (c). To find it:

Let X be the point.

The horizontal velocity of X =

$$\frac{\pi pN}{12} \operatorname{cosec} \alpha \cos \theta \text{ by } (e)$$

and the speed (c) is $\frac{180pN}{12\alpha}$

These are equal if $\pi \operatorname{cosec} \alpha \cos \theta = \frac{180}{\alpha}$

$$\text{or } \cos \theta = \frac{Tr \sin \alpha}{\pi} \qquad (k)$$

The various values of θ for different values of Tr are given in Table I.

TABLE I.

Tr	θ	Log Cos θ
10	10 deg. 22 86 min.	9 9928325
15	6 deg. 54 84 min.	9 9968303
30	3 deg. 27.82 min.	9 9992060

The value of having located the point X by knowing the angle θ is that this point may be known as the point at which "action" commences, or in other words the point at which the horizontal speed of the pitch circle path begins to get greater than the straight speed of the chain.

In order to simplify reference to this point later it appears advisable to give some definition to the portions of the arc AED.

Let AX be termed the period of inaction,
XE be termed the period of action,
EX' (where $EX' = EX$) be termed the period of reaction,
$X'D$ be termed the second period of inaction,
where X is located by the angle EOX whose cosine =

$$\frac{Tr \sin \alpha}{\pi}$$

Point of Impact

It is obvious that the point A on the pitch circle may be accepted as the theoretical point of impact.

In Fig. 3, AK represents the direction of pull of chain at point A and AL represents the direction of pull from wheel at point A.

The pull AK = pull AL. Hence impact pull AJ must be such as will make AL the resultant of AK and AJ.

Now

$$\frac{AJ}{2} = AL \sin \alpha$$

or

$$AJ = 2AL \sin$$

Now, if AK, which $= AL$, $=$ pull on chain, the vertical impact blow must be equal to

$2f \sin \alpha$, where f is the pull on the chain (*m*)

Table II gives values of vertical impact blow for various numbers of teeth, when the speed is such that the point of impact is the point A.

TABLE II

Tr	Impact in Terms of Pull
6	pull × 1.0
9	pull × 0 684
10	pull × 0 618
12	pull × 0 518
15	pull × 0 416
18	pull × 0 347
20	pull × 0 313
30	pull × 0.209
45	pull × 0 134
60	pull × 0.105
90	pull × 0.067

What Happens During the Period of "Action" and "Reaction"

The period of action commences at a point X, which is found by the angle θ being known from formula (*k*), i.e.,

$$\cos \theta = \frac{Tr \sin \alpha}{\pi}$$

So, since the total period of action and reaction: arc AED :: θ : α it follows that between X and X^1 the chain in the straight will have traveled a horizontal distance

$$= \frac{\theta}{\alpha} p \text{ inches} \qquad (o)$$

and between X and X^1 the wheel will have traveled a horizontal distance

$$= \text{chord } XX^1$$
$$= 2XO \sin \theta \text{ in.}$$
$$= p \operatorname{cosec} \alpha \sin \theta \text{ in.} \qquad (p)$$

Consider two studs (n pitches apart) in a chain—the forward is engaged for action at X and the back one is traveling a distance $= np$ behind it. At high speed, in the majority of cases it can be proved from the stud path tests that the path of a stud in the straight is

FIG. 3. CHAIN FORCES

straight. Hence the forward stud will travel a horizontal distance given by (*p*), while the back stud travels a horizontal distance given by (*o*). Also

$$\frac{\text{the distance } (p)}{\text{the distance } (o)} = \frac{p \operatorname{cosec} \alpha \sin \theta}{\frac{\theta p}{\alpha}} = \frac{\frac{\sin \theta}{\theta}}{\frac{\sin \alpha}{\alpha}}$$

Now $\frac{\sin \theta}{\theta}$ is known to decrease as θ increases.

Hence the distance (*p*) is greater than the distance (*o*).

Consequently a certain amount of elasticity is called for in the chain between the forward stud and the stud n pitches behind it when the stud path of the latter is straight. The measurement of this elasticity may be found by subtracting the distance (*o*) from the distance (*p*). Or elasticity required during period of action and reaction

$$= p \operatorname{cosec} \alpha \sin \theta - \frac{\theta p}{\alpha} = p \left(\frac{\sin \theta}{\sin \alpha} - \frac{\theta}{\alpha}\right) \qquad (q)$$

when θ is given by

$$\cos \theta = \frac{Tr}{\pi} \sin \alpha$$

and

$$\alpha = \frac{180}{Tr}$$

The various values for varying numbers of teeth, when $p = 1$ in., are given in Table III.

TABLE III

Tr	p In	$\left(\frac{\sin \theta}{\sin \alpha} - \frac{\theta}{\alpha}\right)$
10	1	0 00640
15	1	0.00283
30	1	0 00070

Or, when θ and α are small, this formula (*q*) may be written:

Elasticity required during period of action and reaction

$$= \frac{0.64p}{Tr^2} \qquad (r)$$

How Does Impact Affect Life of Chain?

Damage done by impact may be considered under two headings:

1. Invisible damage, such as fatigue of material.
2. Visible damage, such as the loss or malformation of metal from the tooth of a wheel, back of liner, face of silent link, surface of roller, etc.

These two types of damage at first sight involve complications in arriving at a life formula. If, however, a chain drive has a reasonable factor of safety the invisible damage or fatigue of material does not exist as a potential factor, but it is undoubtedly the factor which comes into evidence when tests are carried out under abnormal conditions such, for instance, as a life test on a chain with a factor of, say, 4 on a 15-tooth wheel running at a high speed. On such a test as this the chain fails after a few hours through fatigue of material, and the test is consequently almost valueless for commercial purposes, since few, if any, drives fail in this way, and those which do fail may be due to other causes, such as a low factor having been created by an excessively tight chain. In other words, these tests are similar to Wöhler's researches, which proved that parts subjected to variations of stress for long periods must be provided with a higher factor of safety than parts subjected to a steady load.

Hence for practical purposes damage which is only visible under the microscope may be overlooked, but it must not be forgotten when complaints arise, since it is then a potential factor.

Visible damage creates malgearing, and the greater the damage the greater the malgearing, and consequently the greater the impact. Summing this up, it appears as if damage accumulates at compound interest —thus, if a chain has increased in pitch 1 per cent during five years it will certainly have increased more than 2 per cent in ten years, and may quite conceivably have increased 2 per cent in six years. This compound interest may possibly be reckoned as constant for one type of chain, but the constant is hardly likely to be the same for a roller chain as for a silent chain; moreover, it may vary with the pitch of the chain. There appears at present to be no method of arriving at this constant except by the lengthy process of testing.

Some useful purpose will be gained by arriving at a comparative life formula for any one chain with varying numbers of teeth in the wheels. Such a formula will be useful in determining the commercial value of the number of teeth in a wheel.

Damage done per minute to the studs is proportional to the impact blow $\times$ number of times it occurs per minute.

$= 2f \sin \alpha \times NTr$, using formula ($m$).

N being the r.p.m. and f the pull on the chain.

Life of the chain varies as

$$\frac{\textit{Number of studs}}{\textit{damage per min. to the studs}}$$

If L = length of chain, number of studs $= \frac{L}{p}$

$$\therefore \text{Life of chain varies as } \frac{\frac{L}{p}}{2f \sin \alpha \, NTr}$$

$$= \frac{L}{2fpNTr \sin \alpha}$$

Now the drive is given, $\therefore f \times$ speed of chain is constant

$\therefore \frac{fpN}{12} Tr$ is constant, using formula (c)

$\therefore$ Life of chain for a given drive varies as

$$\frac{L}{\sin \alpha} \text{ where } \alpha = \frac{180}{Tr} \qquad (s)$$

EXAMPLE

A 10-hp. drive, 600 r.p.m. to 200 r.p.m., centers 4 ft., chain 1 in. pitch. Which drive is the best commercial proposition, the drive arranged with 15T and 45T, making the cost of the drive \$100, or a drive having 20T and 60T costing \$120. Length of chain for the 15T drive, say, 126 in. Length of chain for 20T drive, say, 136 in.

Life of 15T drive : life of 20T drive :: 126 cosec 12 deg. : 136 cosec 9 deg. :: 603 : 870, making commercial value of life \$100 : \$145, whereas cost of 15T drive : cost of 20T drive :: \$100 : \$120.

Hence the 20T wheel drive is a better commercial proposition.

It must, of course, be borne in mind that there is a limit to the number of teeth which can be used, for, when a chain wears, it gets out of gear quicker with a large wheel than a small one.

This question of damage by impact opens up a strong case for small wheels being of the same hardness as the portion of the chain which engages with the wheel.

Thus in the case of roller chain wheels with only a few teeth, these should be hardened, since the roller of

TABLE IV. TESTS CARRIED OUT AT THE WORKS OF MESSRS. HANS RENOLD, LTD., MANCHESTER

No.	Type of Chain	Pitch of Chain, In.	Tr	Tn	R.p.m.	F.p.m.	Pull	Approx. Hp.	Centers In.	Lubrication
1	Roller	1	17	17	1,000	1,420	230	10	Long	None
2	Roller	1	17	17	1,000	1,420	230	10	30¼	Oiled
3*	Roller	1	17	17	1,000	1,420	230	10	30¼	Oiled
4	Roller	1¼	10	30	450	560	.	..	45	Oiled
5	Roller	1¼	10	30	900	1,125	.	...	45	Oiled
6	Roller	1¼	10	30	1,200	1,500	220	10	45	Oiled
7	Roller	1¼	16	30	1,200	1,500	.	..	45	Oiled
8	Roller	1¼	10	30	900	1,125	73	2½	45	Oiled
9	Silent	1¼	15	54	1,200	2,250	36	2½	45	Oiled
10	Silent	1¼	15	54	900	1,700	48	2½	45	Oiled
11	Silent	1¼	15	54	450	850	96	2½	45	Oiled
12	Silent	¾	15	15	1,040	650	920	18	..	Oil pump

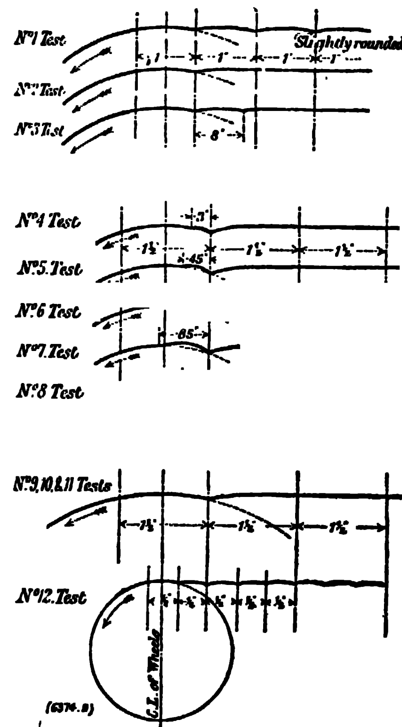
*In test No. 3 the point was attached to the rear stud of outside link. In all other cases it was attached to forward stud on outside link.

the roller chain is hardened, but in the case of small wheels for chains in which unhardened links engage with the wheels, it is probably sounder policy to have a mild steel wheel unhardened.

Mention has already been made of the method adopted to record on wax the actual path of a stud. Particulars of a few of these tests are given in Table IV, and the salient points reproduced in Table V.

Tests 1, 2 and 3 may be grouped and termed lubrication tests, since the only altered factor between Nos. 1 and 2 was oil, and between Nos. 2 and 3 the only

TABLE V



alteration was that the chain was reversed so that the point scribed the path of the stud at the rear end of the outside link.

Much valuable information can be obtained from these three stud paths. In the first place (test 2) the stud path leading up to the wheel assumed a straight line when the chain was oiled, whereas when the chain was bone dry (test 1) the path showed a series of arcs with slightly rounded joints. Secondly, when the pointer was placed on the rear stud of the outer link (test 3) the path showed a straight line finishing off with one arc before entering the wheel.

The only possible explanation for the difference in path before and after oiling lies in the theory that lubrication supplied the necessary elasticity. Formula (*r*) gives the necessary elasticity in this case to be 0.0022 in.—which elasticity in test 2 might be provided by oil in any one of the following four places:

(*a*) Between tooth of wheel and roller of chain.
(*b*) Between roller and bush.
(*c*) Between bush and stud in engagement.
(*d*) Between bush and stud behind engagement.

Thus it appears that each film of oil supplied 0.0006 in. of elasticity.

In order to test if this theory was correct, test 3 was tried, since lubrication could not affect the rear stud path of an outside link when this was one pitch in distance

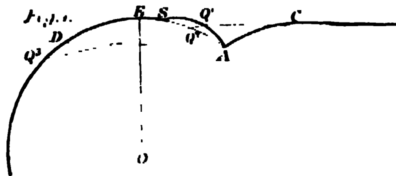


FIG. 4. STUD CENTER PATH

from engagement. The result here proved the case, the path being a straight line ending with an arc before engagement with the wheel. The measurement of this arc, i.e., 80 per cent of the pitch of the chain, should be noted—the probable explanation lies in the fact that the rear stud continued to drop until the forward stud reached the point of action.

IMPACT TESTS

Nos. 4, 5, 6, 7 and 8 may be termed impact tests, and would have been more complete if they had been duplicated with the pointer on the rear stud of the outside link, and if the horsepower could have been accurately measured.

All these tests were severe—a 10*T* driver wheel and chain speeds varying from 560 ft. per minute to 1,500 ft. per minute.

Tests 4, 5 and 7 had no appreciable load, and speeds alone were varied. The effect of impact was clearly marked on the stud path, the stud being actually "thrown" by impact off the pitch circle path. In No. 4 test it was thrown for 20 per cent of the pitch arc; in No. 5 test for 30 per cent of the pitch arc, and in No. 7 for 55 per cent of the pitch arc. No. 8 test gave the same result as No. 5, which might be expected, since the only alteration was a slight increase in horsepower which could not be accurately measured. Test 6 was similar to test 7, the only difference being a considerable increase in horsepower transmitted. The length of the throw path was considerably less, having decreased to 33 per cent of pitch arc from 56 per cent.

In none of these tests were there any signs of arcs in the path leading to the wheel, but in every case the path dropped to the point of impact. If formula (*r*) is applied to tests 4 to 8, it will be found that the elasticity required is 0.0096 in. Before considering how this elasticity is provided it is advisable to state the two facts that have been established by these five tests.

1. Impact can throw a stud off its normal path.
2. To some extent the length of the throw varies with the speed and inversely with the pull of the chain.

In tests 1, 2 and 3 it was found that lubrication provided 0.0022 in. of elasticity—possibly, from the fact that tests 4 to 8 were run with 1¼-in. pitch chain, whereas tests 1 to 3 were run with 1-in. pitch chain, it might be argued that more elasticity could be expected, but a detail investigation of the throw path proves that, if the stud can be thrown off its path, elasticity is not necessary to the extent provided for in formula (*r*).

LUBRICATION STUD PATH TESTS

In Fig. 4, let $AQ'S$ represent the throw path, A being the point of impact.

Now the length of the line $AQ'SD$ is greater than the length of the line $AQ'SD$.

Hence the stud path speed is greater from the point A than is represented by speed (*b*).

But

$$\frac{\text{Speed } (b)}{\text{Speed } (c)} = \frac{\alpha}{\frac{180}{\pi}\sin\alpha}$$

which is constant for any given wheel.

Hence if speed (*b*) is increased by impact, speed (*c*) is increased in the same proportion.

But the straight stud path is straight, hence the straight speed must be greater than that supplied by speed (*c*). In other words, the effect of the throw path is equivalent to increasing the pitch circle diameter, which, in turn, increases the straight speed and so reduces the difference between speed (*b*) and speed (*c*).

It is thus obvious that if sufficient elasticity cannot be supplied by the chain and wheel either a throw path must exist, or else the chain in the straight will "pitch arc."

It must be noted from these tests, 4 to 8, that the length of the throw path varies, that, in fact, it increases with the speed of the chain and decreases with the load. It must also be noted from Fig. 4 that when the center of the stud is on the throw path it is not in gear with the wheel and does not come into gear with the wheel until it reaches the point S, hence action commences at S.

This explanation accounts for the reduction of length of throw path in test 6, as compared with test 7. No. 7 test was taken with the chain running with practically no load so that it was only necessary for the wheel to impart a short push during the period of reaction and before the second period of inaction commenced.

In test 7 the second period of inaction commences at a point which corresponds to 79 per cent of the pitch arc, whereas owing to the light load the period of action only commenced at a point corresponding to 56 per cent of the pitch arc. In test 6 the load was increased and the period of action started at a point equivalent to 33 per cent of the pitch arc.

When the speed is high and the number of teeth in a wheel is so low that a throw path exists, the effect on the chain is what may be described as vibratory whipping, this whipping being caused by a series of jerks from the teeth of the wheel. Whipping may exist owing to an impulsive load, but these two types of whipping can usually be distinguished by their frequency and depth—the impulsive load type being less frequent and of greater depth.

ARCHED LINK TESTS

Tests 9, 10 and 11 were carried out with the arched link type of chain (commercially known as noiseless or silent type). The characteristics of these paths is in the easy curve at the point of impact—thereby showing that impact is absorbed gradually. A brief look at the

design will show that the arch link when subjected to a sudden load can supply elasticity by elongation and that the effect of this elongation is to produce gearing at that part of face of link furthest from the stud center. This means more gradual engagement and explains the reason for this design being, under normal conditions, quieter than the roller design. Lubrication also supplies elasticity as in the roller tests.

Test 12 was carried out with a load which gave a very low factor of safety—the stud path is most instructive —without resorting to the wax board it was easy to see the light waves throughout the length of chain between driver and driven wheel. It will be noticed that this wave is similar to that obtained in No. 1 test (i.e., when lubrication was absent), but in No. 12 test oil was being pumped into the chain; however, the bearing pressure on the studs was so great that oil could not reach the surface.

These few tests are given to show that the practical results obtained agree with the theory, and that having established a portion of the theory the complete theory can be developed together with the practical stud path tests. For the value of the stud path test is one which no firm of chain makers can afford to overlook.

Chain Curve

Before closing the subject it is necessary to place on record a few notes connected with the chain leaving the driver wheel, entering the driven wheel, and leaving the driven wheel.

When a chain is running at a fairly high speed with wheels having a small number of teeth, it will be observed that it takes an inward curve after leaving the

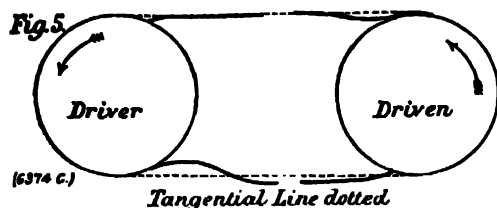


FIG. 5. CHAIN CURVE

wheel as shown in Fig. 5. This can be seen in both cases, i.e., leaving the driver wheel or leaving the driven, and is accounted for by the fact that the speed (b) is greater than the straight speed (c). In consequence, since the chain cannot alter from one speed to another instantaneously, it is necessary for it to assume a curve whose function is deceleration.

The same theory can be applied to the chain entering the driven wheel as has already been applied to it entering the driver wheel. The speed has to increase from speed (c) to speed (b)—Tn being of course inserted in obtaining the value of x. This speeding up occurs by impact supplied from the driven wheel, and since there is no load being transmitted and the chain is slack the throw path will be found to be so serious as to prevent a very slack chain being run at a high speed with a small driven wheel, since the chain will then get thrown out of gear with the wheel.

American Export of Dyes and Dyestuffs

The total amount of dyes and dyestuffs exported from the United States during the calendar year 1919 amounted in value to $17,084,435, of which Japan imported $3,196,550 and Canada $2,143,097.

German-French Potash Negotiations

"The result of the war has broken the former German world monopoly of potash, since by the terms of the peace treaty the thirteen Alsatian works have passed into the control of the French State," says the *Frankfurter Zeitung* for June 30. Although the output of Alsace, as compared with that of Germany, is relatively small, it is nevertheless important enough to affect prices on the world market. During 1919 Alsace produced 40,000 metric tons of potash, while it is expected that the output for 1920 will be five times that amount. The total sales of the German potash syndicate during 1919, in which 198 works participated, amounted to 812,000 metric tons of K_2O, and the output is capable of great development. Concerning this newly arisen competition the *Zeitung* says:

> Neither in France nor in Germany has the state or the producing industry any interest in spoiling prices on the world market by competition. In view of present economic conditions it is to the benefit of both countries to develop their export at the best possible prices. An agreement between France and Germany as to potash prices on the world markets would therefore be to the advantage of both. At a recent general meeting of the Deutschen Kaliwerke a. G. it was reported that negotiations were then going on with France with the object of coming to an agreement regarding the Alsatian potash industry. The result of the negotiations cannot yet be foreseen; however, the economic interests common to both countries should be strong enough to overcome present objections and difficulties. It must not be forgotten that sooner or later Spanish potash will appear on the world markets. Also that overseas sales are not being made easier by the substitute industries which are being founded, as an example in the United States.
>
> The chairman of the Deutschen Kaliwerke a. G. reported that sales are still slack. On political grounds, and in consequence of the unfavorable state of their currencies, sales to Poland and Czechoslovakia have almost entirely ceased. This is the more regrettable as sales to Poland in normal times are estimated at about 1,000,000 double centners (about 110,000 short tons) of pure potash.

Shark Fishing in Lower California

The shark-fishing industry is becoming increasingly important in the Ensenada consular district. The Lower California shark, known locally as the dogfish shark, is from 4 to 5 ft. long and weighs from 90 to 125 lb. The fishing is usually done by individual fishermen working out from camps on land. The fish are caught on long set lines, on which are fifty to one hundred hooks baited with small fish or lumps of shark meat. These lines are secured to floats, and the fisherman visits the lines daily to remove the catch.

The fins are sold for consumption by Chinese in shark-fin soup. The liver is boiled down and shark oil rendered out; each liver gives an average of 1 gal. of oil. This oil is used in paints and as a leather preservative. The remainder of the fish is dried and made into fertilizer or chicken feed. The skins are not utilized, except for fertilizer. Frequently shark steaks are sold by Chinese under the name of grayfish.

The large canneries operating fish-fertilizer plants in San Diego, Cal., are eager to buy shark, and the newly finished plant at Sauzal, Lower California, expects to specialize on converting shark into fish-meal fertilizer. Whereas formerly sharks caught in nets were separated from the more valuable fish and returned to the water, they are now brought ashore, although the demand is not yet sufficient to warrant using nets for sharks exclusively.

Studies of the Macrostructure of Cast Steel

Simple and Reliable Procedure Is Outlined for the Development and Record of Macrostructure—A Peculiar Banded Structure Is Described—Symmentrical Arrangement of Dendrites Is Necessary for Consistent Physical Tests—Pouring Cold Metal Suppresses Dendrites

BY FRED G. ALLISON AND MARTIN M. ROCK*

WE HAVE wondered for a long time why it is that a larger number of the host of investigators in the field of metallurgy have not given more attention to the many easily observed but as yet unexplained phenomena which occur in the steel foundry. This may be due in part to the fact that experimenting with molten steel is too large a task for the laboratories of the average educational institution and in part to the fact that the attention of the foundry metallurgist is very largely absorbed with problems of immediate production. Whatever the cause may be, it seems that the steel foundry offers exceptional opportunities and a fertile field to the research metallurgist.

In his paper on "The Elastic Development of Steel," published in CHEMICAL & METALLURGICAL ENGINEERING of April 14, 1920, Sidney Cornell expresses the view that it would be a step toward betterment in the art of heat treating steel if more experimenters would simply publish observed facts without waiting for the development of completed treatises. We are in hearty accord with this view not only as it applies to the heat treating of steel but also in its application to the subject matter of this paper. Our observations on the macrostructure of cast steel are decidedly incomplete and the conclusions only tentative, yet they have seemed sufficiently interesting to justify this presentation.

RECENT PUBLICATIONS BY HUMFREY, LE CHATELIER AND BOGITCH

Interest in the macrostructure of cast steel was first aroused through the study of its microstructure and especially by the fact that the picric acid structure is apparently only slightly changed by what is known as a straight anneal. This interest was, however, greatly stimulated by two recent papers in the technical journals. One of these is by J. C. W. Humfrey[1] in the *Iron and Steel Institute* (1919) and the other by H. Le Chatelier and B. Bogitch[2] in *Revue Metallurgie*, vol. 16, No. 2, March-April, 1919.

Le Chatlelier and Bogitch note the strange difference between the transitory and easily modified structural appearances caused by carbon and observed at relatively high magnification, and the entirely independent structural features observable by the naked eye—features which are extremely stable and almost unstudied, despite their industrial use in identifying steels of quality. They melted electrolytic iron in a closed silica tube under 3 or 4 cm. pressure of hydrogen, with or without additions of phosphide. Stead's reagent, Heyn's reagent, an iodine reagent (iodine 10 g., KI 20 g., H_2O 100 c.c.) and boiling acid did nothing to such samples except tone the allotriomorphic ferrite crystals differently. On the other hand, if electrolytic iron, with or without additions of chemically pure iron sulphide, iron phosphide, iron oxide, manganese or silicon, be melted in a gas furnace, any of these reagents will reveal marked chemical homogeneity unrelated to the ferrite crystals. Stead's reagent as modified by Le Chatelier and Dupuy (95 per cent ethyl alcohol 100 c.c., water 10 c.c., cupric chloride 1 g., picric acid ½ g. and hydrochloric acid 1 to 3 c.c.) gives exactly reverse action to the other reagents, as comparative studies on the same section prove.

That such differential etching is due to oxygen only is proved by the method of melting, by the fact that

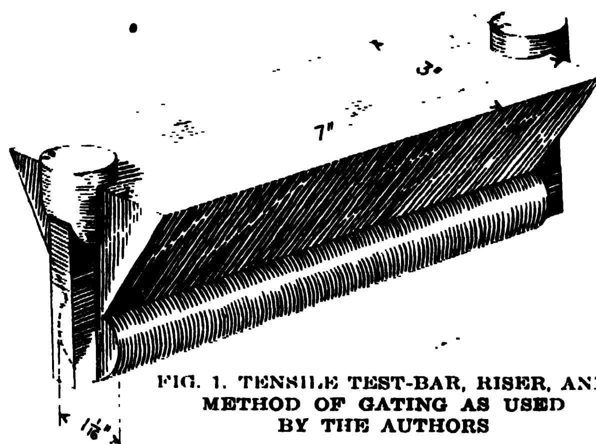


FIG. 1. TENSILE TEST-BAR, RISER, AND METHOD OF GATING AS USED BY THE AUTHORS

an annealing in hydrogen produces a superficial immunity. Comparing the action of Stead's reagent on steels with constantly increasing oxygen content, the authors advance their conclusion that this reagent attacks parts poor in oxygen, while the others eat into parts rich in oxygen.

The black marks made on bromide paper moistened with 2 per cent H_2SO_4 when in contact with steel are said to be due to sulphur only, since no markings occurred when testing any of the sulphur-free melts. Again, fumes from dissolving cast-iron filings will blacken such paper, yet if they are first bubbled through lead acetate they are without effect, and the lead precipitate upon analysis will be found to contain sulphur.

In his paper on "Macro-etching and Macro-printing" Humfrey recommends polishing the specimens with emery cloth, etching deeply with a 12 per cent aqueous solution of cupric ammonium chloride, to eliminate tool marks and surface hardening.

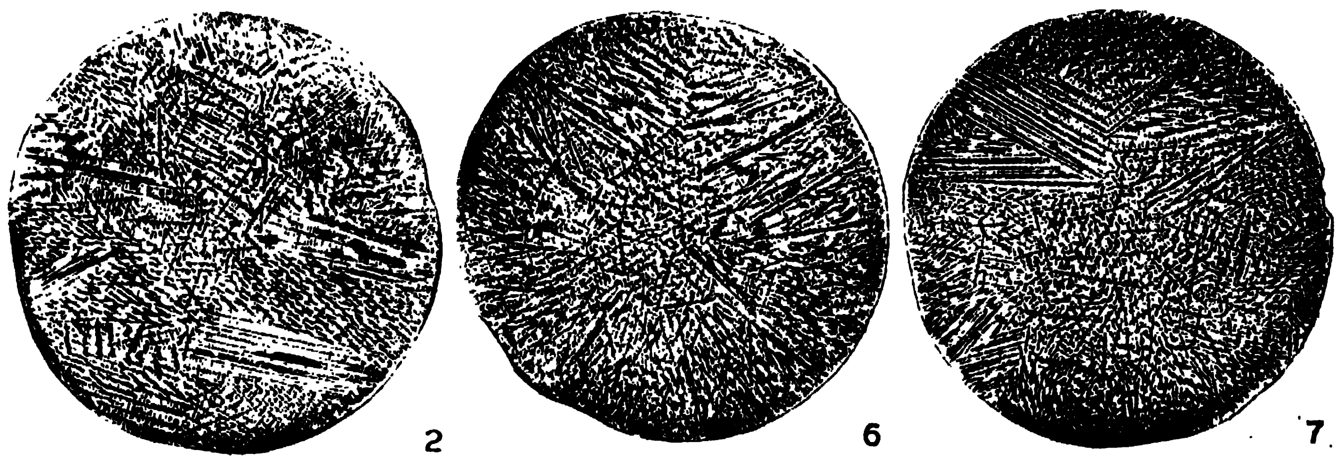
Etching is continued by the reagent cupric ammonium chloride 120 g., concentrated hydrocloric acid 50 c.c. (more or less), water 1,000 c.c., by pouring on fresh additions at intervals. Deposited copper can readily be

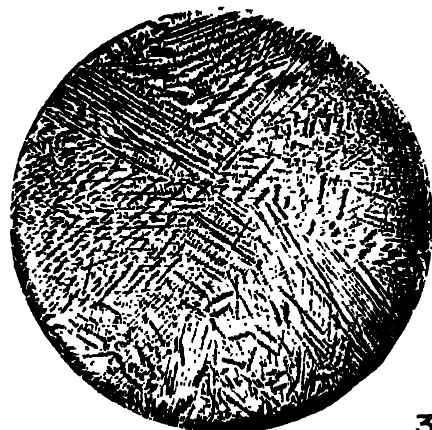
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*Both authors of the technical staff of the George H. Smith Steel Casting Co.

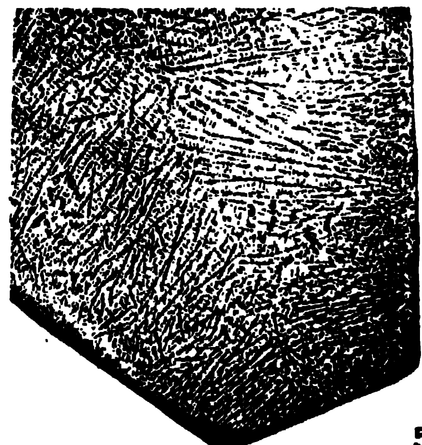
[1]See CHEM. & MET. ENG., vol. 21, p. 40 (July 1, 1919). Also abstracted in *Chem. Abs.*, Sept. 20, 1919.

[2]*Chem. Abs.*, Sept. 20, 1919.









FIGS. 2 TO 7. MACROGRAPHS OF "CELA" TEST-BARS

Fig. 2. Test-bar 1 cut about 1 in. from large end.
Fig. 3. Same bar a short distance further.
Fig. 4. Same bar cut longitudinally.
Fig. 5. Portion of riser from test-bar 1.
Fig. 6. Test-bar 3 cut about 1 in. from large end.
Fig. 7. Test-bar 5 cut about 1 in. from large end.

wiped off; in case examination reveals insufficient attack it should be resumed first with the neutral reagent. The strong relief is brought out by light buffing, and recorded by printing the etched surface on engraver's proof paper with printer's ink. A first trial of this procedure proved so satisfactory and so much superior to all other methods for developing the macrostructure that the studies were continued with renewed interest. The method is simple, rapid, requires very little apparatus, and the etched surfaces withstand rough handling.

Development of Macrostructure

We polish the specimens to 000 emery cloth, immerse while still warm in the 12 per cent neutral solution of cupric ammonium chloride until a rather heavy and somewhat flaky deposit of copper is formed, transfer to a second vessel containing some of the same solution to which has been added about 5 or 10 per cent HCl and allow them to remain for from 15 to 30 min. After washing and drying, the etched surface is cautiously polished with crocus cloth. If the deposit of copper is too light, the acidified solution causes it to adhere firmly, giving a final brassy appearance which is difficult to remove, especially in the case of alloy steels. If examination shows that the etching has not been carried far enough to develop the structures to the desired depth, the treatment is repeated as before without regrinding. The temperature of the etching reagents greatly influences the speed of their action, but it is difficult to go far wrong. No special difficulty was experienced in etching nickel and other alloy steels by this method.

Instead of printing the etched surfaces with ink it is found very convenient to photograph them with an ordinary camera equipped with an enlarging lens and a Silverman illuminator, attached closely in front of the lens to give vertical illumination. Photographic contrast may be increased by rubbing the etched surface with a moistened portion of the crocus cloth, an action which deposits some of the rouge paste in the indentations, where it absorbs light. After allowing a few moments for the paste to dry, the specimen is again gently polished. Many specimens were 1 in. in diameter and gave excellent photographs when enlarged four times—in fact, the macrographs here given were originally photographed at four diameters but for printing convenience are reduced to about 2.3×. The method of photographing etched sections at low magnifications described by Foley[3] or the similar method described by Monypenny[4] should prove very satisfactory for specimens of this sort.

Although the method of photographing macrostructures is considered superior for some purposes to printing them directly on paper as described by Humfrey, the study of these structures can very profitably

[3]CHEM. & MET. ENG., Aug. 1, 1919, vol. 21, p. 140.
[4]CHEM. & MET. ENG., May 12, 1920, vol. 22, p. 882.

be undertaken without printing of any sort. Examination of the etched sections with a simple hand lens, such as is commonly used for the examination of fractures, is in many respects the most satisfactory method. The entire process is so simple that, as Le Chatelier and Bogitch state in the article referred to above, it seems surprising that the structures revealed have not been studied more in the past. Etching by this method might very well be included among the first laboratory exercises accompanying a systematic study of metallography.

WHAT DOES DEEP ETCHING REVEAL?

Deep etching of steel has been employed by investigators for many years, but the exact nature of the structures developed seems still to be in some doubt. Stead's and other similar reagents, which are said to show phosphorus segregation, give effects which are practically identical with those produced by Humfrey's and similar procedures. The so-called sulphur print also shows about the same structures. According to Humfrey the etching reagents dissolve most those portions of the metal which solidified first. From the results of their very carefully conducted experiments Le Chatelier and Bogitch, on the other hand, draw the conclusion that the heterogeneity is caused by oxygen in some state of combination—viz., FeO, $FePO_4$, etc.

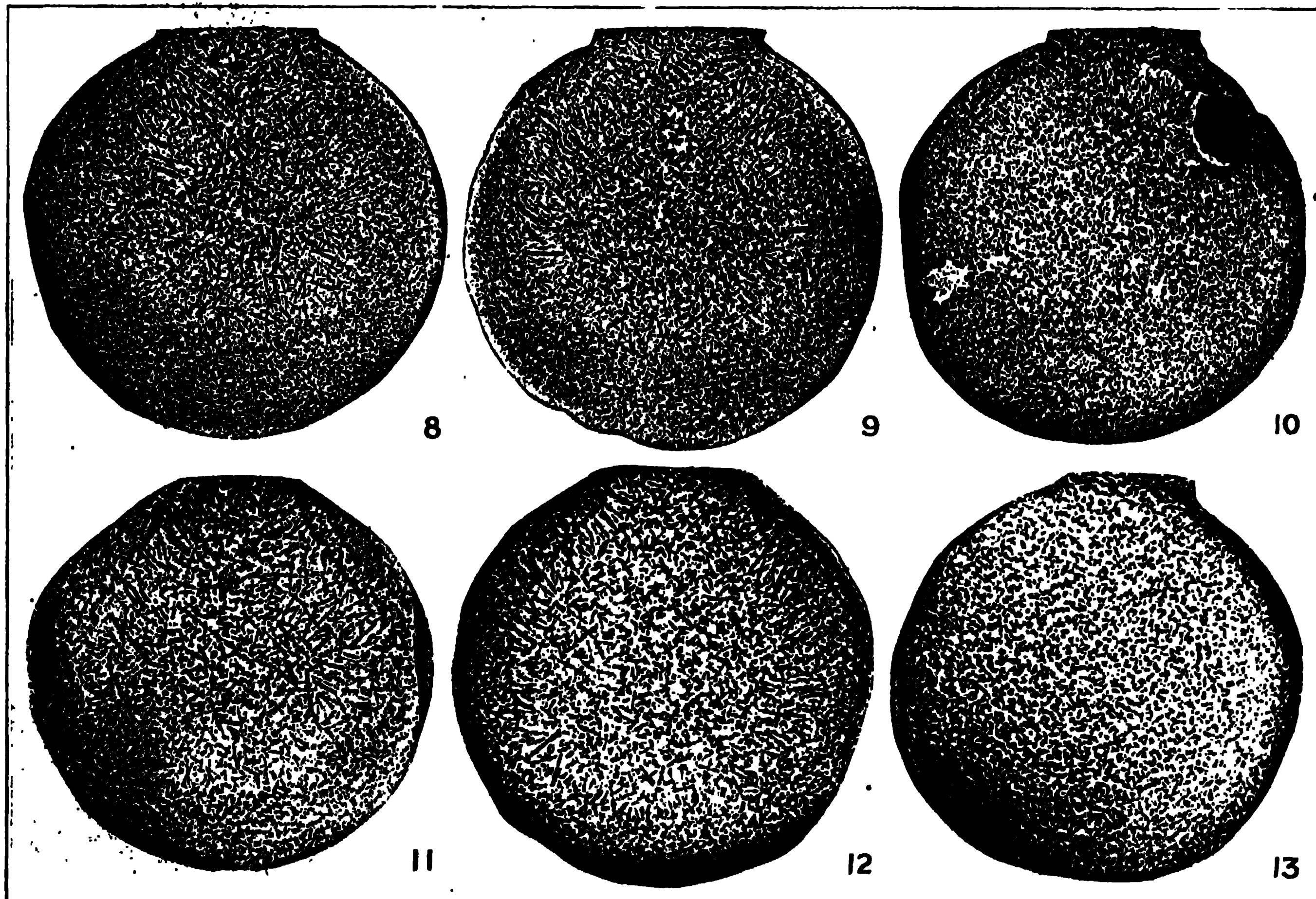
A large number of the specimens which we have examined were obtained from the standard tensile test-bar and its riser which the George H. Smith Casting Co. is using at the present time. A sketch of this test-bar with riser and method of gating is shown in Fig. 1. The mold is made in two parts in a core box and is cemented and baked in the usual way. For the tensile test the cylindrical portion is cut off with a power hacksaw and machined to standard size, leaving the ends about ⅞ in. in diameter. This pattern gives a solid test-piece which can be machined to size with a minimum of effort.

BANDED AND LATTICE-LIKE STRUCTURE

Among the first specimens which we etched with Humfrey's procedure were three broken tensile test-bar stubs from a small experiment which we conducted with "cela" (cerium-lanthanum alloy) as a deoxidizing agent for converter steel. Six test-bars of the type shown in Fig. 1 were cast from a small ladle of a heat analyzing as follows: Carbon 0.22, silicon 0.45, sulphur 0.070, phosphorus 0.063, manganese 0.69 per cent. To two of these bars no "cela" was added; to the second pair enough was added to make about 0.10 per cent,

TABLE I. PHYSICAL PROPERTIES OF "CELA" TEST-BARS

Test-Bar No.	Additions of "Cela," per Cent	Yield Point, Lb. per Sq.In	Tensile Strength, Lb per Sq.In	Elongation in 2 In. per Cent	Reduction of Area, per Cent
1	None	43,500	73,500	29 5	50.1
2	None	42,740	74,300	30 5	48.6
3	0 10	45,500	74,250	30 0	33.4
4	0 10	44,140	74,350	32.0	50.0
5	0 15	45,750	74,000	30 0	48 1
6	0 15	44,090	74,700	29 5	42 5



FIGS. 8 TO 13

Fig. 8. Hot-poured steel, mold jarred during solidification.
Fig. 9. Hot-poured steel, quietly cooled.
Fig. 10. Cold-poured steel.
Fig. 11. Same as Fig. 8 after annealing 5 hr. at 1,832 deg. F.
Fig. 12. Same as Fig. 9 after annealing 5 hr. at 1,832 deg. F.
Fig. 13. Same as Fig. 10 after annealing 5 hr. at 1,832 deg. F.

and to the third pair enough to make about 0.15 per cent. Although no special observation was made at the time, it is thought that the molten metal was very hot. These test-bars were all heated for four hours at 1,650 deg. F. (900 deg. C.) and cooled slowly in the furnace. The tensile tests, made by two different firms of inspecting engineers, are given in Table I. Although these data are not given especially for that purpose they show that the "cela" conferred no evident benefit.

The broken stubs from test-bars No. 1, 3 and 5 were cut about 1 in. from the large end and the structures developed are shown in Figs. 2, 6 and 7 respectively. The photographs show the entire end of the bars, the indentations at the circumference being caused by the jaws of the tensile machine.

The banded dendrites and lattice-work structures seen in Figs. 2 and 7 are interesting, to say the least. At first glance they suggest massive slip lines, perhaps due to the combined forces in the tensile machine, but no evidence supports such a suggestion. Fig. 6 (a section of bar No. 3) shows only the expected radial arrangement of the dendrites. This bar, however, showed the lowest reduction of area of any in the lot and it is possible that there is some connection between these facts.

Fig. 3 shows a second section through bar No. 1, a short distance from that shown in Fig. 2, and Fig. 4 is a longitudinal section through part of the same piece. The banded dendrites and lattice-work structure evidently extended throughout this cylindrical part and in all planes. In examining Figs. 2, 3, 6 and 7 it should

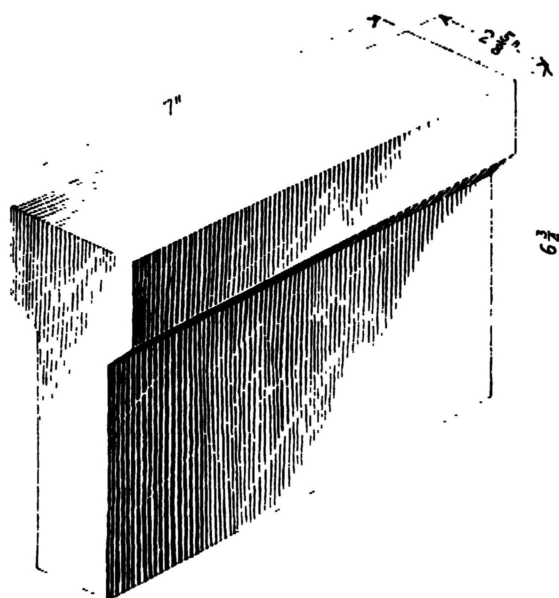


FIG. 14. TEST COUPON POPULAR AMONG STEEL FOUNDERS

be remembered that only a small amount of metal, perhaps ⅛ in., was removed by the lathe. Fig. 5 shows a portion of the riser from test-bar No. 1. Here a tendency toward the banded structure is seen near the point at which the cylindrical part was attached (lower edge of figure). In the main, however, the riser shows the dendrites at right angles to the surface of the mold. The peculiar structures found in these test-bars may have been caused by deformation of the normal radial dendrites during the mushy stage. The tensile tests show that their quality was unimpaired. It may be worth noting in this connection that hot cracks in steel castings sometimes show banded dendrites similar to those of Fig. 2. Their appearance has been usually attributed to exudation of the semi-fluid metal.

Macrostructure of Cold-Poured Metal

Writing of the elements of fiber, Howe[3] states that "The conditions which favor the dendritic form are rapid and quiet solidification." It is well recognized by steel foundrymen that it is difficult to refine the structure of a casting which has coarse dendrites and that the simplest way to avoid this difficulty is to pour the metal at the lowest practicable temperature. These thoughts prompted us to make the following experiment.

Three test-bars of the type shown in Fig. 1 were cast from a small ladle of a heat of converter steel which analyzed as follows: Carbon 0.37 per cent, silicon 0.42 per cent, sulphur, 0.063 per cent, phosphorus 0.056 per cent, manganese 0.72 per cent. The first of these three test-pieces was poured with the metal very hot (no pyrometer was used) and the board beneath the mold

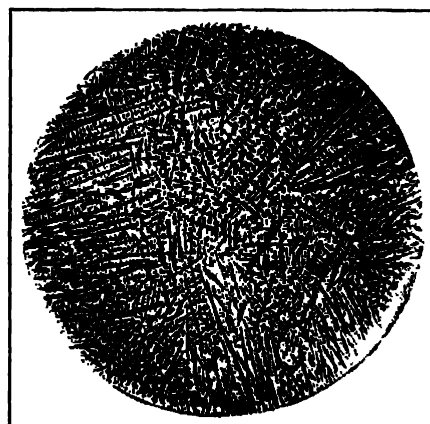


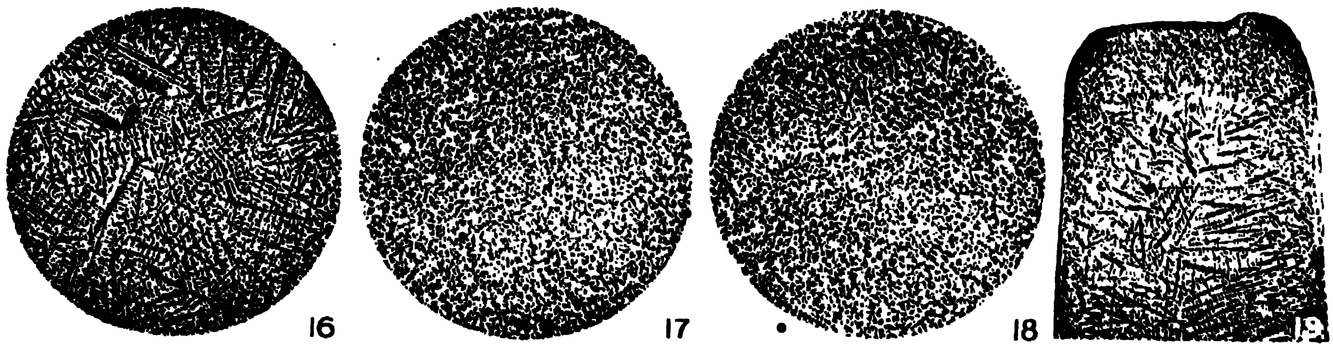
FIG. 15. CROSS-SECTION OF TENSION TEST-PIECE MADE FROM COUPON SHOWN IN FIG. 14

was pounded continuously during solidification with an air rammer. The second was also poured with hot metal, but allowed to solidify quietly. Pouring of the third was postponed until the metal in the ladle was as cold as possible and still flow into the mold, too cold for practical work with small castings. Sections of these three cylindrical bars were cut at about ⅜ in. from the end before they were annealed and their macrostructures are shown in Figs. 8, 9 and 10. Fig. 8 shows the specimen which was cast with hot metal and vibrated during solidification, Fig. 9 the one which was cast hot and allowed to solidify quietly and Fig. 10 the one which was poured with very cold metal.

The main portions of these bars were then annealed by heating to 1,832 deg. F. (1,000 deg. C.), holding for five hours and cooling slowly in the furnace. Sections were again cut about ½ in. from the previous ones and their structures are shown in Figs. 11, 12 and 13. Fig. 11 shows the annealed structure of a section close to the unannealed section in Fig. 8. In like manner Fig. 12 goes with Fig. 9 and Fig. 13 with Fig. 10.

The zones of dendrites located about half way between the center and periphery in Figs. 8, 9, 11 and 12 continue into the riser in a similar manner. Jarring of the metal during solidification seemed to produce no effect, although the small size of the casting and probable rapid solidification may be responsible. Although the

[3]"The Metallography of Steel and Cast Iron," p. 558.



FIGS. 16 TO 19

Fig. 16. Typical macrostructure of hot-poured steel. Fig. 17. Typical macrostructure of cold-poured steel. Fig. 18. Isolated accumulation of dendrites. Fig. 19. Section of small steel casting.

annealing treatment was much more vigorous than would ordinarily be used in a steel foundry, diffusion was quite imperfect. The smaller branches of the dendrites disappeared, and the grain size, if it may be so called, in the non-dendritic areas seems to have enlarged somewhat. Although the photographs do not show it very well, the grain or crystal boundary lines in the annealed specimens are indefinite and show that diffusion was in progress. The comparative effect of hot and cold pouring is shown very clearly. The gas cavities shown in Fig. 10 are such as usually occur when steel is cast at too low a temperature. Close to these gas cavities there are small areas which seem to consist of very small dendrites. Just what causes them might develop into an interesting question. The test-bar corresponding to Fig. 12 gave the following tensile test: Yield point 48,500 lb., tensile strength 84,750 lb., elongation in 2 in. 22.5 per cent, reduction of area 30.8 per cent.

Strength as Affected by Shape of Coupon

A number of tests were conducted with different heats to find out if the casting temperature would affect the tensile strength. The standard test coupon, shown in Fig. 1, was used, but the results thus far are inconclusive. It seems probable that our failure to find the expected difference in every case may be due in large part to the shape of the bar as cast. With this cylindrical shape, cast hot, there is frequently an area in the center with a network or "delta" structure, and that is really the portion which is tested. Moreover, with a normal radial arrangement of dendrites reaching uniformly to the center, the machined test-bar would have a "balanced" strength on all sides. Previous experience with many different types of tensile test coupons has indicated that this matter of "balanced strength" is very important.

Fig. 14 shows a type of test-piece or coupon which has been used extensively by steel foundries. Several slices suitable for machining into tensile-test bars may be cut from each piece. Fig. 15 shows the macrostructure of a cross-section of a tensile-test stub made from the first cut of such a coupon, cast with hot metal. An examination of this figure shows very clearly the side at which it was attached to the main portion. Test-bars which show this arrangement of dendrites, when placed under tension, frequently develop incipient cracks along one side before breaking. Such test-bar stubs may be etched with copper reagents without further polishing and there seems to be a definite relation between the incipient cracks and a coarse macrostructure. As a rule, the second cut from this style of test coupon gives a poorer tensile test than the first cut.

In the study of the effect of casting temperature, many sections of the cylindrical bars and V-shaped risers, cast with hot and cold metal analyzing about 0.25 per cent carbon and 0.70 per cent manganese were examined. Although exact temperature readings were not taken and the structures varied somewhat, Figs. 16 and 17 show typical hot and cold structures of 0.25 per cent carbon steel. These figures were derived from the risers and are from the same heat. Fig. 18 shows a small dendritic area entirely surrounded by non-dendritic. This particular area was located near the top of a riser. Fig. 19 is a section through the end of a small casting. Both of these figures show again that the growth of dendrites does not always start at the surface of the mold.

A study of sections of variously shaped castings shows that if the flowing metal passes through a long channel it is sufficiently cooled by contact with the mold surface to greatly reduce the likelihood of a dendritic structure.

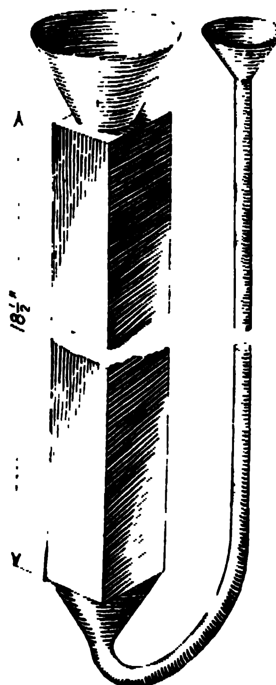


FIG. 20.
Long bar cast vertically, with gate, runner and riser.

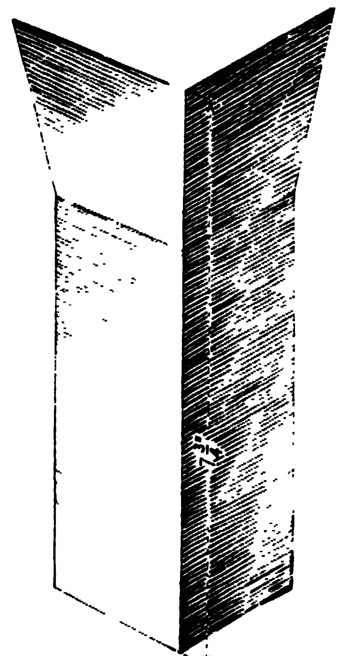


FIG. 21.
Ingots for chemical analysis.

A T-shaped cross-section may have dendrites in two branches, but none in the third. If the movement or flow of molten metal continues until the temperature approaches the mushy stage, nuclei for crystal growth seem to appear throughout the entire mass, and both space and time for dendritic growth are lacking. If, however, this flow is continued until the temperature drops still further, there seems to be a tendency toward what may be called a variety of segregation. This condition is illustrated in Fig. 22. This figure represents a cross-section near the top of a long small casting poured with rather cold metal. A sketch of the pattern with method of gating is shown in Fig. 20. In pouring this casting the first metal to enter passed down 18 in. through the runner, then up 18 in. to the top. The small dark rounded areas of Fig. 22 are gas cavities similar in nature and cause to those seen in Fig. 10. The concentric arrangement of those constituents which are least attacked by the reagents seems to have been due to the flow continuing into the early part of the mushy stage.

The effect of movement of the molten metal as its temperature approaches the solidus upon the nature of the crystalline growth is well illustrated in Fig. 23. This figure is part of a section of a feeder about 2 in. in diameter. At the outside (top of figure) the normal radial dendrites are found; then there is an irregular zone of what, for a lack of a better name, may be called network structure; then a second zone of irregular dendrites, and in the center (bottom of figure) an area which seems to show segregation.

Figs. 24 and 25 are partial sections of chemical-test ingots which were cast in split iron molds. A sketch of one of these ingots is shown in Fig. 21. The walls of the small iron molds in which these are cast are about ⅜ in. thick, and the metal solidifies very quickly. The ingot from which Fig. 24 was derived was cast with hot metal (carbon 0.20 per cent). The very small, needle-like dendrites should be compared with those in Fig. 16, which shows hot poured steel of similar composition but cast in a dry sand mold. The ingot represented by Fig. 25 was cast with 0.36 per cent carbon steel, temperature of casting unknown. The small grain size here should be compared with that seen in Fig. 17. The carbon content was different, and that may be partly responsible for the great difference in size of grains. The light areas at the bottom of both Figs. 24 and 25 were in the centers of the ingots. These areas, like the one at the lower edge of Fig. 23, show what may be considered segregation, although the practical foundryman would attribute them to shrinkage. It is difficult to understand how there could have been sufficient time for segregation strictly as understood to take place in the chilled ingots.

Many Unknown Causes of Structure

Many of the factors which influence the formation of dendrites are unknown. Two of the most important may be mentioned here as being well established by the data and also as being in line with theoretical considerations on this matter. The first is the relative

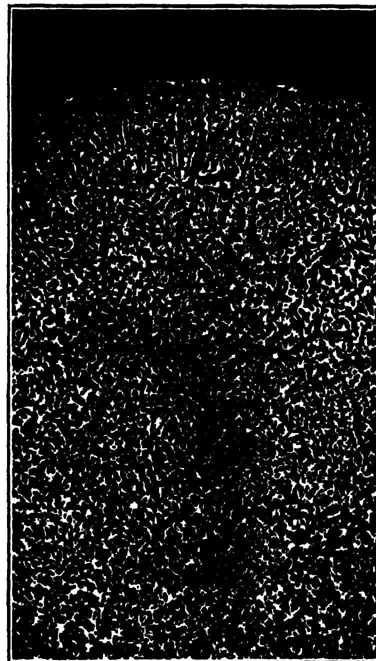
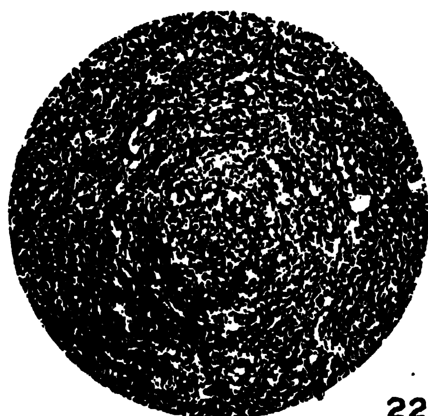
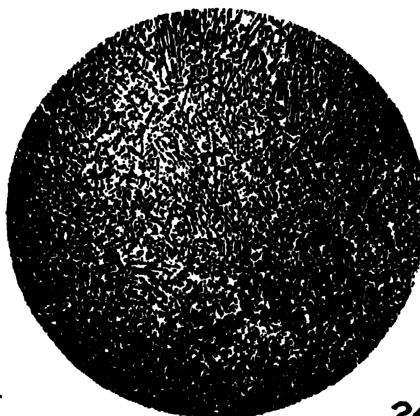


Fig. 23. Variable macrostructure in 2-in. feeder.

temperature of different parts of the molten mass during the solidification period, or, in other words, the thermal gradient. Dendrites grow from nuclei formed at or below the solidification point toward the hotter regions, as from the surface toward the center. Local heating or cooling conditions, such as the flow of metal through certain parts of the ingot, or the presence of a cavity, may cause a change in the direction of the





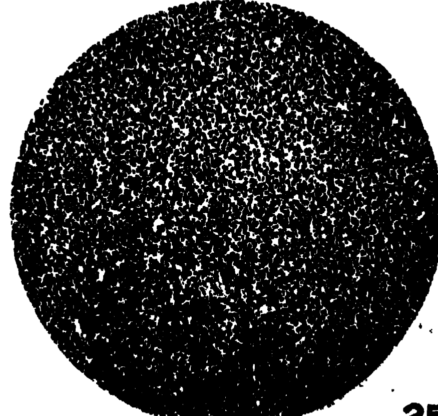


Fig. 22. Segregation in end of long casting.

Fig. 24. Hot steel cast in iron mold.

Fig. 25. Cold steel cast in iron mold.

dendrites. Again, if the metal when poured is near the solidification point, the conditions for dendritic growth may be lacking and the metal will solidify around nuclei well distributed throughout the mass, giving rise to the network structure. Second, selective freezing no doubt has a very important effect upon the macrostructure. This would account for the influence of phosphorus or of oxygen, if the theory of Le Chatelier and Bogitch be correct. But other elements besides these two have an influence upon selective freezing.

Our firm makes a very low-carbon cast steel which is used extensively for dynamo and motor frames because of its high magnetic permeability. This steel runs about 0.07 per cent carbon, 0.06 per cent silicon and 0.05 per cent manganese. Although cast at a very high temperature, an examination of a number of specimens shows that dendrites are of rare occurrence. The phosphorus content of this steel is as high as that of the higher carbon steel and there is every reason to believe that the oxygen content is at least as high. The absence of a well-developed macrostructure in this steel and its presence in the higher carbon steel cannot be accounted for by the theory that these two elements are the only controlling factors. Carbon, manganese and silicon may be considered to play an important part. So, too, alloy steels such as nickel and chromium show a highly dendritic structure.

CONCLUSION

In concluding this brief discussion of some miscellaneous studies of cast steel macrostructure, our previous statement may be repeated: The steel foundry offers exceptional opportunities and a fertile field to the research metallurgist. Most of the literature of the science of metallography, textbooks included, deals with forged or worked metal, and the technologist is still without accurate data on some very elementary matters. It is evident that a proper understanding of the crystalline structure of cast steel should begin with a study of its macrostructure.

Milwaukee, Wis.

Dyestuffs Trade in Japan

The following item appeared in the *Japan Chronicle* for June 4, 1920:

An official of the Mitsui Co. is quoted as stating that in Japan a small quantity of natural indigo was produced in Chugoku, Shikoku and Saitama Prefectures before the war, but the domestic demand for indigo was largely met by imports of the German indigotin. On the outbreak of the war the direct importation of German dyestuffs ceased, and prices rose in consequence, offering an opportunity for the establishment of dyestuff companies in Japan. The termination of hostilities, however, brought about a fall in price, and it is now considered that in view of the fact that Japanese dyes are inferior to foreign products in quality it is advisable to import the goods rather than to manufacture them at home. Even though Japan could produce dyestuffs equal in quality to those of foreign countries, it is unable to manufacture them at the same low cost.

Japan is able to manufacture black and methyl violet of good quality, and these manufactures not only supply the domestic demands but are exported to China in large quantities. Other kinds of dyes are, for the most part, imported from America, England, and Switzerland. The Miike factory of the Mitsui Co. is producing alizarine dyes.

The imports of dyestuffs into Japan for last year were valued at 15,000,000 yen ($7,477,500 at normal exchange), while in pre-war days the imports were about 5,000,000 yen ($2,492,500) worth of artificial indigo and about 5,000,000 yen ($2,492,500) worth of other kinds of dyestuffs. As the price was lower before the war, the quantity of imports was larger in pre-war years than last year. Before 1914, Germany and Switzerland were practically the only countries that produced artificial indigo, and most of the natural indigo was supplied by India and Java. The shortage during the war was very great, owing to the suspension of imports, and Japan was compelled to be economical with what it had left.

When the highest price was ruling, 200 yen ($99.70) per kin (1.32 lb.) was a common price. At present the market has fallen to 15 or 16 yen ($7.48-$7.98) per kin. This decline in price is partly due to the economic depression now prevailing. Up to the end of February last the market price of 24 to 25 yen ($11.96 to $12.46) per kin had been maintained. "Direct" black had been quoted at 8.40 yen ($4.19) per kin up to the end of February, but the price has fallen to 7 yen ($3.49). It is even said that in some cases it is sold as low as 5 yen ($2.49). At present there is no business, and although a good price will have to be paid by the buyer, there is practically no price that can be demanded by the seller. In short, the price has fallen by 20 per cent, being influenced by the present economic depression. The official of the Japanese firm quoted believes that the market price of dyestuffs will rise in the future, however.

Decline in the Production of Graphite

A heavy decline in the production of graphite in the United States in 1919 is shown by preliminary estimates just made public by the United States Geological Survey.

The shipments of domestic graphite amounted to approximately 7,717 short tons, valued at $743,000, a decrease of about 41 per cent in quantity and 51 per cent in value from the figures for 1918. This decrease is apparently due to several well-known causes. After the War Industries Board, on Aug. 10, 1918, ordered the use of at least 25 per cent of American graphite in crucible mixtures to be sold during the year 1919, the purchases of domestic and Canadian graphite were heavy, reaching 500 tons or more a month during August, September and October, 1918. After the armistice was signed, however, on Nov. 11, 1918, an abrupt decline in shipments began, which was accelerated by the order of the War Trade Board of Jan. 16, 1919, removing all restrictions on purchases of graphite. This order naturally weakened the market, for customers were then already burdened by accumulated stocks. The cost of manual labor in the United States increased enormously in 1918 and 1919, but as the demand for graphite was weak and as the market was thrown open to foreign competition the producers were unable to raise their prices proportionately. Although marine freight rates had been increased, the producers of crystalline graphite in Ceylon and of flake graphite in Madagascar, by reason of cheap native labor and unusual conditions of foreign exchange, were able to market their product at prices that forced the smaller American producers to suspend production, so that at the close of the year 1919 only the strongest and best organized companies were able to continue operations.

DOMESTIC GRAPHITE SOLD IN 1915-1919
(Short Tons)

Year	Amorphous		Crystalline		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1915	1,181	$12,358	3,537	$417,273	4,718	$429,631
1916	2,622	20,723	5,466	914,748	8,088	935,471
1917	8,301	73,481	5,292	1,094,398	13,593	1,167,879
1918	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919	4,000	47,000	3,717	696,000	7,717	743,000

During 1919 the New York prices for the best grades of Ceylon lump graphite ranged from 13¾ to 15½ cents a pound. Domestic flake brought from 4 to 10½ cents and dust from 1 to 3 cents.

Studies in Evaporator Design*—III

The Effect of Hydrostatic Head on Heat Transmission in Vertical Tube Evaporators — Method of Manipulation and Accuracy of Results — Maximum Heating One-Third Tube Depth†

BY W. L. BADGER AND P. W. SHEPARD

THIS paper reports a series of determinations of heat transmission in an experimental vertical tube evaporator, to show the effect of hydrostatic head (and incidentally the effect of the shape of the bottom of the evaporator) on this constant. This investigation was undertaken in the evaporator experiment station of the University of Michigan as a part of the general program of the study and correlation of all the factors and variables affecting heat transmission in evaporators. It was felt that since our general problem involved a quantitative study of evaporators on a larger scale, over wider ranges and with a different disposal of heating surface than any investigator has hitherto attempted as a research proposition, it would be well to risk the possible repetition of some of the work already done.

PRIOR LITERATURE

Claassen very early pointed out the fact that increasing the hydrostatic head on a surface must result in a decrease in heat transmission. He carried out some experiments[1] in a small experimental evaporator which has been described in a previous paper.[2] His experiments on this subject are only four in number and the actual hydrostatic head is not recorded. The experiments with "high" hydrostatic heads show a heat transmission about 5 per cent lower than those with "low" hydrostatic heads.

Hausbrand[3] omits entirely the discussion of this point with reference to heat transmission.

Kerr[4] has studied this point and has given several curves showing the effect of hydrostatic head on heat transmission. He shows that the maximum heat transmission occurs when the tubes are about one-third submerged, that the decrease in heat transmission at higher levels than this approximately follows a straight line and that this decrease is greater than the decrease calculated from the increased pressure. In other places in the literature[5] are found the statements that vertical tube evaporators give the maximum heat transmission when the tubes are about one-third submerged.

APPARATUS

The experiments here described were run in the vertical tube evaporator at the evaporator experiment station of the University of Michigan. This apparatus has been previously described[6]. The steam basket employed in these runs contains twenty-four 2-in. 13-gage charcoal iron tubes, 30 in. long. These experiments are divided into three series corresponding to different arrangements of the evaporator. In series A the body of the evaporator from bottom flange to top flange was 8 ft. high and the evaporator was equipped with a round bottom. In series B an intermediate section was added so that the body of the evaporator was 12 ft. high, but otherwise the same as in series A. Series C was also run with the body 12 ft. high, but a 60 deg. cone bottom was substituted for the round bottom of the previous tests.

METHOD OF MANIPULATION AND ACCURACY OF RESULTS

These have been discussed in a previous paper and this discussion need not be repeated here.

Results. The results are given in Tables I, II and III and in Fig. 1. At levels above 24 in., all the results at a point were averaged. At levels below 24 in., the results when the round bottom was used are averaged separately from the results with the cone bottom. In all runs the liquor level averaged less than ½ in. from the desired point. Consequently all the individual results obtained at each level should be in a single vertical line. They are spread sideways a little to make it possible to distinguish individual determinations. There are several interesting features in this curve.

It will be noted that with the round bottom the maximum heat transmission occurs at exactly one-third submergence. This confirms the results of other investigators. It will also be noticed that at levels higher than the top tube sheet, heat transmission decreases with increase in level along a straight line; but this relation does not hold between the top tube sheet and the maximum.

The point of greatest significance is the difference in the shape of these curves, due to the shape of the bottom of the evaporator. The explanation for this difference is fairly obvious. As will be shown later, although these curves show the change in heat transmission as the liquor level is varied, this change is really due largely to changes in circulation and only to a small extent to changes in hydrostatic head. The round bottom contains a comparatively small amount of liquid in proportion to the amount above the bottom tube sheet and therefore circulation of the entire mass is very vigorous. The cone bottom contains a large mass of liquid which absorbs energy of circulation in eddy currents. With low liquor levels the proportion of liquid in the cone to liquid above the bottom tube sheet is large and therefore the effect of the cone is marked. As the liquor level rises the proportion of liquid in the cone becomes less, so that at levels approximately at the top tube sheet it has no effect on the general circulation.

The bearing of this relation on the design of evapo-

*Read before the American Institute of Chemical Engineers, June 27, 1920.

†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 6 and 7, Aug. 11 and 18, 1920, pp. 237 and 281.

[1] *Z. Ver. Zuckerind.*, vol. 52, p. 373.

[2] See CHEM. & MET. ENG., vol. 23, No. 5, Aug. 11, 1920, p. 237.

[3] Verdampfen Kondensieren und Kuhlen, 6th Ed., 1918.

[4] Bull. 149, La. Agri. Exper. Sta.

[5] Webre, *J. Ind. Eng. Chem.*, vol. 10, p. 191; Rousseau, *Trans.*, A.I.M.E., vol. 38, p. 109.

[6] CHEM. & MET. ENG., vol. 23, No. 4, July 28, 1920, p. 159.

TABLE I. DATA OF INDIVIDUAL RUNS

Series	Run No.	Level, In. above bottom tube sheet	Time	Absolute body pressure p_v	Corres. body temperature, t_w	Body temp. from thermometer	Absolute steam pressure	Corres. steam temp t_s	Condensate temperature	Condensate	Apparent temperature drop θ	Apparent K	U
			Min.	mm.Hg	Deg. C.	Deg. C.	mm.Hg	Deg C.	Deg. C.	lb.			
A	50	3	50.33	285 4	74 69	73.88	769 1	100 33	93 47	309 0	25 64	873	178
A	47	6	36.42	286 2	74 74	73.46	762 0	100 07	96 14	695 0	25 33	2732	560
A	48	6	40 75	281 6	74.38	73.36	761 9	100 07	96 64	808 0	25 69	2796	573
A	49	6	37 80	283 5	74.54	72.46	767 2	100 26	96 57	716 0	25 72	2668	547
A	44	9	40 08	278 6	74.12	72 74	758 3	99 94	96 35	835 5	25 82	2925	599
A	45	9	35 75	280.1	74.26	73 28	764 6	100 17	96 73	708 0	25 91	2768	567
A	46	9	40.50	283 0	74.32	73 38	760 2	100 01	96 77	782 0	25 69	2722	558
A	40	12	39 75	270 4	73.42	72 84	761 5	100 06	94 80	776 0	26 64	2664	546
A	41	12	36 50	280 7	74 30	73 95	759 3	99 97	93 99	711 5	25 67	2763	566
A	42	12	38 75	280.4	74 27	72 95	762 3	100 08	95 91	764 0	25 81	2833	580
A	43	12	36 13	280 3	74 26	73 55	767 9	100 28	96 49	707 5	26 02	2724	558
A	36	18	48 25	282 0	74 40	74.07	764 8	100 18	94 47	807 5	25 78	2361	484
A	37	18	41 42	282 1	74 41	73.85	762 1	100 11	93 73	703 0	25 70	2405	493
A	38	18	47 42	286 1	74 89	74 07	759 4	99 98	94 35	790 0	25 09	2414	495
A	39	18	44 75	277 1	74.00	73 47	760 3	100 01	93 14	796 0	26 01	2494	511
A	32	24	51 50	283 4	74.53	74.60	761 1	100 04	93 30	789 0	25 51	2192	449
A	33	24	50 75	285 1	74 65	74 91	760 3	100 01	92 41	768 5	25 36	2179	446
A	34	24	49 83	285 7	74 70	75.00	760 5	100 02	93 73	737 5	25 32	2129	436
A	35	24	45 75	285 8	74 71	74 79	758 8	99 96	94 36	693 5	25 25	2179	446
C	2B	24	31.75	282 7	74 47	74 99	762 4	100 09	88 94	474 0	25 62	2141	439
C	3B	24	30 83	282 6	74 47	74 92	760 9	100 03	88 63	467 5	25 56	2180	446
A	21	30	52 25	283 0	74 48	74 20	765 5	100.20	94 60	715 0	25 72	1935	396
A	22	30	50 00	279 4	74.18	74 30	765 2	100 19	93 10	692 5	26 02	1941	398
A	23	30	48.75	288 6	74 94	75.10	765 2	100 19	94 10	679 5	25 25	2008	412
A	24	30	57 33	287 6	74 85	75.00	765 6	100 21	94 50	776 0	25 36	1942	398
A	26	30	58 82	283 0	74 54	74.60	765 3	100 20	93 90	834 5	25 66	2012	412
A	27	30	61 33	285 9	74.72	74 70	761 8	100 07	92 90	860 0	25 35	2016	413
B	59	30	48 82	291 7	75 22	74.60	770 0	100 37	93 94	705 0	25 15	2109	432
B	60	30	60.83	294 1	75 47	74 93	770 5	100 38	94 58	878 5	24 97	2104	431
B	61	30	51 50	288 6	74.94	74 78	765 6	100 21	94 33	749 5	25 24	2098	430
B	62	30	51.17	287 3	74.86	74.66	764 1	100 13	94 17	723 5	25 29	2034	416
C	101	30	50 75	279.4	74 19	74.43	759 6	99 99	95 29	762 4	25 80	2114	433
C	102	30	46.25	276.6	73.96	73.73	754.5	99 79	95 46	680 5	25 83	2067	423
C	8A	30	37 00	285 5	74 82	74 76	759.6	99 98	89 61	558 5	25 16	2201	451
C	1B	30	33.92	282 6	74 46	74 97	762 0	100 07	87 03	498 5	25 61	2115	433
A	29	48	57.42	288 6	74 94	74 55	761 0	100 03	92 60	678 0	25 10	1720	352
A	30	48	61.42	276 3	73.93	73 13	765 5	100 20	92 55	796.5	26 27	1802	369
A	31	48	54 08	277 2	74 01	73 81	758 5	99 94	91 45	631 5	25 93	1620	332
B	51	48	60 41	286 4	74 78	74 71	761.1	100 04	95 13	781 5	25 26	1858	380
B	52	48	55 67	280 6	74 29	75 75	762 7	100 10	95 24	671 0	25 81	1696	347
B	55	48	50 53	280.2	74 26	74 17	762 1	100 08	94 58	629 5	25 82	1758	360
B	58	48	50 08	275 6	73 84	72.19	761 3	100 05	93 65	672 0	26 21	1905	390
C	5B	48	42 72	281 1	74 36	75 78	763 1	100 11	94 56	538 0	25 75	1778	364
C	6B	48	41 83	281 0	74 35	75 69	762 8	100 10	94 89	530 0	25 75	1787	366
B	53	60	65 75	277 9	74 04	75 42	763 8	100 14	95 35	695 0	26 07	1473	302
B	54	60	70 42	28[illegible].2	74 68	75.15	767 8	100 29	94 84	707 0	25 61	1425	292
C	7B	60	43 50	295 8	75.55	76 28	764 2	100 15	94 36	437 0	24 60	1486	304
C	8B	60	44 67	294 8	75.47	76 92	763 7	100 13	85 08	456 0	24 56	1539	315
B	56	72	65 75	278.9	74 15	72 78	764 3	100 16	93 74	617 5	26 01	1314	269
B	63	72	52 00	286 3	74 77	74 85	767.7	100 28	93 05	430 0	25 51	1182	240
B	64	84	71 33	279.6	74.21	75.12	767 3	100 27	94 48	525 0	26 06	1030	211
B	65	84	68 08	283 4	74 53	75 96	766 2	100 23	93 03	490 5	25 70	1022	209
C	22A	3	43.75	288 5	74.96	73 82	764 9	100 18	94 56	115 5	25 22	385	79
C	23A	3	41 00	288.4	74.95	72 30	761 0	100 04	93 64	110 0	25 09	390	80
C	10B	6	52.00	285.6	74 72	75 06	761.0	100 04	91 24	297 5	25 32	828	170
C	12B	6	52 67	287.4	74 87	75 68	764 9	100 18	94 64	302 0	25 31	824	167
C	13B	6	42.33	293.6	75 37	75 48	759.2	99 97	94 80	258 5	24 60	902	185
C	107	9	41 00	289 5	75 04	74.47	760 1	100 00	94 43	385 0	24 96	1369	280
C	108	9	42.33	281.9	74 31	73 41	756 4	99 87	94 35	450 5	25 56	1514	310
C	9B	12	40 82	277 5	74 03	73 85	763 3	100 12	95 36	632 5	26 09	2156	441
C	9A	12	32.00	286 8	74.57	74.09	764 1	100 15	86 37	306 5	25 58	2261	463
C	12A	12	30.75	295 9	75.56	74 04	767.5	100 27	95 66	451 5	24 71	2151	441
C	13A	12	51.75	299.1	75.82	73.84	763 0	100 11	95 34	742 0	24 29	2144	439
C	14A	12	40 58	274.6	73 78	72.48	764 3	100 16	95 55	676 0	26 38	2292	470
C	15A	12	50.33	283.3	74.57	73.98	762.8	100 10	95 72	808 0	25.53	2281	468
C	10A	18	32.25	284.0	74 58	74.82	765.8	100 21	86 19	506 5	25 63	2263	464
C	11A	18	33.83	280.8	74.31	74.91	760.3	100 01	87 20	520 0	25 70	2230	457
Average....				283.9	74.57		763.3	100.11			25.54		

AVERAGES BY GROUPS

Series	Level	K	U	Series	Level	K	U
A	3	873	178	B-C	60	1481	303
A	6	2732	560	B	72	1248	254
A	9	2805	575	B	84	1026	210
A	12	2746	562	C	3	388	80
A	18	2418	496	C	6	851	174
A-C	24	2167	444	C	9	1442	295
A-B-C	30	2050	420	C	12	2214	480
A-B-C	48	1769	362	C	18	2246	460

TABLE II. HYDROSTATIC HEAD CORRECTION FOR LEVELS BELOW TOP TUBE SHEET

Average apparent temperature drop for all series (θ_1) · 25.54
Average body pressure for all series (p_v) = 283.9.
Corresponding temperature (t_w) = 745.7
Average steam temperature for all series (t_s) = 100.11.

Series	A	A	A	A	A	A + C	C	C	C	C
Level, in. above bottom tube sheet	3	6	9	12	18	24	6	9	12	18
Heating surface above liquor level, H_a	3.540	3.161	2.779	2.401	1 643	0.882	3.161	2 779	2 401	1.643
Heating surface below liquor level, H_b	0.533	0.192	1.294	1.672	2.430	3.191	0 912	1 294	1.672	2 430
Hydrostatic head on bottom tube sheet, p_h	5.5	10.9	16.4	21.8	33 8	43.6	10.9	16 4	21.8	32 8
Total pressure on bottom, p_b	289.4	294.8	300.3	305.8	316 7	327.6	294 8	300 3	305.8	316 7
Temperature at bottom, t_b	75.03	75.49	75.94	76.37	77 22	78.05	75 49	75.94	76.37	77 22
Temperature drop at bottom, θ_2	25.09	24.62	24.17	23.74	22.89	22.06	24.62	24 17	23.74	24 20
Mean weighted temperature difference, θ_{mh}	25.51	25.43	25.32	25.16	24 74	24.12	25 43	25 32	25 16	24 74
Apparent K	873	2732	2805	2746	2418	2167	851	1442	2214	2246
Corrected K	875	2741	2830	2787	2495	2293	854	1453	2247	2317

rators is obvious. A hopper bottom is used on a vertical tube evaporator when the formation of crystals or precipitates is expected. But under these circumstances it is comparatively rare that a vertical tube evaporator would be operated at low liquor levels because of the danger of building up deposits on the heating surface. When an evaporator is run as salting evaporators usually are, with the liquor level at the top tube sheet, the effect of the cone bottom disappears.[4] On the other hand, in evaporators for liquids which can be boiled at low liquor levels it is of importance to keep the volume of liquid below the bottom tube sheet as small as possible.

CALCULATIONS

To determine how much of the effect shown by these curves is actually caused by hydrostatic head, points were read off the curves as plotted and recalculated to actual conductivities as follows:

Let t_s = temperature of heating steam (calculated from pressure).

t_w = temperature of the boiling liquid at its surface (calculated from the vacuum).

t_b = temperature of the boiling liquid at the bottom tube sheet.

t_t = temperature of the boiling liquid at the top tube sheet.

$\theta_1 = t_s - t_w$ = temperature difference at the surface (apparent temperature difference).

$\theta_2 = t_s - t_b$ = temperature difference at the bottom tube sheet, corrected for hydrostatic head.

$\theta_3 = t_s - t_t$ = temperature difference at the top tube sheet, corrected for hydrostatic head.

θ_{mh} = mean weighted temperature difference, corrected for hydrostatic head.

p_v = absolute pressure in the vapor in mm. mercury.

p_h = head of liquid on the bottom tube sheet, mm. mercury.

p'_h = head of liquid on the top tube sheet, mm. mercury.

$p_b = p_v + p_h$ = total pressure at the bottom tube sheet in mm. mercury.

$p_t = p_v + p'_h$ = total pressure at the top tube sheet, mm. mercury.

H_a = heating surface above liquor level, sq.m.

H_b = heating surface below liquor level, sq.m.

Then to illustrate the derivation of the values in Table II, for hydrostatic heads below the tube sheet, the following computation is given:

$p_t = p_v = 283.9.$

$p_b = p_v + p_h = 283.9 + 43.6 = 327.6.$

$t_t = t_w = 74.57.$

$t_b = 78.05.$

$\theta_1 = \theta_3 = t_s - t_w = 100.11 - 74.57 = 25.54$ deg.

$\theta_2 = t_s - t_b = 100.11 - 78.05 = 22.06$ deg.

$$\theta_{mh} = \frac{\theta_2 H_b}{H_a} + \frac{\theta_1 H_a}{H_b} = \frac{(22.06 \times 3.191) + (25.54 \times 0.882)}{4.073} = 24.12 \text{ deg}$$

$$\text{Then the corrected } K = \frac{\theta_1}{\theta_{mh}} (\text{apparent } K) = \left(\frac{25.54}{24.12}\right) 2167 = 2293.$$

For levels above the top tube sheet the calculation differs. The corrected temperature at the top tube sheet must be computed, and the arithmetical mean between this and the corrected temperature drop at the bottom tube sheet becomes the new mean (θ_{mh}) from which the corrected K is calculated. The following calculation is for a level 72 in. above the bottom tube sheet:

$p_t = p_v + p'_h = 283.9 + 76.5 = 360.4.$

$p_b = p_v + p_h = 283.9 + 131.1 = 415.0$

From steam tables

$t_t = 80.38.$

$t_b = 83.91.$

$\theta_3 = t_s - t_t = 100.11 - 80.38 = 19.73$

$\theta_2 = t_s - t_b = 100.11 - 83.91 = 16.20.$

$$\theta_{mh} = \frac{\theta_3 + \theta_2}{2} = 17.96.$$

$$\text{Corrected } K = \frac{\theta_1}{\theta_{mh}} (\text{apparent } K) = \left(\frac{25.54}{17.96}\right) 1248 = 1776.$$

In taking θ_{mh} as the arithmetical mean the assumption has been made, to simplify calculation, that the boiling point of water is a linear function of the hydrostatic head. This is, of course, not so, but for want of a simple equation expressing the relationship the above approximation is taken as true enough for our purpose.

TABLE III. HYDROSTATIC HEAD CORRECTIONS FOR LEVELS ABOVE TOP TUBE SHEET.

Average apparent temperature drop for all series (θ_1) = 25.54
Average body pressure for all series (p_v) = 283.9
Corresponding temperature (t_w) = 74.57
Average steam temperature for all series (t_s) = 100.11

Series	A + B	A + B	B	B	B
Level, in. above bottom tube sheet	30	48	60	72	84
Hydrostatic head on top tube sheet, mm., p'_h	0.0	32.8	54.6	76.5	98.3
Total pressure on top tube sheet, p_t	283.9	316.7	338.5	360.4	382.2
Boiling temperature at top tube sheet, t_t	74.57	77.22	78.84	80.38	81.84
Temp. drop at top tube sheet, θ_3	25.54	22.89	21.27	19.73	18.27
Hydrostatic head on bottom tube sheet, p_h	54.6	87.4	109.2	131.1	152.9
Total pressure on bottom tube sheet, p_b	338.5	371.3	393.2	415.0	436.9
Boiling temperature at bottom tube sheet, t_b	78.84	81.12	82.55	83.91	85.22
Temperature drop at bottom tube sheet, θ_2	21.27	18.99	17.56	16.20	14.89
Mean temperature drop, θ_{mh}	23.40	20.94	19.42	17.96	16.58
Apparent K	2050	1705	1475	1248	1026
Corrected K	2236	2065	1940	1776	1579

The results are connected by the curve indicated in Fig. 1. Evidently the effect of hydrostatic head is subordinate to the effect of velocity of circulation. More detailed discussion of the effect of velocity is unprofitable until a considerable number of similar curves under different conditions of operation have been determined.

It should be emphasized that the elevation in boiling point, due to increased hydrostatic head, is not shown by a thermometer immersed in the lower part of the boiling liquid. In an evaporator of the type here used, where the descending circulation is in the outer annular down-take space, a thermometer inserted into this annular space should always read a temperature corre-

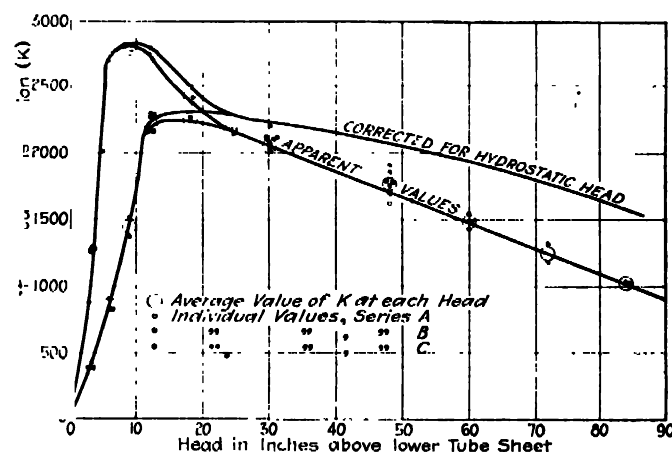


FIG. 1. VARIATION OF HEAT TRANSMISSION WITH HEAD

sponding to the vacuum or a little lower. The liquid in this down-take space is coming from the upper part of the evaporator, where it has lost any superheat it may have had, and must enter the down-take either at the temperature corresponding to the vacuum or at a lower temperature if it cools by radiation.

If the columns showing temperature calculated from vacuum and temperature of body are compared it will be seen that the temperature read by the thermometer tends to be lower than that calculated from the vacuum at low liquor levels and higher than that calculated from vacuum at high liquor levels. This thermometer

was situated not far from the feed inlet and consequently at low liquor levels (which mean high rates of evaporation and consequently high rates of feed in proportion to the total amount of liquid in the evaporator); it gives a low reading, due to currents of colder feed liquor. Through the middle of the range, where the effect of feed is less and yet circulation is strong, the two temperatures agree fairly well. At very high temperature levels there is very little real circulation, but rather an agitation or bouncing. This bouncing may at times result in some superheated liquid from the lower part of the steam basket being carried up into the annular space as far as the thermometer bulb. At ordinary levels and with ordinary circulation there will be no appreciable elevation of the general temperature of the boiling liquid.

Conclusions

The following conclusions must be for the present considered as indicating tendencies only, and should be applied with caution to evaporators which differ very much in design from the evaporator in which they were determined.

1. The maximum heat transmission when boiling water or other non-foaming, non-viscous materials in a vertical tube evaporator occurs when the tubes are from one-third to one-half submerged.

2. The position of this maximum point and its value depends on the size and shape of the evaporator bottom. With bottoms containing little liquid below the bottom tube sheet the maximum occurs at lower levels and has a higher value than with bottoms containing large amounts of liquid.

3. Differences in the shape of the bottom have little effect on heat transmission when the amount of liquid in the evaporator above the bottom tube sheet is larger than the amount of liquid below the bottom tube sheet.

4. As the liquor level is increased above the top tube sheet the heat transmission falls off along a straight line.

5. The change in heat transmission with changing liquor level is only partially due to the effect of hydrostatic head. Changes in velocity of circulation are a very important factor.

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Step-Induction Regulator for Electric Furnace Voltage Control

FOR controlling the energy input for carborundum, graphite, aluminum, zinc and similar types of electric furnaces, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is manufacturing a step-induction regulator which gives a uniform voltage over a wide range. The regulator consists of a furnace transformer, an induction regulator, switches and push-button control. This apparatus utilizes the principle of varying the high-voltage tap on the transformer for controlling the energy input to the furnace.

The function of the induction regulator is to vary the voltage between taps. After the voltage of the adjacent tap is reached the selector and transfer switches automatically transfer the induction regulator so that it will function between the next two taps. One of the main features of this apparatus is that the entire voltage range is controlled by two push-buttons, one for boosting and one for bucking the voltage.

The construction of the apparatus is as follows: On the shaft of the regulator is geared a selector switch, the joints on this switch being connected directly to taps on the high voltage winding of the furnace transformer. The selector switch-arm moves from one contact to the next automatically as the induction regulator moves. The function of the feeder voltage regulator is to add to or subtract from the normal voltage of a transformer tap and is designed so that at the position of maximum boost it will add exactly one-half of the voltage between adjacent transformer taps, while at position of maximum buck it will subtract exactly one-half the voltage between adjacent transformer taps. Considering, then, a single position of the selector switch-arm, a single rotation of the moving coil of the induction regulator will vary the voltage impressed on the high tension winding from a position one-half step below to a position one-half step above the voltage point actually represented by the transformer tap. The selector switch arm is moved from one tap to the next just as the voltage one-half way between adjacent taps is reached, so that continued rotation of the regulator coil produces a continuous variation, raising or lowering the voltage depending only on the direction in which the regulator coil is being turned.

While the above is the fundamental operation of the apparatus, in actual practice there are slight modifications. The moving coil of the regulator makes but one-half revolution to go from the position of maximum

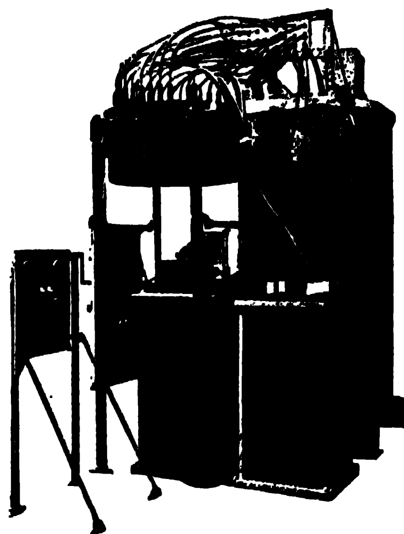


FIG. 1.
Step-induction regulator complete with transformer and control panel, 1,100 kva., 14,500 volts, single-phase, 25 cycle, low-voltage range, 40 to 50 volts.

buck to the position of maximum boost, at which latter point the selector switch moves to the next higher voltage tap, and the regulator must be brought at this point to maximum buck before it can, by continued operation, raise the voltage over another step. That is, at this point, the direction of current through the regulator coil must be reversed. Actually, the result is

obtained by a second coil of opposite polarity which is cut in at the proper time by a transfer switch and the regulator changes directly from maximum boost to maximum buck, so that continued rotation still acts to raise the voltage. The two-coil arrangement also makes desirable two-selector switches geared together for continued voltage variation. With high incoming line voltage a series transformer is interposed between the high tension line and the induction regulator. This allows the use of a less bulky low voltage induction regulator, and insures against trouble with insulating moving parts for high potentials. In this case, two coils are incorporated with the series transformer instead of in the regulator itself, and accomplish the same current reversing purposes. The operation of this regulator may be seen by reference to the schematic diagram.

Assume that the circuit is complete from the incoming high voltage positive line through one-half the high tension winding of the power transformer, through transfer switch T contact a to the upper coil of series transformer SR and through selector switch S to tap 1 on the other half of the high-tension winding, which is divided into equal voltage sections. The primary of the series transformer connects directly to the secondary or

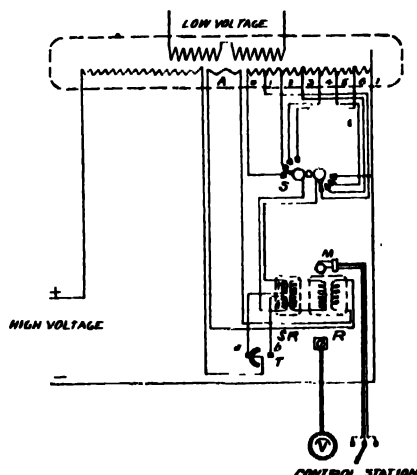


FIG. 2. DIAGRAM OF CONNECTIONS

moving element of the induction regulator R. The series transformer then serves only to insulate the induction regulator from high line voltage, any voltage variation due to induction regulator movement being reflected proportionately in the series transformer coil which is in series with the main supply line. The induction regulator, therefore, adds to or subtracts from normal line voltage in the same manner as though the series transformer were omitted. Assume that the induction regulator is in such position that no voltage is induced in its rotating element. Voltage then is neither added nor subtracted by the series transformer coil and line voltage is impressed across thirteen-fourteenths (one-half plus six-fourteenths) of the high-tension winding and the low-tension voltage will be fourteen-thirteenths of what it would be with the voltage impressed across the entire winding.

Turn the rotating element of the induction regulator from the neutral, and voltage will be induced in its secondary coil from the primary winding which is constantly excited from an auxiliary coil A on the power transformer. The induction regulator and series transformer combination is designed so that its maximum voltage is equal to one-half the voltage difference between adjacent taps. Assume that the moving element is rotated so that the induced voltage adds to that of the line; evidently depending upon the amount of rotation from the neutral no-voltage position the effective voltage of the line may be raised from the normal voltage of tap 1 to any point up to a maximum corresponding to a voltage one-half way to tap 2. With coil rotation in the opposite direction, the induced voltage will subtract from the line, and continued movement of the coil will lower impressed voltage to a point corresponding to that one-half way to tap 0 on the transformer winding. In other words, the range of the induction regulator and series transformer combination itself is between adjacent transformer taps.

Consider now that the induction regulator has been rotated to its maximum boost position, while connected to tap 1. In effect a voltage one-half way between tap 1 and 2 is impressed upon the power transformer winding. Evidently the same result in voltage would be obtained if the coil of the series transformer were connected to tap 2 and the induction regulator was in its maximum buck position. With the coil voltage bucking, continued rotation in a boost direction would raise the voltage through the range of the induction regulator and progress over another step could be undertaken.

It is desirable, therefore, at the position of maximum boost to advance connections to the next higher voltage tap and simultaneously to change the induction regulator to give maximum voltage buck. This is accomplished by driving selector switch S and transfer switch T through gearing from the induction regulator shaft so that taps on the transformer winding are connected automatically and at the proper time polarity is changed from maximum voltage boost to maximum voltage buck. Continued rotation in one direction of the induction regulator raises the voltage over the entire range.

Any voltage within the range of the extreme taps on the transformer winding may be obtained by closing a two-way switch in either a "raise" or "lower" position, the voltage setting of the regulator being indicated by an adjacent voltmeter.

Difficulties of the German Paper Industry

According to a recent issue of *Kölner Zeitung*, the German paper industry is seriously handicapped by the scarcity and increased prices of raw materials. This is particularly true of old paper and rags, which are extremely difficult to obtain and have reached a price which appears unjustified. It is believed that old paper and rag dealers have been holding their supplies to drive prices up. The demand is very great and constantly increasing in spite of the fact that consumers believe present prices cannot continue. The cellulose plants in eastern Germany, which have been forced to suspend production for some weeks owing to the shortage of coal, have recently resumed operations, and it is hoped that renewed deliveries of cellulose will help to drive down the prices of old paper and rags. Straw, which is used in large quantities in the German paper industry, is now quoted at 55 to 60 marks per 100 kilos, but this price is expected to fall in the near future. It is hoped that this will also have an effect on the prices of other raw materials. Wages in the industry have risen over 100 per cent since December, and the cost of coal, chemicals, dyes and other raw materials has risen in like manner.

Synopsis of Recent Chemical & Metallurgical Literature

Synthetic Ammonia.—GEORGES CLAUDE has recently outlined the results of his work on synthetic ammonia before the Société Chimique de France and the Société d'Encouragement pour l'Industrie Nationale de France. He proposes the use of ammonium chloride instead of ammonium sulphate as fertilizer and stated that in the manufacture of the chloride for each kg. of fixed nitrogen produced it will be possible to obtain with practically no additional cost more than three tons of sodium carbonate. He reviews the history of the production of synthetic ammonia by the use of catalyzers and high pressures, and cites that the French chemist Tellier as late as 1867 was the first to make use of the affinity of iron for nitrogen. A few years later iron at red heat was used as catalyzer for the production of synthetic ammonia, but with little practical results.

It was due to the work of the German chemists Nernst and Haber based on the theoretical principles of the Frenchman Le Chatelier that synthetic ammonia can be produced now industrially and on a commercial scale. Nernst used iron as catalyzer with a 50 to 75 atm. pressure with encouraging but not economic results. Haber, with the financial help of the Badische Anilin, studied the catalyzing properties of uranium and osmium and succeeded in replacing iron as catalyzer by what the Badische Anilin calls activators. By the use of high pressures (200 atm.) and specially constructed machines it was possible for the Badische Anlin Co. in 1912 to realize large-scale production of synthetic ammonia, with its activators at red heat, and hydrogen from water gas at its Oppau plant.

Mr. Claude, studying further Le Chatelier's axiom that ammonia is formed with reduction of volume and that this formation is greatly facilitated by pressure, succeeded as late as 1917 in realizing his hyper-compressors for the production of 1,000 atm. pressure which now can compress 100 cu.m. of the mixture $N_2 + 3H_2$ per hour. The working of the apparatus is so simple that he was able to have a model in operation before his audience. He dwelt on the advantages in using hyper-pressures.

With the pressures used in Germany (200 atm.) the efficiency is 13 per cent, whereas with the pressure used by Claude the efficiency is 40 per cent. In both cases the use of a catalyzer is indispensable, and the temperature used is quite the same.

For a capacity of 100 cu.m. per hour per liter of catalyzing space the percentage of NH_3 can reach 25 per cent with the Claude process, as against 6 per cent with the Haber process, figures which correspond to a production of 6 g. instead of 0.5 g. per hour per gram of catalyzer.

In the German process the efficient combination of the gases takes place only by their passing a great number of times over the catalyzer and by the elimination of the NH_3 formed with water injected under pressure, whereas in the Claude process the gases once compressed are passed successively through three or four apparatuses in series and the pressure of the ammonia formed is still so high (250 atm. instead of the 12 atm. with the Haber process) that it is liquefied by its merely passing through a coil immersed in water.

Another advantage of the Claude process is that the product is liquefied NH_3 instead of an aqueous solution (Haber) from which the NH_3 has often to be recovered by distillation.

In the Haber process operating difficulties arise from the fact that the temperature must be increased by costly means. With the Claude process this is just the reverse, as the heat of reaction is even higher than that required and has often to be lowered. Under the operating conditions for synthetic ammonia it is certainly easier and more economical to lower the temperature than to raise it.

In the Haber process the production of the highly purified hydrogen requires enormous installations, whereas with the Claude process the hydrogen may be obtained by electrolysis of water or as a byproduct from coke-oven gas. This is a very important economic problem when it is considered that in the nitrogen fixation industry 1 part nitrogen requires 3 parts hydrogen. Mr. Claude is experimenting on a method by which to extract hydrogen from any hydrogen-containing gas mixture. If his expectations from this method are justified, as he thinks they are, it will be possible to install synthetic ammonia plants near coke ovens where at present immense quantities of hydrogen-containing gases are actually lost or badly utilized.

The advantages of the Claude process outlined above and other additional mechanical advantages and installation facilities warrant the statement that the Claude process is at present the most efficient and economical means of producing synthetic ammonia. The ease with which the process has been practically demonstrated before the audience is the best proof of its practicability. (*L'Industrie Chimique*, July, 1920.)

The Properties of Stoneware Clays.—Results of experiments conducted by the Bureau of Mines at its ceramic station at Columbus, Ohio, on the properties of some Ohio and Pennsylvania stoneware clays are described in Technical Paper 233, recently issued by the bureau, entitled "The Properties of Some Stoneware Clays," by H. G. SCHURECHT. The work has special reference to the possible use of these clays in making chemical stoneware, but many of the results brought out can be applied to other industries as well. It was conducted in co-operation with the Ohio Geological Survey, the Pennsylvania Geological Survey also assisting in collection of samples.

The resistance of vitrified clay to chemical action, together with its impenetrability to liquids, has made chemical stoneware an important product in the chemical industries. Stoneware distilling kettles, receivers, filters, condensing worms, centrifugal pumps, acid-proof pipe fittings, tower packing, acid-proof tanks, photographic tanks, and troughs and tubes for electrical processes are used in these industries. Stoneware equipment is also used in the preparation of foods, as, for example, sugar, flavoring extracts, and preserves. During the war, on account of the increased production of explosives and the production of poisonous gases, there was a marked increase in the demand for chemical stoneware and stoneware clays. A wider use of chemical stoneware is limited only by its comparative brittleness and sensitiveness to sudden temperature changes.

From each of the eleven clays tested, a series of seven bodies was prepared, the clay being ground to different grades of fineness and used alone and with varying proportions of feldspar, or feldspar and calcium carbonate added. From these bodies test pieces were prepared for which the drying shrinkage, tempering water, shrinkage water, pore water, rate of slaking in water, and transverse strengths in the green condition were determined for each body. The softening temperature and the porosity and volume shrinkage at various temperatures were determined by firing tests.

The results are tabulated in detail, and show a wide range of properties among the different clays tested. They indicate that some of the clays might be used for chemical stoneware.

Aluminum as Catalyst in the Preparation of Chlorbenzenes.—Chlorine combines directly with benzene under the influence of sunlight producing the α and β benzene-hexachlorides, but in the dark chlorination takes place only in the presence of a catalytic agent. The first catalyzer used was iodine, but JEAN MEUNIER has found that the catalytic action of aluminum is far superior to that of iodine and he presented the results of his work at the June 14, 1920, meeting of the French Academy of Sciences (*Comptes rendus*, vol. 170, No. 24. pp. 1451-2). He found that the best conditions for the preparation of chlorbenzenes, especially of the monochlorbenzene, is to use aluminum filings in the proportion of 1 part aluminum for 1,000 parts of benzene. During the chlorination the products obtained are C_6H_5Cl plus some more chlorinated benzene. When it is desired to produce only the monochlorbenzene it is necessary to stop the supply of chlorine when the density of the liquid reaches 1.008 at 15 deg. C., the density of the benzene being 0.876. The fractionation of this liquid made under reduced pressure and by heating on a water bath gives the following results:

	Per Cent
C_6H_5Cl (density 1.1084 at 11 deg. C.)	77
Light products (benzene and traces of C_6H_5Cl)	13
Denser products (dichlorbenzenes)	10

The light products are submitted to additional chlorination, giving 10 per cent C_6H_5Cl. The total efficiency of the process is thus 87 per cent.

Determination of Zirconium and Titanium in Zirconium Ores. — An article on "The Determination of Zirconium and Titanium in Zirconium Ores," by G. E. F. LUNDELL and H. B. KNOWLES, appeared in the July, 1920, number of the *Journal of the American Chemical Society*, pages 1,439-1,448. This article may be summarized as follows: Methods of decomposing zirconium ores are listed. A cupferron method for the determination of zirconium and titanium in zirconium ores is given. The method provides for the following elements which have been found in zirconium ores: Zirconium, titanium, silicon, thorium, cerium, iron, aluminum, scandium, yttrium, erbium, didymium, glucinum, calcium, magnesium, sodium, potassium, lithium, uranium, phosphorus, tantalum, manganese, zinc, cobalt, tin, lead, copper, and bismuth. It is also worthy of note that chromium and nickel do not interfere in a cupferron precipitation; that tungsten would not cause trouble since it is removed before the final precipitation; and that vanadium would require special treatment. Since this element has not been reported in zirconium ores, and since its presence in significant amounts would be indicated at various stages of the analysis, it would cause no trouble.

Recent Chemical & Metallurgical Patents

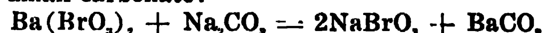
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Manufacture of Bromates.—In the manufacture of bromides, solutions containing sodium bromide and sodium bromate are obtained. The best fractional crystallization of this mixture leaves a liquor containing the salts in the ratio of about 93 per cent NaBr to 7 per cent $NaBrO_3$. In order to effect a complete separation, COULTER W. JONES, of Midland, Mich., takes advantage of the relative insolubility of barium bromate, which is precipitated from the mixture by adding barium bromide:



$$2NaBrO_3 + BaBr_2 = Ba(BrO_3)_2 + 2NaBr$$

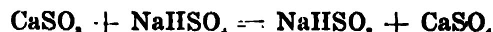
The alkali bromate may be reformed by treatment with alkali carbonate:



$$Ba(BrO_3)_2 + Na_2CO_3 = 2NaBrO_3 + BaCO_3$$

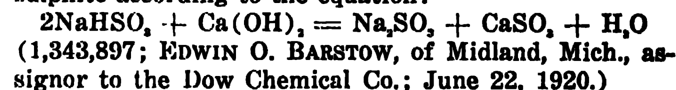
The barium carbonate is converted into bromide for use in the first step by hydrobromic acid or ferric bromide. (1,343,918; assigned to Dow Chemical Co.; June 22, 1920.)

Sodium Sulphite. — Calcium sulphite, which is a waste product in the manufacture of certain spray compounds and in the manufacture of magnesium chloride by certain processes, may be converted into sodium bisulphite by treatment with sodium bisulphate or niter cake:



$$CaSO_3 + NaHSO_4 = NaHSO_3 + CaSO_4$$

Milk of lime changes the acid sulphite into normal sulphite according to the equation:



$$2NaHSO_3 + Ca(OH)_2 = Na_2SO_3 + CaSO_3 + H_2O$$

(1,343,897; EDWIN O. BARSTOW, of Midland, Mich., assignor to the Dow Chemical Co.; June 22, 1920.)

Magnesium Arsenate.—Certain compounds of magnesium with arsenic acid are entirely suitable for insecticidal use and, according to EDWIN O. BARSTOW, of Midland, Mich., possess certain physical characteristics which render them equal to if not superior to lead arsenate and calcium arsenate. The preferred compounds, $MgHAsO_4$ and $Mg_3(AsO_4)_2$, may be prepared from magnesium hydroxide and arsenic acid or from magnesium chloride and sodium arsenate. (1,344,018, assigned to Dow Chemical Co.; June 22, 1920.)

Aluminum Nitride. — Briquets of finely-ground alumina and the calculated quantity of carbon are mixed with larger pieces of carbon in the form of coke, etc., and fed continuously through an electric furnace provided with stationary electrodes and an inlet for gas containing nitrogen, such as producer gas. The larger carbon pieces serve as resistors and carry most of the current required to heat the mass to the reaction temperature, at the same time separating the briquets and preventing them from fusing together. Owing to difference in size, the discharged mixture of briquets and resistors can easily be separated by screening. The resistors are used repeatedly until reduced in size by mechanical wear to a point where separation from the briquets becomes difficult. (1,344,153; MARK SHOELD, of Chicago, Ill., assignor to Armour Fertilizer Works; June 22, 1920.)

Electrolytic Oxygen-Hydrogen Generator.—Certain improvements in unit type oxygen-hydrogen generators are embodied in a cell designed by EDWARD O. BENJAMIN, of Newark, N. J. The diaphragm and all electrode surface exposed within the cell are completely submerged in the electrolyte, thus insuring the efficient functioning of these parts. There is no non-generating electrode surface to waste energy by reversing and acting as a gas battery. An additional advantage of such construction is its adaptability for use on shipboard. Since circulation of electrolyte through the diaphragm tends to impair its gas-proof qualities, provision is made for circulation of the electrolyte (due to difference in specific gravity of the electrolyte on opposite sides of the diaphragm) through suitable passages in the frame above and below the diaphragm. The circulation is slow and the passages are so constructed that there is no possibility of entrained gases passing from one side of the diaphragm to the other. Any number of cells may be connected in series by bolting together the side extensions on the plate electrodes. Should trouble develop, the cell or cells responsible may easily be short-circuited, disconnected and removed for repair without interfering with the operation of the remaining cells. (1,344,220; assigned to International Oxygen Co.; June 22, 1920.)

Synthetic Tanning Material. — Sulpho-phenol carboxylic acids and sulpho-cresol-carboxylic acids will yield condensation products with formaldehyde which are amorphous and water-soluble and which will produce a white, soft and strong leather when employed as tanning materials. (1,344,950 and 1,344,951; ARTHUR KOETZLE, of New York, N. Y., assignor to Rohm & Hass Co.; June 29, 1920.)

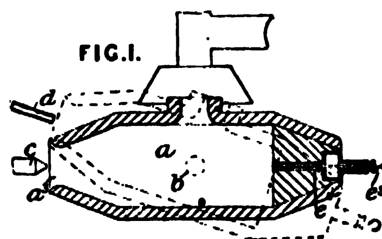
British Patents

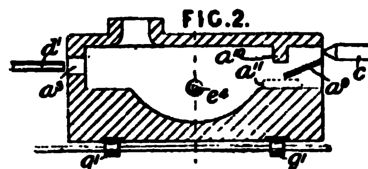
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

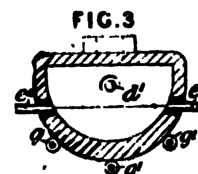
Ammonium Sulphate.—Dry neutral ammonium sulphate is manufactured by treating the commercial salt with a neutralizing agent and simultaneously to agitation and drying under the action of heat, a granular or pulverulent product being obtained if the material is also subjected to treatment to effect mechanical reduction, while if the treatment is effected under suitable conditions, for instance in a partial vacuum or in a gas current, the pyridine is removed and can be recovered. The neutralizing agents mentioned are lime, magnesia or other alkaline earths or their carbonates, alkalis or their carbonates, ammonia, or suitable ammonium salts such as the carbonate, sulphide or sulphite. They may be added dry or as solutions or suspensions, and ammonia may be used in the form of gases, such as coal-gas, containing it, which, if hot, may effect the drying. The apparatus employed may contain grinding bodies, such as balls or pebbles. The gases escaping from the apparatus may be treated for instance with an absorbent such as water, acid solution or an oil or may be submitted to condensation, in order to recover pyridine and any escaping ammonia. In an example, the ammonium sulphate is treated with a small quantity of lime or of ammonia liquor in an externally heated ball-mill. Air is then blown or sucked through, the escaping gas being washed in a scrubber supplied with acid solution of ammonium sulphate such as a saturator mother-liquor. When a product is desired free from pyridine, the quantity of the neutralizing-agent should be equivalent to the quantity of the free acid plus the acid combined with the pyridine. (Br. Pat. 141,787—1919. S. E. LEODHOLT, Buckhurst Hill, Essex, and R. LESSING, London, June 23, 1920.)

Ammonium Sulphate.—Dry and neutral ammonium sulphate is prepared from the sulphate obtained by passing ammonia into sulphuric acid, by neutralizing in known manner the crystals separated in an acid condition from the liquor, and then drying them at a raised temperature, for example by causing the crystals to descend a tower up which heated air is passed. The dry and neutralized sulphate so obtained may be afterwards crushed. (Br. Pat. 141,798—1919. SOUTH METROPOLITAN GAS CO., E. V. EVANS and H. HOLLINGS, London, June 23, 1920.)

Production of Oxides of Tin and Zinc.—Oxides of tin and zinc are produced by supplying a blast of air under high pressure, say 4 or 5 lb., into the melted metal, and a blast of air under low pressure, say 0.15 to 0.5 lb., above the surface of the metal, auxiliary heating by an oil burner being employed if necessary. The oxide is carried off by the blast and collected. The apparatus consists of a tilting furnace *a* on trunnions *b*, Fig. 1, or rollers g^1, Fig. 3, having an oil burner *c*, a low-pressure blast *d* or d^1, and a high-pressure blast *e*, which may be provided with a rod e^3 to keep the opening clear. In the arrangement shown in Fig. 1, the furnace is heated and charged while horizontal, and is then tilted as shown in dotted lines to bring the open end a^2 opposite the low-pressure blast *d* and submerge the high-pressure blast. In the arrangement shown in Figs. 2 and 3, two high-pressure blasts e^4 are provided at opposite sides, the furnace being tilted so that first one and then the other is submerged. A screen a^9 is arranged below the burner *c*, and a baffle a^{10} directs the flame downward. Ingots a^{11} of metal are fed in beneath the screen a^9 without allowing the fumes to escape. In an arrangement of this kind, the low-pressure pipe d^1 may be dispensed with, the opening a^5 then being plugged, and the low-pressure blast is sent in through the burner *c*. The temperature can then be controlled by regulating the proportions of air and oil admitted through the burner. (Br. Pat. 142,157—1919. H. MACONOCHIE, London, and D. DE ROS, Greenhithe, Kent, June 30, 1920.)







Recovery of Nickel Oxide From Alloy or Scrap.—Copper-nickel alloys or metallic scrap are treated for the recovery of nickel oxide by melting in a basic reverberatory furnace or in a basic converter, and air is blown on to the surface or through the molten mass. Nickel oxide volatilizes and is recovered, for instance, in a bag-house or by electric precipitation. (Br. Pat. 142,310—1919. A. MCKECHNIE and MCKECHNIE BROS., London, June 30, 1920.)

Fatty Acids; Soaps.—Fatty acids containing a number of double linkages are converted into fatty acids resembling oleic acid by saponifying them for their glycerides, and heating the resulting neutral soaps to 210-250 deg. C, without evaporation to dryness. The product may be treated with mineral acid to isolate the fatty acid, or may be used as soaps if alkalis are used as saponifying agents. If alkaline earths are used for saponification, the products may be treated with alkali carbonates for the production of soaps. As raw material, sesame or cottonseed oil or the fatty acids therefrom may be employed. (Br. Pat. 141,720—1919. PERSAPOL GAS, Hanover, Germany, June 19, 1920.)

Hydrogen Peroxide.—An alkaline persulphate, e.g. ammonium persulphate produced electrolytically, is separated from the greater part of the electrolyte by means of a vacuum or centrifugal filter, and is placed in a steam-jacketed horizontal tube into which steam is introduced and which is connected through the medium of a condenser to a vacuum pump. The hydrogen peroxide produced collects in the condenser, and the residue of alkali bisulphate remaining in the tube, after dissolving in a quantity of water, can be returned to the electrolytic chamber, since the ratio of base to sulphuric acid has not been changed. (Br. Pat. 141,758—1919. L'AIR LIQUIDE SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDÉS G. CLAUDE, Paris, France, June 16, 1920.)

Ammonium Sulphate.—The acid usually present in ammonium sulphate is removed by washing the sulphate at a raised temperature with a solution of ammonia obtained by condensing the vapors from a fixed ammonia still and diluting the solution thus obtained to such a strength that, at the temperature at which it is to be used, the vapor pressure of the ammonia is too low to entail substantial loss of ammonia. By washing at a raised temperature, chilling of the ammonium sulphate crystals, which might lead to the choking of the centrifugal, is avoided. A suitable diluent for the ammonia solution is obtained by subjecting the hot waste liquor from the fixed ammonia still to a slightly reduced pressure, and condensing at a suitable temperature the mixture of steam and ammonia withdrawn. (Br. Pat. 141,819—1919. SOUTH METROPOLITAN GAS CO., London, P. PARRISH, London, W. A. M. VALON, Stafford, June 23, 1920.)

Plastic Compositions.—A plastic composition which is a non-conductor of heat and electricity and is incombustible, is formed by mixing fibers of paper, wood, rag, etc., plaster, and a solution of gelatine containing stannic oxide. The mixture is heated with a solution of formaldehyde or of sodium bichromate. Colors may be added. An example of proportions is 25 parts of fiber, 175 parts of plaster, 45 parts of gelatine, 10 parts of tin dioxide and 110 parts of water mixed with 5 parts of formalin or sodium bichromate in 30 parts of water. (Br. Pat. 141,987—1919. L. DELEGLISE, Boulogne sur Mer, June 23, 1920.)

Basic Magnesium Hypochlorite.—When chlorine is passed into an aqueous suspension of magnesium oxide, basic magnesium hypochlorite is precipitated, provided that for every molecule of normal hypochlorite produced, more than two (preferably five to six) molecules of magnesia remain unattacked. The most favorable temperature for the process is 20-22 deg. C. Practically the whole of the available chlorine is absorbed by the precipitate without any appreciable production of chlorate if, after the introduction of the chlorine, the reacting mixture be allowed to stand for a considerable time, or be heated to 80 deg. C. and kept at that temperature for from 6 to 8 hr. in the dark. The precipitate, after washing well with hot water, is dried with exclusion of carbon dioxide. (Br. Pat. 142,081—1919. G. KERESZTY and E. WOLF, Budapest, Hungary, June 23, 1920.)

Vulcanizing India Rubber.—In the vulcanization of rubber compounds by hot air, litharge or its derivatives are replaced by an organic or inorganic reducing agent to obtain a light-colored product. Suitable reducing agents are hydroquinone, pyrogallol, tannins, paramidophenol, glycerine, trioxymethylene and other derivatives of formaldehyde, hydrosulphites, neutral sulphites. In general, the amount of reducing agent should not exceed 10 per cent of the rubber. (Br. Pat. 142,083—1919. A. H. HELBRONNER, Paris, June 23, 1920.)

Cracking of Hydrocarbons.—In the cracking of hydrocarbon oils, the thermal decomposition of fats to obtain glycerine, the production of oil and coal gas, and the destructive distillation of coal, peat, shale, etc., the lower molecular weight products are separated, while the higher molecular weight products and undecomposed substances are retained for further exposure to the decomposition conditions, by interposing one or more porous septa between the decomposition chamber and the condenser or receiver. The decomposition conditions may be maintained up to the porous septum; but it is preferred to place the porous septum in a separate chamber inside or outside the decomposition vessel; and a plurality of diffusion chambers may be used arranged either in series or in parallel. The invention is applicable to processes carried out either in the vapor or liquid phases; and in the former case, the removal of the vapors is facilitated and controlled by lowering the pressure on the condenser side of the septum with respect to that on the other side. (Br. Pat. 142,206—1919. W. MANN, London, June 30, 1920.)

Alkali Cyanides.—Alkali cyanides are obtained by reacting upon carbon and nitrogen with an alkali metal and an alkali metal compound. The alkali metal, such as sodium, may be used in the form of vapor, which may be mixed with carbon monoxide, and may be used to suck in the powdered alkali metal compound, such as soda. The alkali metal compound may be used in powdered or liquid condition, and may be introduced with the charge of carbon. (Br. Pat. 142,122—1919. H. MEHNER, Berlin, June 30, 1920.)

Hardening and Tempering.—Relates to means for hardening and tempering a nickel-chromium steel armor-piercing projectile having zones of steel of successively increasing hardness toward the point. The projectile, which is made of steel containing 0.58 to 0.7 per cent of carbon, 2 to 3.5 per cent of nickel and 2 to 3 per cent of chromium, is heated all over to 800-860 deg. C. and dipped point downward to its base in water until properly hardened, when it is removed and tempered by heating to a base temperature of about 760 deg. C. and an internal temperature of about 575-700 deg. C., while the head is immersed to a small depth in water; it is then cooled in the tempering plant to an internal temperature of 320-120 deg. C., after which it is cooled to atmospheric temperature. (Br. Pat. 142,143—1919. Sir R. A. HADFIELD, Westminster; A. G. M. JACK, Sheffield, and I. B. MILNE, Totley, Derbyshire, June 30, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Chemical Warfare Officers' Reserve Corps

Second in importance only to the establishment of the Chemical Warfare Service as a separate entity within the War Department was the order of the Secretary of War dated Aug. 24, 1920, authorizing the immediate formation of a Chemical Warfare Officers' Reserve Corps. General Amos A. Fries, Chief of the Chemical Warfare Service, announces that he will begin the formation of the Reserve Corps at once. He hopes to be able to obtain the assistance of some of the officers who will enter the Reserve Corps to assist in the organization work.

"This Reserve Corps means," said General Fries, "that the Chemical Warfare Service will know where to put its hand on two thousand chemical warfare officers in case of an emergency. Each member of the Reserve Corps will be classified carefully as to his specialties and other qualifications. This will permit their being called into service only as needed.

"The Reserve Corps not only will put the Chemical Warfare Service in a position to render most efficient work, but it will provide a highly necessary step in the interest of the national defense."

The fact that reserve officers may not be called into service in peace time without their consent and the fact that the Chemical Warfare Service is a separate subdivision of the War Department remove the principal objections to membership in the corps. During the time the placing of the Chemical Warfare Service in the Quartermaster Corps was being considered, many former chemical officers objected to entering the Reserve Corps, since there was no assurance that they would not be detailed to any duties in the Quartermaster Corps.

It is the hope of General Fries that he will be able to draw officers from the Reserve Corps for short periods of duty. He believes that many chemists would be willing to spend their vacation periods on duties pertaining to the work of the service. During such temporary duty the reserve officers would receive the pay of their rank and would be given mileage.

Chemists Perfect Process of Protecting Raw Sugar From Mold and Bacteria

According to a bulletin of the Louisiana Sugar Experiment Station in New Orleans, Dr. Nicholas Kopeloff and Mrs. Lillian Kopeloff, bacteriologist and assistant bacteriologist, have completed a method of preventing deterioration of sugar by molds and bacteria.

It is estimated that about 70,000,000 lb. of the Cuban sugar, valued at $1,500,000, or enough sugar to supply 873,000 persons for one year, is destroyed annually by the activity of these organisms.

Dr. and Mrs. Kopeloff, by making bacteriological examinations at every stage of the sugar-making process, have found that sugar deterioration can be prevented by substituting dry or super-heated steam for water in the final process of washing sugar in the drums in which sugar is dried. The centrifugals in their whirling suck up from the floor air which may be contaminated with germs. Also it is common practice to make the color of the sugar lighter by washing the crystals with water which may be contaminated with molds and bacteria.

In the new process it is shown that dry steam is successful in killing over 99 per cent of these avid molds and bacteria.

Water-Power Act Regulations

Due to the length of time required to develop the actual wording of the water-power act regulations which would be satisfactory to all concerned it has been decided to issue a statement of principles. The exact language of the regulations then can be worked out more leisurely. It is expected that another public hearing will be held to go over the final draft of the regulations before their promulgation. This arrangement will allow the committee representing outside interests, of which F. H. Griffith is chairman, to disband for the present.

The Federal Power Commission conducted a hearing on Aug. 24 on the Great Falls project. The water-power act provides that a report must be made before Jan. 1 on this project, which is being relied upon to furnish power for the District of Columbia and for the development of industrial areas in nearby portions of Virginia and Maryland.

All witnesses urged the development of Great Falls except the representative of the Potomac Electric Power Co., who contended that the commercial development of the falls under present conditions would not be feasible.

Difficulties in Obtaining Balloon Gas

The international balloon races which were planned for last month in Indianapolis have been somewhat delayed by the inability to secure the necessary balloon gas at this location. The Air Service is now seeking a new location at which adequate facilities will be available.

The gas required is, of course, one of low specific gravity in order to give high lifting power. Stripped run-of-oven byproduct gas, special coal gas made at high temperature to give low specific gravity, or uncarbureted water gas are the usual supplies employed for these purposes. Gas of a gravity of approximately 0.40 or slightly less is desired for the type of free balloon which is to be used by the contestants. If other means fail, it may be necessary to produce this supply by adding hydrogen to city gas supplies. The hydrogen thus used would have to be manufactured in the portable-type ferrosilicon plants used as field equipment by the Air Service.

Steel Treaters' Convention and Exhibit

A joint meeting of the consolidated American Steel Treaters' Society and the Steel Treating Research Society will be held at the Commercial Museum, 34th and Spruce Sts., Philadelphia, Pa., from Sept. 14 to Sept. 18 inclusive. Throughout the same week and in the same building the societies will sponsor an exhibit of heat-treating appliances and heat-treated products, over 130 firms occupying about 80,000 sq.ft. of floor space. In view of the great success of a like exhibition held last year in Chicago, and the preliminary space reservations, this feature of the event will be of the greatest interest and advantage to the metallurgists in attendance.

Mrs. D. K. Bullens is chairman of the Ladies' Entertainment Committee, and many sight-seeing and social events are being planned. Prominent among them will be trips to historic spots in the vicinity, inspections of Wanamaker's, Curtis Publishing Co., and the Navy Yard.

The exhibition will be open daily from 9 a.m. to 10:30 p.m. Two-hour technical sessions will be held each morning, afternoon and evening on Tuesday, Wednesday and Thursday, except on the latter day, when an informal banquet and entertainment will be given at the Bellevue-Stratford. Friday and Saturday are reserved for inspection trips.

A partial list of the authors and papers follows:

Carbonizing

"High Temperature-Resisting Alloys for Carbonizing," by A. Bensel.

"Proper Heat Treatment for Carburized Steel Parts," by Louis A. Ellner.

"Heat-Resisting Metals," by G. W. Franzheim.

"Rapid Carburizing, Hardening and Tempering of High Carbon Alloy Steels," by R. L. Gilman.

"Containers Used in Heat-Treatment Processes," by H. H. Harris.

"Proper Carburizing Temperature," by C. A. Haux.

"Heat-Treated Flame and Acid-Resisting Steel," by Charles M. Johnson.

"Carburizing Thin Stock," by R. B. Kerr.

"A Research in Case Carburizing," by G. S. McFarland.

"Action of Cyanide in Case Hardening," by G. R. Brophy and Miss S. B. Leiter.

"Case Hardening," by Theo. G. Selleck.

Alloy Steels

"Effect of Zirconium and Cobalt on Steel," by J. Culver Hartzell.

"Molybdenum Steel," by R. L. Herrick.

"Stainless Steel," by W. H. Marble.

"Open-Hearth Steel vs. Crucible Steel," by George Porteous.

Hardening

"Relation of Time, Temperature, Mass and Surface to Hardening," by Eric E. Bilgart.

"Quenching Tank for Tool and Die Work," by N. E. Brown.

"Progress in Small Shop Hardening Methods," by O. C. Hedin.

"Efficiency of Various Quenching Mediums," by V. E. Hillman, W. G. Lottes and J. B. Morey.

General Heat Treatment

"Factors Governing Production of Heated Product," by J. A. Brown.

"Heat Treatment of High Tensile Steels," by A. K. Drury.

"Heat Treatment of a High-Chromium Steel," by H. J. French.

"Ordnance Work Applied to Peaceful Uses," by F. V. Larkin.

"Annealing and Heat Treatment of Miscellaneous Steel Castings," by Charles Ring.

"Effect of Heat Treatment Upon Fatigue Strength," by E. P. Stenger.

"Heat-Treated Parts in Locomotive Service," by A. F. Strubing, C. B. Peck and J. C. Marsh.

"Effect of Repeated Heat Treatment Compared to Extended Heat Treatment," by A. Tabachnick.

"Practical Aid to Treatment," by W. R. Ward.

"Commercial Heat Treating," by J. A. Wilson.

Forgings

"Forging Temperatures," by Peter Chambers.

"Treatment of Axle Forgings," by H. E. Hemstreet.

"Forging of Chrome: Nickel Steel Spindles," by H. B. Smith and F. J. Olcott.

"Forging Light Steel," by Robert B. Pottinger.

Tool Steel

"Working Test of High-Speed Steel," by A. H. D'Arcambal.

"Hardening Small Tools by Molten Lead," by W. F. Newhouse.

"Selection of High-Speed Steels," by Henry Traphagen.

"Hardening, Quenching and Tempering High-Speed Steels," by A. E. Bellis.

"Heat Treatment of High-Speed Steel," by J. L. Thorne.

Other Discussions

Furnace design and fuels will be discussed from different angles by T. F. Baily, James Brakes, Jr., E. F. Collins, William A. Ehlers, W. O. Kellogg, W. H. Lyman, G. H. Trout, Henry Voltman, W. H. Weigand, H. P. MacDonald and Edward F. Davis.

Various phases of pyrometry will be discussed by J. D. Andrews, Arthur N. Armitage, H. G. Hall, Carl C. Jensen and F. J. McIntyre.

Miscellaneous

"Relation of the Steel Salesman to the Development of Heat Treatment," by Guy B. Bible.

"Functions of a Chemist and Metallurgist," by C. U. Geesey.

"Factors Limiting Strength of Materials," by I. T. Hook.

"Injecting Salesmanship Into Metallurgy," by G. W. Keller.

"Oxidation During Heating," by H. O. Loebell.

"High-Grade Helical Springs," by T. A. Lynch.

"Relation of Metallurgical Laboratory to Inspection Department," by Marshall Medwedeff and E. W. Pierce.

"Recent Testing Machines, by T. Y. Olsen.

American Institute of Fertilizer Chemists

The first meeting of the American Institute of Fertilizer Chemists since its organization in June at White Sulphur Springs, W. Va., at the annual sessions of the National Fertilizer Association, took place at the Southern Hotel, Baltimore, on Aug. 2 and 3.

Dr. Frank G. Parker, of Charleston, the president, occupied the chair. Others present were: A. G. Stillwell, New York, vice-president; W. J. Gascoyne, Jr., Baltimore, treasurer; Samuel W. Wiley, Baltimore, secretary; Thomas C. Law, Atlanta; Charles W. Rice, Columbia, S. C.; Philip McG. Shuey, Savannah; Ralph W. Bailey, New York; Philip E. Chazal, Charleston; B. H. Morrison, Philadelphia.

At this meeting the work to be done by the institute was discussed at length. The purposes of the organization are to engender among fertilizer chemists a closer and more harmonious relationship; to impress upon the fertilizer trade the fact that the "independent" laboratory is all that the name implies, and that the members of the institute are bound by a code of ethics as rigid as that of other professional bodies, with the penalty of expulsion for transgressions; to provide a means for the members to confer and co-operate in minimizing discrepancies due to personal differences in technique and to secure from fertilizer manufacturers more careful attention to the obtaining of accurate samples of materials for analysis.

A pamphlet giving directions for the correct sampling of the various fertilizer materials will be prepared. The institute will also endeavor to bring about more efficient methods of chemical control at fertilizer plants.

Novel Repair Process

Among the novel repair processes developed by the war is the electrolytic deposition of a thin layer of iron up to one-twelfth of an inch thickness on any simple cylindrical surface of wrought iron or mild or cast steel. Describing the method to the British Institution of Automobile Engineers, B. H. Thomas states that the iron is deposited directly on the surface without any intermediate film of copper, and can be heated to redness without apparent deterioration, can be carbonized or hardened in the ordinary way, can be filed and ground, and takes a high polish. The work being properly done, the adhesion was so strong that the film could not be chipped away from the metal beneath with hammer and chisel. In a heavy repair shop the motor vehicle parts reclaimed in this way included stub axle arms, steering swivel pins, brake and clutch shaft ends, change speed lever shafts, insides of wheel hubs, outside of axles, tubes and universal joint pins. The wearing qualities of the deposit on a high-speed journal do not appear to have been determined. So far the process cannot be used for cast iron or aluminum and its value would be much increased if it could give an adherent coating to such parts as worn gear boxes and ball-race housings.

Groves Endowment Fund for Scientific Research

Charles Edward Groves, F.R.S., editor of the *Journal* of the London Chemical Society from 1884 to 1899 and vice-president of the society from 1899 to 1902, who died on Feb. 1, aged seventy-nine, has left £10,000 to the Royal Institution for the "Groves Endowment Fund" for the promotion of scientific research, to take effect on the death of the last surviving member of his family.

Canada's Sugar Industry

In a recent report of Consul Johnson, stationed at Kingston, it is stated that Canada has eight sugar plants in her provinces, which have a combined annual output of over 650,000,000 lb. Three of these plants are situated in the Province of Ontario, two in Quebec, and one each in British Columbia, New Brunswick and Nova Scotia.

The amount of capital invested in the sugar industry for the whole of Canada in 1918 was $37,256,851, divided among land, buildings and fixtures, $17,733,990; machinery and tools, $6,108,445; materials, stocks in process, finished products, fuel and miscellaneous supplies on hand, $6,511,626; and cash operating accounts, etc., $6,902,790. The Ontario plants represented an investment of $11,407,382, those of Quebec, $5,869,592 and the remaining provinces, $19,979,877.

The accompanying tables show the quantity and value of material used at the plant in 1918 and the quantity and value of the finished products:

QUANTITY AND VALUE OF MATERIAL

Classes of Materials	Tons	Cut Value at Works
Beets	204,017	$2,593,715
Raw sugar	313,651	39,991,144
Bone black and other materials	......	529,059
Boxes, bags and other containers	......	2,289,119
Total value		$45,403,037

QUANTITY AND VALUE OF FINISHED PRODUCTS

Kinds of Products	Quantity	Value
Sugar, granulated, lb	651,940,965	$57,080,353
Molasses or sirup, gal	1,559,694	1,016,626
Beet pulp, tons	11,069	411,645
Lime, bushels	22,590	6,250
Fertilizers, tons	1,284	43,075
Cattle food	....	151,776
All other products	....	102,494
Total value		$58,812,219

Japanese Exports of Calcium Carbide

Due to war conditions the exports in 1918 of calcium carbide, which is shipped chiefly to Australia, British India and China, amounted to 28,844,680 lb., valued at 5,476,000 yen, the 1919 exports falling to 3,399,904 lb., valued at 525,240 yen, while the 1920 exports run about the same as in 1919. As electric power costs at least 8 sen per kw., the cost of production of calcium carbide is about 5 sen per lb., and it is believed that unless the cost of electric power is reduced to less than 7 sen per kw. and the calcium carbide is improved in quality the Japanese product will find difficulty in meeting foreign competition.

Movement of Nitrate of Soda

During June, 109,953 tons of nitrate of soda moved through the Panama Canal. With the exception of three cargoes, which went to the United Kingdom, all of the nitrate was consigned to Atlantic ports of the United States.

Four cargoes of sulphur from the Louisiana and Texas fields passed through the canal during June destined to Portland, Ore., Vancouver, B. C., and Melbourne, Australia.

Tests Made of Firebricks

Tests made at the Columbus Experiment Station of the Bureau of Mines have developed the fact that firebrick with the highest alumina content last longest when used in malleable iron furnaces. Hot crushing strength tests were made of a number of varieties of firebrick.

Personal

P. W. BOUTWELL, assistant professor of agricultural chemistry at the University of Wisconsin, Madison, Wis., has been appointed associate professor of chemistry at Beloit College, Beloit, Wis.

Dr. F. G. COTTRELL, the director of the Bureau of Mines, in order to determine the moot question of the subjects to be handled at the new Mine Experiment Station at Tuscaloosa, Ala., will confer with the officials of the University of Alabama about the middle of September and gather first-hand information as to what subjects had best be handled at this station.

T. LINSEY CROSSLEY has become editor of the *Canadian Chemical Journal*, which is the official organ of the Canadian Institute of Chemistry.

R. E. DOOLITTLE spoke before the Chicago Chemists' Club recently on "Botulism and Proper Preparation of Ripe Olives."

General AMOS A. FRIES, chief of the Chemical Warfare Service, and Colonel E. J. Atkisson, the commander of Edgewood Arsenal, along with four or five other officers of the Chemical Warfare Service, will attend the meeting of the American Chemical Society in Chicago.

M. J. GAVIN, refinery engineer of the U. S. Bureau of Mines, who has been in Washington, has returned to his station at Salt Lake City.

RALPH A. GOULD, chemical engineer, 216 Pine St., and BRYANT S. DRAKE, chemical engineer, 14 Montgomery St., San Francisco, Cal., announce their association, from Aug. 1, 1920, in a partnership under the name of Gould & Drake, chemical engineers, with offices at 216 Pine St., San Francisco, Cal.

ERNEST J. HOPKINS, who recently resigned as assistant chemist, U. S. Bureau of Mines, Pittsburgh, Pa., has accepted a position in organic research with W. B. Pratt, Inc., Boston, Mass.

Dr. DAVID KLEIN, who was formerly associate professor of biochemistry in the Johns Hopkins University School of Public Health and Hygiene, is now with the Hollister-Wilson Laboratories, Chicago, Ill., as director of research and control laboratories.

A. T. MARCH has recently returned from Namtu, Upper Burma, India, where he has for the past several years been in charge of the silver refining for the Burma Mines, Ltd.

H. B. NORTHRUP has resigned his position as associate professor of metallurgy at the Penn State College, State College, Pa., to become chief metallurgist for the Diamond Chain & Mfg. Co.

ROBERT J. QUINN has recently severed connection with A. Daigger & Co. to become associated with the Mathieson Alkali Co., of Chicago, as district manager. Mr. Quinn is a graduate of chemical engineering at the University of Illinois, was subsequently chief chemist with Morris & Co., packers; later he became associated with the Wahl Henius Institute, consulting engineer in charge of packing department, and left to take a position with the Midland Chemical Co. His new address is 617 Webster Bldg., Chicago, Ill.

Dr. J. H. RANSOM, director of chemical research at the Michigan Smelting & Refining Co., Detroit, Michigan, recently delivered a lecture on non-ferrous alloys before the students of the school of chemical engineers, Purdue University.

RICHARD R. REES, who was formerly chief metallurgical chemist at the U. S. Arsenal, Watervliet, N. Y., and not chief metallurgist as erroneously given in this column in our last issue, is now with the Neptune Meter Co., Long Island City, N. Y.

Dr. WALDEMAR T. SCHALLER has severed his connection with the Great Southern Sulphur Co., Inc., of New Orleans, La., and has returned to the U. S. Geological Survey, Washington, D. C.

C. N. SHUETTE, recently superintendent of the Mariscal quicksilver mine in Texas, has rejoined the staff of the U. S. Bureau of Mines at Berkeley, Cal.

Dr. E. WARD TILLOTSON of the Mellon Institute is accompanying the members of the Institute of Glass Technologists who are here from England on their itinerary to the glass factories of the Eastern United States.

R. M. WILHELM, who has been chief of the thermometer laboratory of the National Bureau of Standards, has resigned to accept a position with C. J. Tagliabue Manufacturing Co., Brooklyn, N. Y. Mr. Wilhelm will begin work in his new position about the first of September.

W. WOODWARD WILLIAMS has resigned as vice-president of the Redding Iron Co. effective Sept. 1, when he will become assistant to the president of the Pittsburgh Gage & Supply Co.

Obituary

REGINALD K. PIERCE, secretary of the Semet-Solvay Co. and of the Kentucky Solvay Co., in an attempt to avoid an accident was killed near Oran, N. Y., on Sunday evening, Aug. 15, while driving a high-powered roadster which turned over in a ditch as he tried to avoid a collision with a smaller machine. Mr. Pierce was instantly killed. He was a brother of Edward L. Pierce, president of the Semet-Solvay Co. and the Kentucky Solvay Co., and had been associated with these companies for about twelve years, holding several important offices. He was elected secretary and sales manager of the companies about three years ago and was serving in these capacities at the time of his death. He was forty-two years old. He leaves three brothers, Edward L. Pierce of the Solvay companies; Charles Pierce of Boston, counsel for the New England Telephone Co., and George Pierce, a prominent Boston physician.

JAMES WILSON, who served as Secretary of Agriculture for fifteen years, died on Aug. 26 at Traer, Iowa, after an illness of many weeks.

Book Reviews

WATER POWERS OF BRITISH COLUMBIA. By *Arthur V. White*, assisted by *Charles J. Vick*. 644 pp. and maps, illus. Ottawa: Commission of Conservation.

This is part of an exhaustive study undertaken by the Commission of Conservation to prepare a complete inventory of the water-power resources of Canada. The work was begun in 1910 and has resulted in publication of volumes on Water Powers of Canada, Water Powers of Manitoba, Saskatchewan and Alberta and the current volume of Water Powers in British Columbia. The estimated total of horsepower in the latter province is 2,500,000. The commission calls attention to the fact, however, that the grand totals representing horsepower possibilities for large sections of a country are apt to be misleading. Furthermore in the development of water power it must be recognized that such interests as domestic and municipal water supply, agriculture, irrigation and navigation, fisheries, mining and riparian rights are dependent on the same source. The volume contains a chapter on water legislation in British Columbia and another on rules and regulations for the development of power. A separate chapter is devoted to the topography of power-site tables of the Columbia, Fraser and MacKenzie rivers, Vancouver Island and mainland Pacific coast. Other chapters are devoted to stream flow data, and another on meteorological data. The book will be of distinct value to companies contemplating the development of water power in Canada or to industries which require water power in their operations. H. C. PARMELEE.

Current Market Reports

The Iron and Steel Market

Pittsburgh, August 27, 1920.

In the past week or two the iron and steel market has exhibited itself as quite lacking in definite motive or substantial basis. Nearly everything that occurs has a distinct opportunist coloring. For illustration, pig-iron prices in most districts have been shoved upward, when prices were already too high for safety in proportion to steel prices. Those who were in the market as buyers were not particular as to prices, since they were buying only for urgent requirements of the present or near future. Again, the steel market cannot be regarded as really on a rational basis until the selling prices of the Steel Corporation and the independents are together, or at least not far apart, but the gap is not being bridged. That it is possible for the two sets of prices to exist side by side is due to the fact that the markets are entirely different in point of delivery, and the difference in time of delivery has been widening. At the beginning of the year, when the departure of the independent prices from the Steel Corporation prices became clearly marked, the corporation had 8,000,000 tons of unfilled business on books, while now it has 11,000,000 tons. The independents were then able to sell much more week by week than they were producing, whereas of late their sales have run well below their shipments. In other words, it requires a greater promptness of delivery, compared with a Steel Corporation delivery, to enable an independent to get the extra price.

Illustrative of the peculiar alignments in the market, the Industrial Board prices of March 21, 1919, may be taken as a basis. The prices in that schedule were fairly well proportioned. The Steel Corporation prices are Industrial Board prices exactly. Prices obtained lately by independent mills on steel products run about $20 a ton, or about 30 per cent, above the Industrial Board prices, while prices of pig iron with the latest advances average about 75 per cent above the Industrial Board figures. Before the event one could scarcely have conceived the possibility of such price relations existing even for a moment, let alone of their continuing with no signs of the law of supply and demand working toward a readjustment.

Dull Markets

Apart from the activity in pig iron, which has been in prices more than in tonnage turnover, since prices advanced on a relatively small amount of buying, the iron and steel markets generally have been very dull, and even more stagnant than they were earlier in this midsummer period. It seems to be clearly established now that the dullness is not associated closely with the season of the year but is a product of more fundamental conditions, including the state of business generally and the awkward position into which prices have worked themselves.

Such demand for steel as is exhibited is confined almost wholly to the deliveries that are very difficult to get. The independent sheet mills are sold through November and about 40 per cent into December, according to their computation, and there is insistent demand for sheets even for October and November delivery. Plates, on the other hand, can be obtained for delivery in a very few weeks and there is scarcely any demand for plates. One can buy plates at 3.25c., although some mills ask 3.50c. and higher. Early in the year plates commanded much higher prices than merchant bars, but now bars in the smaller sizes are "scarce" and there is ready sale at 3.50c., sometimes at still higher prices. Shapes can be had at 3.10c. and are entirely neglected.

The report for July of the Bridge Builders' and Structural Society shows bookings of fabricated steel contracts during the month at 50 per cent of the fabricating capacity, this corresponding with the report for June. The continued dullness in this line is practically unprecedented.

Railroad demand has not developed in volume, and is hardly expected for some time to come. Car buying is almost entirely confined to industrial companies and thus does not run into volume. There is a fair running demand for steel for car repairs.

Transportation Improving

Transportation conditions continue to improve. Mills are now reducing their accumulated stocks of steel, produced aganist orders but held on account of car shortage, whereas until late in July there were almost constant additions to stocks. The movement, however, may be considered as one in quantity rather than in quality. The shipments that leave the mills are good, but on account of embargoes and other restrictive influences the distribution is poor, some consumers receiving very good shipments and others very light shipments.

It is a common view in iron and steel circles that the railroads are "set" for a great improvement in physical operations, now that Sept. 1 is so near at hand, this being the date upon which the railroads must begin making their revenue themselves. The Interstate Commerce Commission has ordered that sixty open-top cars be furnished daily to pipe mills in the Pittsburgh and Youngstown districts, for moving oil-country goods to the South and Southwest.

Semi-Finished Steel

In the East several thousand tons of standard billets have been sold on the basis of $60 Pittsburgh, a figure that was difficult for a buyer to get two or three weeks ago and was practically impossible a month ago. Several sales of sheet bars have been made at $67.50 Pittsburgh, when $75 was the market a few weeks ago. Semi-finished steel has been declining, while pig iron, metallurgically the raw material, has been advancing.

In nearly all districts pig-iron prices have been advancing, and sharply at that, though the sales are in thousands of tons when tens of thousands of tons have hitherto figured when prices were advancing. Small transactions in valley bessemer and basic, just running into four figures, have established those grades at $48.50 valley, or $1.50 advance in bessemer and $2 advance in basic, while foundry remains at $50 valley, to which it advanced recently by a $4 jump.

In the past few days slight signs have appeared perhaps portending a weakening in prices, or at any rate a refusal of consumers to follow the market. Southern iron in the past generally took the lead of pig iron in general in advances and declines, and it may be significant therefore that Southern iron did not advance in the past two or three weeks, when the valley, eastern Pennsylvania, Buffalo and other markets were advancing, while it is now said that there are more sellers of Southern iron at the $42 minimum, and fewer at premiums over this price, than ten days ago.

The Chemical and Allied Industrial Markets

New York, August 27, 1920.

There has been very little activity in the chemicals during the week—in fact, dealers and handlers report they have done nothing in the way of actual business. The *acid* branch is in about the same condition, suffering from lack of interest that has been apparent for some time. It is a peculiar fact that in spite of the present weakness prices are practically the same as in the last report, with the following exceptions noted:

	Today	Week Ago	Year Ago
Oxalic, crystals	$0.53 @0.57	$0.55@0.60	$0.25 @0.30
Lactic, 44 per cent.....	0.10 @0.11	0.11@0.12	0.11 @0.14
Salammoniac, white...	0.15½@0.16½	0.16@0.16½	0.12½@0.13
Copperas	2.00 @2.50	2.50@3.00	1.00 @1.20
Potassium sulphate ...	2.40 @2.55	2.25@2.40	2.25

Methyl alcohol, to be listed hereafter as *methanol*, is nominally quoted $3.25@$3.30 for 95 per cent and $3.50@ $3.55 per gal. for the pure grade. The Government restrictions placed on the sale of this article are so stringent that it has become very difficult for a small buyer to make a purchase, while *ethyl* alcohol because of scarcity is nominally quoted around $5.50@$5.75 per gal. In line with

these prices *formaldehyde* is still firm at 48c. in car lots and 50c. in less than car lots. The above figures are manufacturers' prices and have been in force for some time, but small quantities that have been on the market for some time can be obtained as low as 40c. per lb.

Coal-Tar Products

Prices have been well sustained during the period despite the very inactive condition of the market. The present situation of the spot market is the antithesis of that prevailing a few months ago, when it was practically impossible to obtain any of the crudes or intermediates for prompt delivery. Now the spot demand is so small that business is at a standstill and wherever a likely purchaser is found generous concessions are made on the prevailing prices. Producers are progressing rapidly and most of them are in a fair way to catch up on back contracts which had to remain untouched under the pressure of recent conditions.

Naval Stores

An unusual condition exists in the *rosin* market inasmuch as the lowest grade, B, is selling 10c. higher than any of the other grades. Grades D to W are all quoted at $14.50, and this price, it is expected, will prevail for some time. This situation has been brought about by an excessively heavy demand for the lower grades from South America, where it is used in manufacturing soaps and varnishes. The domestic demand for the higher grades which are used for the same purpose has fallen off to such an extent that there is surplus on hand, thus lowering the price to the same level as the B-I grades. The supply in the local market is ample to meet the demand, which has been very light recently. *Turpentine* is also weaker, with a 5c. drop recorded from last week's $1.60 mark. This has been caused by two elements, the light buying interest and the uncertainty existing in the Savannah market. Buyers are holding back and are evidently expecting lower prices in this commodity.

Oils

This market is practically at a standstill, as buyers are either well taken care of or are holding out for still lower levels. Prices on the list are nominal, as concessions can be obtained on almost all of the quotations listed. *Linseed* has still further declined and current prices are: $1.43 in less than car lots; $1.37@$1.40 in car lots. Whatever buying that is being done is for actual requirements only, and on a spot basis. There has been very little interest manifested in futures, and this condition is expected to prevail for a few weeks more at least.

The Chicago Market

Chicago, August 25, 1920.

The situation in the local market is no different from that in the rest of the country in that the entire trade—buyers, dealers and manufacturers—is engaged in watchful waiting. A feeling of uncertainty as to the future trend of prices is acting as a stop on trading, and this cessation of business in itself gives the market a weak tendency, as all holders of stock, particularly re-sellers, are desirous of moving goods.

This uncertain feeling is most pronounced in regard to vegetable oils. Enormous imports of flaxseed from the Argentine, coupled with a large crop in Canada and the Northwest, tends to make the future of linseed oil a little dubious. A heavy cotton crop coming up and an immense carry-over of cottonseed oil from last year combine to make present prices look too high, and Oriental financial troubles make anything possible in the copra and coconut oil trade. Other oils, in sympathy, are correspondingly weak and uncertain.

Among the heavy chemicals, the *alkalis*, former leaders in high prices, are at a standstill, traders and buyers alike apparently awaiting the issuance of 1921 quotations by makers. Chemical manufacturers in general claim to look for higher prices, while buyers are equally strong in the opinion that the peak has already been passed. This renders the one not anxious to sell and the other unwilling to buy, hence the stagnant market.

In the main, railroad service is good, though some complaint is heard from the fertilizer and acid people. Imposition of the new tariffs will undoubtedly have some effect on prices, although the extent will remain unknown until the manufacturers and dealers have had time to study the rates.

Heavy Chemicals

The *alcohols* remain unchanged during the past month. *Ethyl* grade, at $5.52½ in five barrel lots, $5.57½ in single barrels, is firmly held, and but little is changing hands. *Methanol* (methyl alcohol), 95 per cent, is quoted at $3.35@$3.65 per gal., but this quotation means little, as it is practically unobtainable. *Denatured* is a little freer in movement at $1.09 per gal. *Formaldehyde* has reflected recent fluctuation in the Eastern market by a decline last week to 51c. followed by a stronger market this week, today's price being 53c. This is a net decline of 2c. since the first of the month, and in view of the relatively high price and the scarcity of *methyl alcohol* a recovery is not improbable.

Copper sulphate continues to show good business at 9c. per lb. in car lots. Should export demand increase, higher prices can be expected. *Copper carbonate* is firm at 27c., solely on account of cost of production, as demand is very light. *Copperas* is offered at $2.35 per cwt., f.o.b. works, with no takers, and spots are quoted at $2.75, with considerable shading being necessary to induce business. *Arsenic* is uncertain in price, tending to lower levels. Current transactions in *white arsenic* are reported at about 15c. per lb. and red is going at 19@20c. Supply is quite free and futures can be engaged at 1@2c. lower on both kinds.

Bleaching powder, still hard to get, is alone among the alkalis in holding firm. It is quoted today at around 7c. per lb., being available in extremely limited quantities only. *Soda ash*, selling weakly on the spot at $3.15@$3.25 per cwt., is still quoted by makers at $3.35. Not much business is being closed at that figure. *Caustic soda* is in good supply and the price continues weak at 5½c. per lb. or less. Much interest is noted in the price to be set by producers on 1921 goods. Not much free *sal soda* is in the market and current quotations are fairly firm at 2c. per lb.

A little better market is noted the last few days in the *acids*, but prices in general are weak and subject to shading. Definite quotations are hard to get. *Acetic acid*, 28 per cent, commercial, is bringing $3.65@$3.75 per cwt., export *carbolic* is quoted all the way from 12@15c. and *sulphuric*, 66 degree, is still quoted at $22 per ton.

Coal-Tar Products

Very slow market continues the rule in Chicago with no sensational price changes. The apparent approaching end of the Russo-Polish war has a weakening tendency which, in the face of prevailing high prices, discourages any active trading. *Benzol* is quoted at 38c. per gal. for spot deliveries, but some shading is in evidence. *Cresol*, held strongly at 18½@19c., is not very plentiful and *toluol* is equally firm at 37c., though but little actual movement is noted in any of these crudes. *Aniline oil* is off for sales from local stock, sales as low as 30c. per lb. being recorded and future offers being made at 28c. Light demand is making holders of second hands willing to shade prices. The same is true of *aniline salt*, which is quoted down to 38c. this week. *Benzoic acid* is in good demand at 90c. per lb. for U. S. P., and *benzaldehide* is correspondingly strong at 68c. per lb. for the technical, $2.30@$2.50 for F.F.C.

Naval Stores

The market in general is a little slower, although local dealers are still disposing of goods as rapidly as they are received. Rail conditions are no longer a problem, shipments moving easily. Current quotation on *turpentine* is $1.62@$1.63 per gal., 13c. less than at the first of the month, while *pine oil*, both pure and destructively distilled, remains firm at $1.90. *Rosin* is off a shade on all grades, current transactions ranging from $15.75@$16 in less than car lots.

Vegetable Oils

Holders of stock are facing heavy shrinkages in value, as prices continue to decline with still no buyers to take advantage of them. *Linseed oil* quotations cover a wide range, $1.40 per gal. apparently being as close a quotation as is obtainable. *Red oil*, with the disappearance of consumers from the market, finds no buyers at 12c. and *cottonseed oil*, facing an enormous production this fall, is down to 16c. or even less for refined and deodorized. Orientals are holding slightly more firm, *soya bean oil* being quoted at 9¾c., seller's tanks, f.o.b. coast and *coconut oil* at 13c. On the latter product, local price is firm at 17¼c. for spots.

The Baltimore Market

Baltimore, Md., August 26, 1920.

During the past two weeks there have been a number of developments which have tended to depress the fertilizer market. Farm products for the first time in a number of years have been selling at or below cost of production, resulting in some of the farmers deciding not to harvest certain crops. This will in turn seriously affect payment of fertilizer bills, and practically the entire trade has decided in view of unsettled conditions to defer future purchases of materials, awaiting further developments.

On account of the heavy crop of cotton seed and lack of demand from either fertilizer or feed manufacturers, the market on *cottonseed meal* has further declined, and no immediate relief seems to be in sight. The prospects of finding an outlet for export are not very encouraging, first, on account of the present foreign exchange situation, and secondly, because European vegetable meals are obtainable there on a lower basis than prevailing prices in this country. Prime *cottonseed meal* is now obtainable for September-December shipment as low as $7.75 per unit based on the increased freight rates, which amount to about 50c. per unit. This difference, therefore, about represents the decline in the market during the past two weeks.

Acid Phosphate

No important changes have taken place in this article, and it is one of the few materials that is not affected by the present depression, on account of the well sold up condition of the market, and many of the dry mixers still have to cover for their requirements. It is anticipated that the market on *acid phosphate* will remain stationary, at least for the immediate future, and October-December is still nominally quoted at $19@$20 per ton, in bulk, basis 16 per cent.

Tankage

Prices on this commodity are ruling easier, and it is now possible to secure Eastern ground tankage at about $7.60@$7.75 and 10c. c.a.f. Baltimore, which price, however, is lower than the Western product can be delivered here. *Foreign nitrogenous material*, however, is obtainable at $7.25 per unit of ammonia delivered Baltimore, with no buying interest being manifested.

Nitrate of Soda

The market is easy and September-October deliveries are nominally quoted at $3.65@$3.70, November-December $3.75@$3.80, and January-April $3.90@$3.95. It is reported that the present favorable low rates of sterling exchange are responsible for the decreased prices.

Potash

Practically the entire trade is playing the waiting game, and it is expected that this will have the desired effect in the near future. There is practically no demand for spot deliveries, and August-September arrivals of *muriate* are quoted at $2.40, *manure salt* at $1.95 and *kainit* at $2.05, without any important sales.

Fish Scrap

None of this material is at present pressing on the market either from producers or second hands, and the market remains at $7.50 and 10c. for dry *unground scrap* f.o.b. fish factories.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	-	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3 50 - 3.75	4 00 - 4 50
Acetic, 56 per cent	cwt.	6.50 - 7 50	8 50 - 9 50
Acetic, glacial, 99½ per cent carboy	cwt.	14.00 - 16 00	16.25 -
Boric, crystals	lb.	.15½ .16	.16½ - .19
Boric, powder	lb.	.15½ .16½	.17 - .20
Citric	lb.	.78 .80	.82 84
Hydrochloric (nominal)	cwt.	2 25 - 3 00	3.10 - 4.00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	10 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).			
Nitric, 40 deg.	lb.	06 .07	.07½ .08½
Nitric, 42 deg.	lb.	07½ .08	.08½ - .09½
Oxalic, crystals	lb	.53 54	.55 - .57
Phosphoric, Ortho, 50 per cent solution	lb	.19 - 23	.24 - 25
Picric	lb.	.28 - 35	.40 - .50
Pyrogallic, resublimed	lb	2.30 2 55	2 60 - 2 65
Sulphuric, 60 deg, tank cars	ton	12 00 16 00	
Sulphuric, 60 deg, drums	ton		-
Sulphuric, 66 deg, tank cars	ton	16 00 17 00	18 00 - 20.00
Sulphuric, 66 deg, drums	ton	26 00 - 28.00	-
Sulphuric, 66 deg, carboys	ton		-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27 00 30.00	37 00 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 30 00	38.00 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32 00 35 00	40 00
Tannic, U. S. P	lb.	1 45 1 50	1.55 1 65
Tannic (tech)	lb.	60 - 70	.80 90
Tartaric, crystals	lb.		.74 77
Tungstic, per lb. of WO	lb.		1.20 1.40
Alcohol, Ethyl (nominal)	gal.	5 50 - 5.75	6 00 - 7 00
Alcohol, Methyl (see methanol)		-	
Alcohol, denatured, 188 proof (nominal)	gal.	-	1.10 1 15
Alcohol, denatured, 190 proof (nominal)	gal	-	1.05 1 10
Alum, ammonia lump	lb	.05 05½	.05½ 06
Alum, potash lump	lb.	.08 .08½	.09 - .09½
Alum, chrome lump	lb.	- .17	.18 - .19
Aluminum sulphate, commercial	lb.	.04½	
Aluminum sulphate, iron free	lb	.06	
Aqua ammonia, 26 deg, drums (750 lb)	lb	.09½ - .10½	.11 12
Ammonia, anhydrous, cylinders (100-150 lb)	lb.	.35 - .35½	.36 .37
Ammonium carbonate, powder	lb.	.16 .16½	.17 18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ .16½	.17 - 18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - 13½	.13½ 14½
Ammonium nitrate	lb.	.09 10	11 - 14
Ammonium sulphate	lb.	.07 - 07½	08½ -
Amylacetate	gal.	-	5 00 -
Amylacetate tech.	gal		4 75 - 5 25
Arsenic, oxide, lumps (white arsenic)	lb.	14 - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	20 - .21	22 - .25
Barium chloride	ton	150 00 160 00	-
Barium dioxide (peroxide)	lb	.21 - .23	.24 - 25
Barium nitrate	lb.	.10 - .12	.12½ - 13½
Barium sulphate (precip) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)			-
Blue vitriol (see copper sulphate)		-	-
Borax (see sodium borate)			-
Brimstone (see sulphur, roll)		-	-
Bromine	lb.	.70 - 90	1.00 - 1.05
Calcium acetate	cwt	3 50 - 3 55	-
Calcium carbide	lb.	04½ 04½	.04½ .05½
Calcium chloride, fused, lump	ton	33 00 34 00	35 00 45 00
Calcium chloride, granulated	lb.	.02 02½	03 - 03½
Calcium hypochlorite (bleaching powder)	cwt	6 50 - 7 50	8 00 - 8 50
Calcium peroxide	lb.		1 50 - 1
Calcium phosphate, monobasic	lb.	-	.75
Calcium sulphate, pure	lb.	-	.25
Carbon bisulphide	lb	08 - .09	10 -
Carbon tetrachloride, drums	lb.	.14 - 15	.16 -
Carbonyl chloride (phosgene)	lb		.80 - 1
Caustic potash (see potassium hydroxide)			-
Caustic soda (see sodium hydroxide)		-	-
Chlorine, gas, liquid-cylinders (100 lb)	lb.	09 - .09½	10 .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	-	2 00 - 2 05
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	.27 - .28	.29 .31
Copper cyanide	lb.	-	65 - .70
Copper sulphate, crystals	lb	08 - .09	09 - .09½
Cream of tartar (see potassium bitartrate)		-	-
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.	1.10 - 1 30	1 40
Ethyl Acetate pure (acetic ether 98% to 100%)			1 75
Formaldehyde, 40 per cent (nominal)	lb	48 50	
Fusel oil, ref	gal		5 25 6 00
Fusel oil, crude (nominal)	gal	-	
Glauber's salt (see sodium sulphate)		-	
Glycerine, C. P. drums extra	lb.		26½ 28½
Iodine, resublimed	lb	4 30 - 4.35	4 40 - 4 45
Iron oxide, red	lb.	-	03 - .20
Iron sulphate (copperas)	cwt.	2 00 - 2 25	2.35 - 2.75
Lead acetate, normal	lb.	-	13½ .16
Lead arsenate (paste)	lb.	11 - 12	13 17
Lead nitrate, crystals	lb.	-	.90 - 1 00
Litharge	lb.	.14 - .15	15½ .16
Lithium carbonate	lb.	-	1 50 -
Magnesium carbonate, technical	lb.	.12½ - .13½	15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3 50 - 3 90	4 00 - 4 50
Magnesium sulphate, commercial	100 lb.	-	3 50 - 3 60
Methanol, 95%	gal.	-	3 25 3 30
Methanol, pure	gal.	-	3 50 3 55
Nickel salt, double	lb.		14 - .16
Nickel salt, single	lb.	-	.13 - .14
Phosgene (see carbonyl chloride)		-	
Phosphorus, red	lb.	50 - .55	.60 - .65
Phosphorus, yellow	lb.	-	35 - .37
Potassium bichromate	lb.	.36 - .38	39 - .40

		Carlots		Less Carlots	
Potassium bitartrate (cream of Tartar)	lb.	$0.52	$0 56	$0.57	$0 58
Potassium bromide, granular	lb.			.70	.73
Potassium carbonate, U. S. P.	lb.	50	55	.56	.60
Potassium carbonate, crude	lb.	.20	25	.26	28
Potassium chlorate, crystals	lb.	.16	17½	.18	.20
Potassium hydroxide (caustic potash)	lb.	.27	28	.29	.33
Potassium iodide	lb.	...	....	3.35	3.60
Potassium nitrate	lb.	.17	.17½	.19	.21
Potassium permanganate	lb	75	.80	.85	.95
Potassium prussiate, red	lb.	.90	1.00	1.05	..
Potassium prussiate, yellow	lb.	.32	.36	.35	.40
Potassium sulphate (powdered)	ton	$240.00	255 00	......	......
Rochelle salts (see sodium potas. tartrate)		.....	.....	......	......
Salammoniac (see ammonium chloride)		.....	.....	......	......
Sal soda (see sodium carbonate)		.....	.....	......	......
Salt cake	ton	..	...	40.00	50 00
Silver cyanide (nominal)	oz.	.....	.....	1.25	......
Silver nitrate (nominal)	oz.	..	.....	.60	62
Soda ash, light	100 lb.		.....	3.20	3.50
Soda ash, dense	100 lb.	.	...	3.55	3.65
Sodium acetate	lb.	10	15	.20	.25
Sodium bicarbonate	100 lb.	2.50	2.75	3.00	3.50
Sodium bichromate	lb.	22	.24	.26	27
Sodium bisulphate (nitre cake)	ton	7.00	8.00	9.00	11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08¾	.	10	11
Sodium borate (borax)	lb.	.09	.10	.11	.12
Sodium carbonate (sal soda)	100 lb.	2.00	2.10	2.15	2.25
Sodium chlorate	lb.	11	12	.12½	.14
Sodium cyanide, 96-98 per cent	lb.	.25	.30	.32	.35
Sodium fluoride	lb.	.18	....	.19	.20
Sodium hydroxide (caustic soda)	100 lb.	5 60	5 70	5.75	6.00
Sodium hyposulphite	lb.	...	.....	.03	.04
Sodium molybdate	lb.	2 50	.....	3.25½	...
Sodium nitrate	100 lb.	3 00	3.25	3.75	4.00
Sodium nitrite	lb.	16	.18	.19	.20
Sodium peroxide, powdered	lb.	.32	.35	.35	.40
Sodium phosphate, dibasic	lb.	.03¾	.04½	.04½	.05
Sodium potassium tartrate (Rochelle salts)	lb			.39	.40
Sodium prussiate, yellow	lb.	.23	.27	.31	.32
Sodium silicate, solution (40 deg.)	lb.	.01½	.01¾	.02	.02½
Sodium silicate, solution (60 deg.)	lb.	.02½	.03	.04	.05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60	1.70	1.75	2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½	10	.10½	.11
Sodium sulphite, crystals	lb.	.04	0 4½	.04½	.05
Strontium nitrate, powdered	lb.	.15	.18½	.19	.20
Sulphur chloride red	lb.	.08	.09	.10	.10½
Sulphur, crude	ton	16.00	20 00	..	......
Sulphur dioxide, liquid, cylinders	lb.	.09	......	.10	.12
Sulphur (sublimed), flour	100 lb.		......	3.80	4.35
Sulphur, roll (brimstone)	100 lb.		......	3.40	3.90
Tin bichloride (stannous)	lb.	.42½	.44	.45	.46
Tin oxide	lb.	......	......	55	.65
Zinc carbonate, precipitate	lb.	.16	.18	.19	.20
Zinc chloride, gran.	lb.	.13	.13½	.13½	.17
Zinc cyanide	lb.	.45	.49	.50	.60
Zinc dust	lb.	.11	.12	.12	.13
Zinc oxide, U. S. P.	lb.	.17	.25	.. ...	..
Zinc sulphate	lb.	.03½	.03¾	.04	.06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40	$1.50
Alpha naphthol, refined	lb.	1 60	1.70
Alpha naphthylamine	lb.	.50	.52
Aniline oil, drums extra	lb.	.30	.33
Aniline salts	lb.	.35	.40
Anthracine, 80% in drums (100 lb.)	lb.	.90	1.00
Benzaldehyde (f f.c)	lb.	2.00	2.10
Benzidine, base	lb.	1.35	1.40
Benzidine, sulphate	lb.	1.15	1.25
Benzoic acid, U.S.P.	lb.	.85	.90
Benzoate of soda, U.S.P.	lb.	.80	.90
Benzol, pure, water-white, in drums (100 gal.)	gal.	.38	.40½
Benzol, 90%, in drums (100 gal.)	gal.	.36½	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	.40
Benzyl chloride, tech	lb.	.25	.35
Beta naphthol benzoate (nominal)	lb.	3.50	4.00
Beta naphthol, sublimed (nominal)	lb.	...	..
Beta naphthol, tech (nominal)	lb.	.85	.95
Beta naphthylamine, sublimed	lb.	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	.25
Cresylic acid, 97-99%, straw color, in drums	gal	1.15	1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.05	1.10
Cresylic acid, 50%, first quality, drums	gal.	.65	.75
Dichlorbenzol	lb.	.08	.10
Diethylaniline	lb.	1 50	1.60
Dimethylaniline	lb.	1.00	1.05
Dinitrobenzol	lb.	.30	.37
Dinitroclorbenzol	lb.	.32	.35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	.40	.45
Dinitrotoluol	lb.	..	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	.40
Diphenylamine (nominal)	lb.	80	.85
H-acid (nominal)	lb.	2.00	2.25
Metaphenylenediamine	lb.	1.25	1.30
Monochl rb nzol	lb.	.18	.20
Monoethyl niline	lb.	2.00	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	....
Naphthaline, flake	lb.	....	.19
Naphthaline, balls	lb.	....	.19
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	.85
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.30	.35
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1.10	1.20
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.50	2.65
Paratoluidine	lb.	2.00	2.25
Phthalic anhydride	lb	.60	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	20
Pyridin	gal.	2.00	3.[illegible]0
Resorcin, technical	lb.	4.25	4.5
Resorcin, pure	lb.	6.25	6 75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	.52
Salicylic acid, U. S. P.	lb.	.50	.6[illegible]
Salol	lb.	.90	1 00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	.26
Sulphanilic acid, crude	lb.	.32	.35
Toluidine	lb.	1.70	2.50
Toluidine, mixed	lb.	.45	.55
Toluol, in tank cars	gal.	.35	.....
Toluol, in drums	gal.	.38½	.40½
Xylidine, drums, 100 gal.	lb.	.50	.65
Xylol, pure, in drums	gal.	.47½	.50½
Xylol, pure, in tank cars	gal.	.45	....
Xylol, commercial, in drums, 100 gal.	gal.	.32½	.35½
Xylol, commercial in tank cars	gal.	.30	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	$0.39
Beeswax, refined, light	lb.	.37	.38
Beeswax, white pure	lb.	.63	.68
Carnauba, No. 1. (nominal)	lb.	.90	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	.85
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.17	.18
Montan, crude	lb.	.25	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¾	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	.11½
Paraffine waxes, refined, 125 m.p.	lb.	.12¾	.....
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18½
Stearic acid, single pressed	lb.	.20	.21
Stearic acid, double pressed	lb.	.22	.23
Stearic acid, triple pressed	lb.	.24	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.15
Pine oil, pure, dest. dist.	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$14.60	
Rosin E-I	280 lb.	14.50	
Rosin K-N	280 lb.	14.50	
Rosin W. G.-W. W.	280 lb.	14.50	
Wood rosin, bbl.	280 lb.	15.00	
Spirits of turpentine	gal.	1.55	
Wood turpentine, steam dist.	gal.	.....	
Wood turpentine, dest. dist.	gal.	.....	
Pine tar pitch, bbl.	200 lb.	.....	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	15.00
Retort tar, bbl.	500 lb.	15.00	15.50
Rosin oil, first run	gal.	.72	
Rosin oil, second run	gal.	.75	
Rosin oil, third run	gal.	.92	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.29	$0.31
Upriver coarse	lb.	.19	.20
Upriver caucho ball	lb.	.20	.22
Plantation—First latex crepe	lb.	.30	
Ribbed smoked sheets	lb.	.28	
Brown crepe, thin, clean	lb.	.26	
Amber crepe No. 1	lb.	.28	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	$0.18
Castor oil, AA, in bbls.	lb.	.19	.....
China wood oil, in bbls.	lb.	.17½	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	16½	.16½
Corn oil, crude, in bbls.	lb.	14½	.15½
Cottonseed oil, crude (f.o.b. mill)	lb.	10	.11
Cottonseed oil, summer yellow	lb.	.12½	.13½
Cottonseed oil, winter yellow	lb.	.17½	.18½
Linseed oil, raw, car lots (domestic)	gal.	1.40	1.43
Linseed oil, raw, tank cars (domestic)	gal.	1.37	1.40
Linseed oil, boiled, car lots (domestic)	gal.	1.48	1.50

Olive oil, commercial	gal.	3 00	— 3.10
Palm, Lagos	lb.	.10½	
Palm, bright red	lb.	.10½	
Palm, Niger	lb.	.11	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½	— .12½
Peanut oil, refined, in bbls	lb.	.17	— .18
Rapeseed oil, refined in bbls	gal.	1.40	— 1.50
Rapeseed oil, blown, in bbls	gal.	1.60	— 1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14	— .14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½	— .11

FISH

Winterpressed Menhaden	gal.	$0.90	— $1.05
Yellow bleached Menhaden	gal.	0.95	— 1.05
White bleached Menhaden	gal.	1.00	— 1 25
Blown Menhaden	gal.	1.00	— 1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	- $25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00	- 20 00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8 00	- 10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00	- - 25 00
Barytes, ground, off-color, f.o.b. Cartersville.	net ton	16 00	— 19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12 00	—
Barytes, floated, f.o.b. St. Louis	net ton	26 50	— 28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	- 11 25
Blanc fixe, dry	lb.	.05½	— .06
Blanc fixe, pulp	net ton	60 00	80 00
Casein	lb.	.15	— .18
Chalk, domestic, extra light	lb.	.05	— 06
Chalk, domestic, light	lb.	.04½	- .05½
Chalk, domestic, heavy	lb.	.04	- 05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	.06
Chalk, English, dense	lb.	.04½	- .05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00	- 22 00
China clay (Kaolin) crude f.o.b. Virginia points.	net ton	8 00	-- 12 00
China clay (Kaolin) ground, f.o.b. Virginia points.	net ton	15 00	-- 40 00
China clay (Kaolin), imported, lump	net ton	25 00	-- 35 00
China clay (Kaolin), imported, powdered	net ton	30.00	— 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.	gross ton	7 50	8 00
Feldspar, crude, f.o.b. Maine	net ton	7 50	10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00	20 00
Feldspar, ground, f.o.b. N. Y. State.	net ton	17 00	— 20 00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00	--
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00	—
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	- -
Fuller's earth, imported, powdered	net ton	35.00	-- 40 00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.		— 01
Graphite (dust facing grade 50%) Ashland, Ala	lb.		— .02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.		— .05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.		— .10
Graphite, crucible, 85% carbon	lb.		08
Graphite, crucible, 88% carbon	lb.		09½
Graphite, crucible, 90% carbon	lb.		10½
Pumice stone, imported, lump	lb.	.04	- 50
Pumice stone, domestic, lump	lb.	.06	
Pumice stone, ground	lb.	.04	- 07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		- - 17 00
Quartz, lump, f.o.b. North Carolina	net ton	5 00	— 7.50
Shellac, orange fine	lb.	1 35	— 1 40
Shellac, orange superfine	lb.	1 40	1 45
Shellac, A. C. garnet	lb.	1 10	1 15
Shellac, T. N.	lb.	1.15	1 20
Soapstone	ton	15.00	— 25 00
Talc, paper making grades, f.o.b. Vermont	ton	10 00	- 20 00
Talc, roofing grades, f.o.b. Vermont	ton	9 00	- - 15 00
Talc, rubber grades, f.o.b. Vermont	ton	10 00	- 15 00
Talc, powdered, Southern, f.o.b. cars	ton	20.00	25 00
Talc, imported	ton	60 00	- 70 00
Talc, California Talcum Powder grade	ton	20 00	35 00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90	95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50	55
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75	
Fire clay brick, 2d quality, 9 in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	4-	55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100	110
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90	100
Silica brick, 9-in. and 9-in. sizes, Chicago district.	1,000	55	
Silica brick, f.o.b. Birmingham	1,000	51	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	55	60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	18	- 19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	20	21
Ferro-manganese, 76-80% Mn, domestic	gross ton	195 00	- 225 00
Ferro-manganese, 76-80% Mn, English	gross ton	190 00	--- 2?0 00
Spiegeleisen, 18-22% Mn.	gross ton	75 00	
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 25	- 2 75
Ferro-silicon, 10-15%	gross ton	60 00	— 65.00
Ferro-silicon, 50%	gross ton	80.00	— 90.00
Ferro-silicon, 75%	gross ton	150.00	— 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10	— 1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	— ....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	— 7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 11⁄4% moisture.	gross ton	$10 00	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	60	.65
Chrome ore, 40% min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77	.85
*Coke, foundry, f.o.b. ovens	net ton	20 00 -	
*Coke, furnace, f.o.b. ovens	net ton	18.00 -	20.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17 50 -	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25 00 -	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	85.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	70 -	80
Manganese ore, chemical (MnO_2)	gross ton	75 00 -	.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.75 --	85
Monazite, per unit of ThO_2	unit	42 00 -	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12	14
Pyrites, domestic, fines	unit	12 -	.14
Rutile, 95% TiO_2 per lb. ore.	lb.	.15	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3.	unit	7 00	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6 00	7 00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2 75	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 -	3 00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	
Zircon, washed, iron free	lb.	.10 - -	

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19 00
Aluminum, 98 to 99 per cent.	33 00
Antimony, wholesale lots, Chinese and Japanese	7.50
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45 00
Tin, Straits, spot	48.50
Lead, New York, spot	9 50
Lead, E. St. Louis, spot	8 90
Zinc, spot, New York	8 35
Zinc, spot, E. St. Louis	7 90@8 40

OTHER METALS

Silver (Commercial)	oz.	$0 99½
Cadmium	lb.	1 40@1.50
Bismuth (500 lb. lots)	lb.	2 70
Cobalt	lb.	3 00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	115 00@120 00
Iridium	oz.	350 00
Palladium	oz.	100 00@110 00
Mercury	75 lb.	83 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33 50
Copper bottoms	38 00
Copper rods	38 00@40 00
High brass wire and sheets	30 25
High brass rods	27 00
Low brass wire and sheets	28 50
Low brass rods	29 00
Brazed brass tubing	38 25
Brazed bronze tubing	41 75
Seamless copper tubing	34 00
Seamless high brass tubing	33 00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23 50
Aluminum, sheet scrap	23 00@23 50
Copper, heavy machinery comp.	14 50@15 00
Copper, heavy and wire	15 25@15 75
Copper, light and bottoms	13.00
Copper, heavy cut and crucible	16 25
Brass, heavy	10 25
Brass, light	7 75@8 00
No. 1 clean brass turnings	9 00@9 50
No. 1 comp turnings	12 50@13.50
Lead tea	4 75@5 00
Lead heavy	7 25@7.50
Zinc, scrap	5.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	Year Ago	Current	Year Ago
Structural shapes	$4.47	$3 97	$3 47	$5 00	$3 37	$3 97	$3 47
Soft steel bars	4 47	4 12	3 37	4 50	3 27	3 87	3 37
Soft steel bar shapes	4 47	4 12	3 37	.	3 27	3 87	3 37
Soft steel bands	6 32	5 32	4 07	6.25	.		.
Plates, ¼ to 1 in. thick	4.67	4 17	3.67	4.50	3 57	4 17	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

MARTINEZ—The Petroleum Products Co., San Francisco, is building a lubricating oil refinery near here. Estimated cost, $100,000.

Colorado

DENVER—The Federal Glass Co., c/o Sylvester & Co., First Natl. Bank Bldg., recently incorporated, plans to build a plant, including office bldg., circular glass house, factory and gas plant. Estimated cost, $250,000.

HAXTON—The city council will soon award the contract for the construction of a sanitary sewer system, including a septic tank. Estimated cost, $65,000. Royal D. Salisbury, 1415 E. Colfax Ave., Denver, engr.

ROCKY FORD—The American Beet Sugar Co. plans to build a 3-story building. Laboratory equipment will be installed in same. Estimated cost, $50,000.

YUMA—The city council will soon award the contract for the construction of a sanitary sewerage system, including a septic tank. Estimated cost, $80,000. Royal D. Salisbury, 1415 E. Colfax Ave., Denver, engr.

Connecticut

NEW HAVEN—Yale University is having sketches prepared for the construction of a 2-story chemical laboratory. Estimated cost, $250,000. Delano & Aldrich, 126 East 38th St., New York City, archts.

PORTLAND—The Portland Foundry Co., Freestone St., has awarded the contract for the construction of a 2-story 40x50-ft. foundry addition to Thos. Sellew. Estimated cost, $50,000.

Illinois

MARVA—The city plans to construct a sewage disposal plant. Estimated cost, $83,000. Miller, Holbrook & Waner, Milliken Bldg., Decatur, engrs.

Indiana

ONWARD—The Bd. of Educ. has awarded the contract for the construction of a 2-story, 80x125-ft. high school to S. I. Barnes, Logansport, $95,000. A chemical laboratory will be installed in same.

Maryland

BALTIMORE—The Amer. Can Co., 120 Bway., New York City, is having plans prepared for the construction of a factory. Estimated cost, $500,000.

BALTIMORE—The Coca-Cola Co, Pratt St. and Market Pl., has awarded the contract for the construction of a 4-story 196 x531-ft. factory and cooperage plant on Fort Ave. to the Arthur Tufts Co., Candler Annex, Atlanta, Ga. Estimated cost, $1,250,000.

CURTIS BAY (Baltimore P. O.)—The Union Acids Works plan to extend their plant. A 250x520-ft. site has been purchased on Aspen St. near Curtis Ave.

Massachusetts

BROCKTON—The city plans to build filtration bed. Estimated cost, $150,000.

Michigan

DETROIT—The Detroit Lacer Co., 27 A St., has awarded the contract for the construction of a 1-story, 80x100-ft. heat-treating building on A St. to the Scotten & Katz Building Co. Estimated cost, $35,000. Noted May 4.

GRAND RAPIDS—The city is having plans prepared for the construction of an additional waterworks system, including an addition to the filtration plant, etc. C. A. Paige, City Hall, engr.

WEST DETROIT (Detroit P. O.)—Varney & Varney, archts., Washington Blvd., Detroit, plan to build a 1-story, 70x90-ft. foundry. Estimated cost, $20,000. Owner's name withheld.

Minnesota

BEMIDJI—The Bd. of Educ. plans to build a 3-story high school. Chemical laboratory will be installed in same. Estimated cost, $500,000.

EVELETH—The city plans to install a filter plant. Estimated cost, $50,000.

WABASSO—G. A. Goblirsch, village clk., will receive bids until Sept. 9 for the construction of a sewage treatment plant and disposal plant. Estimated cost, $45,000. John F. Druar, 512 Globe Bldg., St. Paul, engr.

Missouri

ST. LOUIS—The city is having plans prepared for the construction of a morgue. Chemical laboratory and operating rooms will be installed. Estimated cost, $68,000. L. R. Bowen, City Hall, archt. and engr.

ST. LOUIS—The Sisters of Charity, 3539 Pine Blvd., are having preliminary plans prepared for the construction of a hospital on Pine St. Chemical laboratory will be installed in same. Estimated cost, $2,000,000. Lee & Rush, Syndicate Trust Bldg., archts.

ST. LOUIS—The Temtor Corn and Fruit Products Co. is constructing a building on Michigan Ave. and Davis St. Estimated cost, $200,000.

New York

BROOKLYN—Henry Holder, 242 Franklin Ave., will soon award the contract for the construction of a 1-story, 100x250-ft. foundry on Columbia St., for J. Riley. Estimated cost, $250,000.

Ohio

AKRON—The city has awarded the contract for the construction of 10 filtration beds, capacity 20,000,000 gal., to the Garrett Constr. Co., Kent. Estimated cost, $313,624.

BEDFORD—The David Round & Son Co. has awarded the contract for the construction of a 1-story 90x180-ft. foundry addition to the Du Perow Const. Co., Plymouth Bldg., Cleveland. Estimated cost, $50,000.

CINCINNATI—Rendigs, Panzer and Martin, archts., Palace Theatre Bldg., will receive bids about Sept. 15 for the construction of a 1-story pottery to have 45,000 sq.ft. of floor space on Lester Rd. for the Wheatley Pottery Co., Reading Rd.

CLEVELAND—The Rickersberg Brass Co., 3612 Perkins Ave., is building a 1-story 11x24-ft. foundry addition. Estimated cost, $5,000.

CLEVELAND—Western Reserve University, c/o E. Spense, Dean, plans to build a 3-story pharmacy building on Adelbert Rd. and Euclid Ave. Estimated cost, $200,000.

PAINESVILLE—The Light Alloys Co. has awarded the contract for the construction of a 1-story 75x140 ft. factory to the H. K. Ferguson Co., 6532 Euclid Ave., Cleveland. Estimated cost, $65,000.

Oklahoma

FAIRFAX—The city plans to construct sewage disposal plant and waterworks extensions. Estimated cost, $80,000. V. V. Long & Co., 1300 Concord Bldg., Okla. City, consult. engrs.

HENRYETTA—The Cogswell Refining Co. is having plans prepared for the construction of a petroleum refinery, having a capacity of 2,000 bbls. Estimated cost, $25,000. J. C. Bertsch, Tulsa, engr.

Pennsylvania

NEW CASTLE—The Lehigh Portland Cement Co., 718 Hamilton St., Allentown, had plans prepared for the construction of a plant. Estimated cost, $200,000.

PHILADELPHIA—The Hellwig Silk Dyeing Co., 9th and Buttonwood Sts., has awarded the contract for the construction of a 2-story 95x235-ft. factory on Holmestead and Milnor Sts., to F. W. Van Loon, Perry Bldg. Estimated cost, $90,000.

PITTSBURGH—The Pittsburgh Forge & Iron Co., Chamber of Commerce Bldg., is receiving bids for the construction of a 2-story, 18x22 and 35x88-ft. coal mill building. Estimated cost, $40,000. Fuller Engr. Co., Allentown, engrs.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS is holding its one hundred and twenty-second meeting Aug. 20 to Sept. 3, on Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

THE CHEMICAL WARFARE POST of the American Legion will hold its next meeting Sept. 22, at 8 p.m., in the conference room of the Grand Central Palace, New York City.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

Volume 23 — New York, September 8, 1920 — *Number* 10

Putting Our Industries On a Scientific Basis

IT IS neither possible nor advisable to characterize each issue of a technical magazine by a special selection or arrangement of its editorial contents. But occasionally there is advantage in selecting a broad theme and building around it as complete a structure as possible. . Accordingly in this issue of CHEMICAL & METALLURGICAL ENGINEERING we have adopted an editorial plan to which all else is subordinated.

We have always preached the doctrine of applying scientific methods to industrial processes, believing that therein lies our hope of industrial independence and supremacy. This was brought home in the most forcible manner during the war, and since then the rapid adoption of science by industry has been one of the most hopeful elements in our industrial development. And yet much remains to be done to put our industries on a scientific basis. It was with this in mind that we conceived the idea of inviting forward-looking leaders in a group of industries to forecast the scientific developments and applications which must be made if industry is to prosper and flourish in the highest degree. The hearty response to our invitation indicated the extent to which men in all branches of industry are thinking along this line. Some of the contributors to this issue have been delightfully frank, acknowledging the shortcomings of their respective industries and pointing the way to the researches and developments that should be made. In fact we were deprived of the privilege of publishing one article because its author showed a state of affairs so distasteful and uncomplimentary to his principals that they requested him to withdraw the article.

Sugar production is one of our principal industries and in his article on this subject Mr. DAHLBERG shows the possibility of building a byproduct chemical industry on factory refuse. This line of investigation is now engaging the attention of one of our largest beet-sugar companies. The problems of the petroleum industry as forecast by Mr. HAMOR consist principally in a better utilization of present supplies by varying the products of distillation to meet the changing demand. "Cracking," or pyrolysis as Mr. HAMOR more aptly calls it, is still a fertile field for investigation. Dr. WASHBURN shows us clearly in his article that the progress of technology is dependent on the interpretation and application of existing physicochemical knowledge; and this is supplemented by Dr. RICHARDS in his plea for "more and better tools" with which to work. The influence which science is bringing to bear on the treatment of sewage and trade waste is removing much of the obnoxious element in past processes and making possible the handling of these materials without offense. Mr. BAILEY writes instructively of the vegetable-oil industry, which is assuming such vast proportions. Future problems are concerned with the production of crude oils and fats, their refining and the finished products. Research is indicated in methods of solvent-extraction instead of pressing. In the rubber industry we are informed that better physical tests are needed for the guidance of manufacturers, and it appears that future developments will be along physical rather than chemical lines. Mr. STEVENS shows that the great problem of the pulp and paper industry is fuel conservation, the improved design of mechanical equipment and the adoption of vacuum driers. Dr. BANCROFT writes entertainingly on his favorite subject of applied colloid chemistry and illustrates its relation to some practical problems.

The leather industry, according to Mr. WILSON, is greatly in need of fundamental theoretical knowledge, and he feels that the greatest good can be accomplished for his industry through co-operation between university and tannery chemists, the former bringing their fundamental knowledge to bear on the practical work of the latter. The glass industry, we are informed by Dr. TILLOTSON, is indebted for its present position and prospective progress to the application of mechanical engineering in the use of automatic machinery. In the hardwood distillation industry there is much the same need as is evidenced in the petroleum industry for ability to control the nature of the products in accordance with the industrial demand for them. Mr. HAWLEY also discusses the prospect of altering the products of distillation by introducing chemicals into the kiln with the wood. In the paint and varnish industry Mr. TOCH points out the necessity of studying possibilities of blending materials which themselves may be inferior but which in combination may produce a superior product. New pigments also form an attractive field for research. In his article on alloys Dr. FINK reveals an almost unlimited field for research in the production of unusual alloys to meet the ever growing demands of special service. Mr. TUNISON has traced the influence of science on the manufacture of industrial alcohol, illustrating the progress in still and rectifier design. A large field for research remains in the development of byproducts. The future of the animal products industry, according to Mr. RICHARDSON, will be centered primarily in byproducts—the aim of the industry being to convert as much as possible of the material into food. The byproducts range from glue to enzymes. Artificial leather and coated fabrics are destined to play an important industrial role, and the article on that subject will be of general interest.

Of more than ordinary interest is the article on the necessity for research in the oil-shale industry. Mr. GAVIN speaks for the Bureau of Mines, which is conducting investigations of a fundamental character both as to the technology of shale oil and the best type of retort. It is quite evident that science will have an

opportunity to contribute largely to the establishment of this industry. In suggesting experiment with the Scotch retort Mr. GAVIN takes a stand in opposition to other authorities, but his line of reasoning involves building a new industry on past experience. Low-temperature carbonization of coal presents a number of problems which are discussed by Dr. CURTIS. The byproducts from this treatment, consisting of mixtures of paraffine and coal-tar bodies, present problems which will require scientific knowledge for their solution.

This wide range of industries would have been still further expanded by appropriate articles on the future rôle of chemistry in food production, fertilizer manufacture and ceramics had the authors not been unavoidably delayed in their work. These articles we hope to present in subsequent issues. The omission from this issue of the market reports, price lists and other miscellaneous items is caused by the large number of contributions and the necessity for conserving paper.

Chemical Warfare Post Of the American Legion

ONE of the important meetings to be held during the week of the Chemical Exposition will be that of the Chemical Warfare Post of the American Legion. On the evening of Sept. 22 in the Conference Room of the Grand Central Palace it is planned to effect a permanent organization, membership being open to all C. W. S. ex-service men. The new Post should be vigorously supported by those who are eligible to membership, not only for purposes of sociability but for the perpetuation of traditions of the service and assistance to General FRIES and his organization.

The Origin of Signs and Symbols

IT WAS EDMONDO DE AMICIS, we believe, who said that at Constantinople ten thousand people tread the bridge across the Golden Horn every day, but that an idea crosses it only once in ten years. And we wonder how often in our modern affairs we bring ideas from the past over the bridge of scholarship?

If we look into the history of chemistry we find it clearly divided into periods of progress. We cannot well go back of THALES of Miletus (about 640-550 B.C.), who was rather a mathematician than a chemist, although from him we have the postulate that water is the source of all things. He lived on an island, he is said to have been a business man, and it was he who introduced *abstract* geometry, the object of which is to establish precise relations between the different parts of a figure. It seems, however, beyond doubt that in the eighth century B.C. there were astronomical observatories in most of the cities of the Valley of the Euphrates, so that there was great learning and study before his day. The only trouble is that we have lost the threads of it. Plane geometry THALES is said to have learned from Egyptian priests. ANAXIMENES and LEUCIPPUS were a bit younger, but were contemporaries of THALES and also citizens of Miletus. They proposed air and earth as the substantial elements. HERACLITUS of Ephesus came a little later (540-475 B.C.) but was probably born before ANAXIMENES and LEUCIPPUS died, and he maintained that fire was the primordial thing. Before him it was 'OROASTER (660-583 B.C.), who followed still earlier philosophers, antedating even the Chaldeans, from whom ABRAHAM sprang, in regard to the supremacy of fire. It was of these pre-Chaldean teachers that a profound scholar now dead told the writer many years ago that they had left this record: "We worship GOD, and GOD only. We hold the sun to be His symbol, because from it come both light and heat; moreover, in it are contained all the elements of the earth."

EMPIDOCLES (490-430 B.C.) proposed earth, air, fire and water as the four elements of matter, and DEMOCRITUS of about the same time originated the atomic theory. Water, he said, was liquid, because its atoms are smooth and round and can easily glide one over another. A solid like iron, he contended, must be made up of atoms which are hard and rough. ARISTOTLE (384-322 B.C.) made the distinction between what he called the matter and the essence of a substance. If it had not been for the ecclesiastical commentators on ARISTOTLE, who claimed supernatural control of that which is intangible, we might have concluded that he foreshadowed chemical energy and latent heat and that he foretold radioactivity. But even if he did he probably didn't know it. ARISTOTLE also noted that wine yielded an inflammable substance.

ARCHIMEDES (289-212 B.C.) and ERATOSTHENES (276-194 B.C.) addressed themselves rather to hydrostatics and mechanics, and there followed PLINY the Elder (23-79 A.D.), who enjoyed the friendship of emperors and was a delightful old gossip, writing down everything he could read or learn. His Natural History is a joy to this day, even if it is grotesquely wrong in almost every respect. It is beautifully translated, and we know of no more fascinating book for the idle hours of a man of science. Then darkness was upon the earth.

The next glimpse of light seems to have been reflected originally from Egypt, but brought into Europe along about the eighth century by the Arabs. They had the idea of a *materia prima*, present in all things, but always contaminated by impurities. By many processes of purification, especially by fire, it was hoped to obtain the true "essence" or "tincture," and this was substantially the philosopher's stone which could work miracles. But our pious forbears would have none of this ungodly thinking. The learned Arabs were put to death whenever this was possible, because they were unbelievers, and therefore in league with SATAN. Their books were burned. The only idea that was acceptable was the plan to get rich quick by turning baser metals into silver and gold, and this also was under lively suspicion of dæmonic origin. It continued through mediæval and renaissance days, and some of the alchemistic symbols were designed to represent the planets supposed to be associated with various metals. Others were empirical marks made to hide the meaning of the writers lest they be held guilty of the high crime of Inorthodoxy.

Alchemy developed into iatrochemistry, or medical mysticism, which began with PARACELSUS, who was born in 1493, and the symbols were still in use when America was discovered. They were not always the same; many were invented and used by individuals as cipher, but an interesting number of them have come down to us. We have used a few for the cover of this issue, from which we modestly think it may be observed that they lend themselves especially to decorative purposes. The meanings of those shown on our cover, beginning at the upper left-hand corner and reading to the right are: Gold, earth, silver, copper, vitriol, sulphur, salt, air, water, fire, mercury, lead, tin and iron.

Cleanliness In the Plant

A CONTRIBUTOR to FRANKLIN P. ADAMS' "Conning Tower" column of the New York *Tribune* writes as follows: " . . . As I see more and more of benighted Japan I recall with an involuntary shudder a journey through Kansas last spring—Kansas, the richest community on earth, with a bleak environment of derelict outbuildings, faded 'homes' of bald and hideous architecture, lawns conspicuous by infrequency, and right-angled white schoolhouses. I wonder what strange psychology prompts the Japanese peasant, crowded and illiterate, . . . to build him a picturesque little cottage, as neat inside as a new cigar box, surrounded by shrubbery and a priceless garden. And I wonder what instinct prompts the wife to array herself in classically artistic fashion, and to attire her offspring in like manner. In Kansas the stranger closes his eyes; in Japan he rarely encounters anything to affront them."

We do not know why the author selected Kansas for his comparison; there are plenty of other states that would have served equally well. But his point is well taken; we Americans are very low in the scale of artistic conscience. We are practical in a utilitarian sense, but we are among the least practical of peoples in æsthetics. In our own field of industry we probably rank below the farmer in this respect. Chemical works are notoriously ugly, and ugliness of structure and surroundings is one of the principal enemies to cleanliness, to order, to comfort in living, and to the pleasant things of life. Hygienic equipment and baths are excellent in their way, but they do not go all the way. If we learn that a chemical factory is to be built in the neighborhood where we live, we are usually disposed to move away if we can; we fear that it will stink; and we have good reason to believe that it will have a dirty, messy entrance and neglected grounds about it.

We know that, inside the works, cleanliness and not only convenient but pleasant arrangements are worth while. The outside we regard as not important, and here we are wrong. The outside *is* important. Every man and woman that works for us is impressed by appearances as he or she enters our portals. It is not necessary that these be conscious impressions. Psychology and experience both teach us that it is the persistent repetition of impressions that counts large in determining the direction of our thoughts and the mold of our opinions. The worst billboard offenders know this, and make it the very basis of their offenses. For instance, if some enterprising tobacconist plasters the walls and fences of the town with advice to smoke his Mercaptano cigars, we may not be disposed to smoke them, but all unconsciously we find ourselves asking for a couple of Mercaptanos when we step in at the cigar store to buy a smoke.

The stranger that passes by registers an impression of us, whether he knows it or not, if only he casts a glance at our works. This impression is either that as a corporate entity we are ugly and dirty and that we stink, or that we look well and agreeable and pleasant. In order that the latter rather than the former opinion be registered as to our persons, most of us bathe diligently, shave every day, wear clean linen, have our boots polished and do what we can to produce what we call a "good" impression. We may say we don't care what people think, but usually in our hearts we know this is not so. So long as we are beyond the pinch of poverty, even shabby clothes are more likely than not to be a studied carelessness to give the impression of affability with all sorts and conditions of men.

If, then, we would have our persons create an agreeable impression, there is abundant reason why our works should do likewise. True, a proper care for and pride in the exterior of our plant increase the overhead charges, and overhead charges are not popular, especially if they can be avoided. But overhead charges are as necessary as fuel or a sales department. A vast amount of administrative wisdom lies in discrimination as to overhead. Old Uncle DAN'L DOLLARDOODLE, who doesn't know or care for anything but dividends, wants to cut out all "deadwood," as he calls it, as soon as he comes on the board of directors and begins to debilitate the company. He condemns the library, the research laboratory, the testing plant and the gravel walks and sod. He condemns everything on which he does not see a crop of immediate dividends growing. And usually he ruins the business. We recognize the presence of infinitely minute quantities of certain bodies which we cannot analyze, and yet which make or mar our products by their presence. Now, there are intangible qualities that also hold good in regard to the outside of the works. The effect of beauty or ugliness is silent but persistent. In what we do we represent the application of science which, for the welfare of all, we need to introduce into life. History, it is claimed, must be rewritten in the light of science, in the light of man's conquest of nature, rather than according to the might, the battles and the whimsies of kings. The day is dawning when the opinion of men of science is asked in regard to public affairs, and science, like other vocations, is known by its works. The factory is properly called the works. Men of science have a greater public responsibility today than ever before. So far as industrial chemists are concerned, how do their works appear? In the great majority of cases they look like the devil.

Radioactivity as the Possible Cause of Heartbeat

BELATED information from Holland reveals researches which Professor ZWAARDEMAKER has been making into the physiological effects of radioactivity. In some highly interesting experiments with solutions of radioactive metals on isolated frog hearts previously brought to a standstill with potassium-free Ringer's solution, the ingenious professor has coaxed the vital organs into renewed pulsations. Perfusion with solution of radioactive elements in proper dosage restored the heartbeat, whereas none of the non-radioactive elements did so. Dr. ZWAARDEMAKER also discovered that the absence of radioactive element in the kidney allows the passage of sugar and throws the muscular wall of the arterioles out of action, while normal activity is restored by the addition of a radioactive element.

Somehow we cannot help regretting that the eminent doctor made his discoveries. Life is becoming so complex that there seems to be no rest for the weary. After, as has been the habit of some of us, talking so much and saying so little about vitamines, both water-soluble and fat-soluble, must we now begin to worry about our radioactive rations? Must those of us who may be of diabetic propensity now prepare to take a mesothorium cure?

Program of the Exposition

Symposia Prepared by the Exposition Management on Fuel Economy, Industrial Management, Materials Handling, Chemical Engineering, and Ceramics—Motion Pictures Illustrating a Wide Range of Industrial Chemical Operations

FOLLOWING is the program of the Sixth National Exposition of Chemical Industries, to be held at the Grand Central Palace, New York City, Sept. 20 to 25:

Monday, Sept. 20

8 P.M.

Opening address by Charles H. Herty.

"Co-operation in the Industries," Charles L. Reese.

Sir George E. Foster, Canadian Minister of Trade and Commerce, will speak.

"Problems Confronting the American Exporter," Erastus Hopkins (Gaston, Williams & Wigmore, Inc.).

Followed by motion pictures:

1. "The U. S. Ammonium Nitrate Plant No. 2 at Muscle Shoals." (2 reels.) (Courtesy Dwight P. Robinson & Co.)
2. "Modern Packaging Methods." (4 reels.) (Courtesy Pneumatic Scale Corporation.)

Tuesday, Sept. 21

2 P.M.—FUEL ECONOMY SYMPOSIUM

Chairman's Address, R. C. Beadle (Managing Editor, *Combustion*).

"Burning Coal at 100 Per Cent B.t.u. Efficiency," W. O. Rankin (Quigley Furnace Specialties Co.).

"Saving Fuel by Controlling Chimney Losses," F. F. Uehling (Uehling Instrument Co.).

"Fluid Heat Transmission," Alexander B. McKechnie (Parks-Cramer Co.).

"Producer Gas and the Modern Mechanical Producer," W. B. Chapman (Chapman Engineering Co.).

"Refractory Cement: Life Insurance for a Furnace," F. W. Reisman (Quigley Furnace Specialties Co.).

"Preventing Conduction and Radiation Heat Waste," S. L. Barnes (Armstrong Cork Co.).

"Increasing Conduction and Reducing Fuel Consumption," W. R. Van Nortwick (The Roto Co.).

"The Reason for the Fuel Saving in the Dressler Kiln," Conrad Dressler (American Dressler Tunnel Kilns, Inc.).

8 P.M.—MOTION PICTURES

Great U. S. chemical industries:

1. "The Story of Sulphuric Acid." (1 reel.) (Courtesy General Chemical Co.)
2. "The Production of Salt for the Chemical Industry." (1 reel.) (Courtesy International Salt Co.)
3. "Perfumes for the World." (Courtesy Antoine Chiris Co.)
4. "A New Chemical Industry: Leather From the Ocean: Fish Leather." (3 reels.) (Courtesy Ocean Leather Co. and Ford Educational Film Co.)

Wednesday, Sept. 22

2 P.M.—INDUSTRIAL MANAGEMENT SYMPOSIUM

"Ultra Analysis of Costs," Harrington Emerson (The Emerson Engineers).

"Research in Industrial Conservation," H. E. Howe (Chairman, Division of Research Extension, National Research Council).

"Progress of the American Coal-Tar Industry," Grinnell Jones (U. S. Tariff Commission).

3 P.M.—MATERIALS HANDLING SYMPOSIUM

Chairman's Address, Roy V. Wright (Editor, "Material Handling Cyclopedia").

"Material Handling: The Paramount Problem," J. H. Leonard (Editor, "Freight and Terminal Engineering").

"Chain Power Transmission," F. G. Anderson (Morse Chain Co.).

"Steel Collapsible Shipping Containers as Related to the Chemical Industries," Everett W. Morgan (Pneumatic Scale Corporation).

8 P.M.

Meeting of Chemical Warfare Post.
(Speakers to be announced.)

Thursday, Sept. 23

2 P.M.—CHEMICAL ENGINEERING SYMPOSIUM

(Meeting of the American Institute of Chemical Engineers, David Wesson, Chairman.)

"A New Method of Destructive Distillation," Thomas W. Pritchard (Fuel Products Corporation).

"Nitration of Hydrocarbons," A. Hough and W. Savage.

"Recoverance: A Physical Property in Material and Its Importance," Robert G. Guthrie (Widney Test Laboratories).

"Operating Data of a Modern Byproduct Coke Oven Plant," C. R. Bellamy.

"Canada and the Chemist," C. Price-Green (Canadian National Railways).

"Utilization of Peat" (illustrated), B. F. Haanel (Canada Department of Mines).

"Corrosion of Iron and Steel as Affecting the Industries," W. D. Richardson (Swift & Co.).

6:30 P.M.

Dinner of American Institute of Chemical Engineers at the Technology Club.

8 P.M.—MOTION PICTURES

Great U. S. chemical industries:

1. "Modern Coke and Gas Manufacture." (3 reels.) (Courtesy The Koppers Co.)
2. "The Story of Petroleum Oil." (3 reels.) (Courtesy Standard Oil Co. of New Jersey.)

3. "The Asphalt Paving Industry." (1 reel.) (Courtesy Barber Asphalt Paving Co.)

4. "Colloidal Movement in Asphalt." (1 reel.) (Courtesy Barber Asphalt Paving Co.)

Friday, Sept. 24

2 P.M.—CERAMIC SYMPOSIUM

(Meeting of the American Ceramic Society, R. H. Minton, Chairman.)

"The Meaning Attached to the Term 'Ceramics' in Ancient and Modern Usage." Committee Report, Condensed.

"A Classification of Sheet Steel Enamels," R. R. Danielson, (U. S. Bureau of Standards.)

8 P.M.—MOTION PICTURES

Mining industries:

1. "The Story of Coal." (4 reels.) (Courtesy Sullivan Machinery Co. and U. S. Bureau of Mines.)

2. "Building, Mining and Quarrying Machinery." (2 reels.) (Courtesy Sullivan Machinery Co.)

3. "Producing Pumps and Engines." (1 reel.) (Courtesy Midwest Engine Co.)

4. "Silver Mining in Ontario." (1 reel.)

5. "Gold Mining in Ontario." (1 reel.) (Courtesy Ontario Department of Mines).

6. "The Manufacture of Pottery." (1 reel.) (Courtesy American Ceramic Society).

Saturday, Sept. 25

2 P.M.

Speakers to be announced.

8 P.M.—MOTION PICTURES

1. "Manufacture of Asbestos." (1 reel.)

2. "Silks and Satins." (2 reels.) (Both by Courtesy Bureau of Commercial Economics.)

3. "Foamite Firefoam Extinguishing Apparatus at Work." (1 reel.) (Courtesy Foamite Firefoam Co.)

4. "Continuous Motion, Conveying, Stacking, Elevating, Loading and Unloading Machinery." (1 reel.) (Courtesy Brown Portable Machinery Co.)

5. "The U. S. Ammonium Nitrate Plant No. 2 at Muscle Shoals, Alabama." (2 reels.) (Courtesy Westinghouse-Church-Kerr, Inc.)

Exhibitors at the Exposition

A Brief Description of the Exhibits of Over Four Hundred Exhibitors Prepared for the Exposition Visitor Who Wishes to Conserve His Time and Make Certain of Seeing Those Things in Which He Is Most Interested

THE following societies and publications have reserved booths for reception and social purposes where they will be glad to receive their friends.

AMERICAN CHEMICAL SOCIETY.
AMERICAN DYESTUFF REPORTER.
AMERICAN DYES INSTITUTE.
AMERICAN ELECTROCHEMICAL SOCIETY.
AMERICAN FERTILIZER.
CANADIAN CHEMICAL JOURNAL.
CANADIAN MINING JOURNAL.
CANADIAN TEXTILE JOURNAL.
CHEMICAL AGE.
CHEMICAL & METALLURGICAL ENGINEERING.
CHEMICAL CATALOG.
CHEMICAL COLOR AND OIL DAILY.
COLOR TRADE JOURNAL.
COMBUSTION.
CONTAINER CLUB.
IRON AND STEEL OF CANADA.
JOURNAL OF COMMERCE.
JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY.
MANUFACTURERS RECORD
OIL, PAINT AND DRUG REPORTER.
PAPER MILL AND WOOD PULP NEWS.
PULP AND PAPER MAGAZINE OF CANADA.
TEXTILE COLORIST.
TEXTILE WORLD JOURNAL.
TEXTILES.

The following list of exhibitors at the Sixth National Exposition of Chemical Industries, together with a brief statement of their exhibits and names of representatives, will be of special value to those who expect to attend the Exposition. Being published well in advance, it will enable prospective visitors to conserve their time and give attention to those matters in which they are particularly interested. The list is practically complete. Where no description of exhibit is given, the information requested either was not furnished or arrived too late for publication. No attempt has been made to give booth numbers or location in the Grand Central Palace, because these will be more easily obtained from the handbook and guide which will be distributed at the Exposition with our compliments.

ABBE ENGINEERING CO.—Ball mills, pebble mills, laboratory grinding machines, disintegrators, rotary cutters for roots, herbs, rubber, etc.; bolting cloth. In charge of exhibit: H. F. Kleinfeldt.

ABBE, PAUL O., INC.

AINSWORTH, WM., & SONS.—Precision analytical and assay balances; precision analytical balance with keyboard-operated weight carrier for handling fractional gram weights. Precision assay balance with a sensitivity of 1/1000 mg.; readings are indicated by a reflected beam of light. In charge of exhibit: Robert G. Ainsworth.

AJAX ELECTROTHERMIC CORP.—Laboratory induction furnace with vacuum tube; brass tube annealing furnace; brass-melting furnace for materials of melting point not above 1,550 deg. C. In charge of exhibit: Edwin F. Northrup, Dudley Willcox and Harry F. Porter.

ALBERENE STONE CO.—Exhibit of laboratory construction of Alberene stone, consisting of a typical fume hood, wall table with reagent shelves, sink, peg-board, etc. In charge of exhibit: E. L. Collins, W. K. Fields, R. G. Grothe, W. Heins, A. Y. Meeker and N. N. Moneypenny, Jr.

ALCOHOL PRODUCTS CO.

ALEXANDER, W. H.

ALLEN ELECTROLYTIC CELL CORP.—The Allen-Moore electrolytic cell. In charge of exhibit: Kent R. Fox and Howard D. Marsh.

ALLIS-CHALMERS MANUFACTURING CO., INC.—Dust collector, motors, rubber-lined centrifugal pump, pulverator. In charge of exhibit: Representatives from the New York office.

AMERICAN ANILINE PRODUCTS, INC.—Full line of colors dyed on felt, leather, wool, cotton and silk. Line of essential oils and fine chemicals. In charge of exhibit: Messrs. Fenton, Gossen, Roelofs, Mehnen, Bennefield, Giroward, Collins, Chase, O'Hara, Hennessy, Whyte, Greegor, McDermott, Schleicher and Cheesman.

AMERICAN CHEMICAL & MFG. CO.

AMERICAN CHEMICAL & SUGAR MACHINERY CO.—Patent multiplex film evaporator and McLaurin patent gas scrubber. In charge of exhibit: Messrs. Lawrence and Dunglinson.

AMERICAN CYANAMID CO.—Illuminated wall case showing models of the principal apparatus used in the fixation of atmospheric nitrogen, and the intermediate and finished products of the cyanamide process. In charge of exhibit: E. J. Pranke, R. R. Stewart and J. P. Hubbell.

AMERICAN DRESSLER TUNNEL KILNS—Illuminated screen showing continuous view of tunnel kilns and their application to chemical processes; samples of materials such as bricks, porcelain, steel, and malleable iron which have been treated in tunnel kilns. In charge of exhibit: Conrad Dressler.

AMERICAN HARD RUBBER CO. Hard rubber equipment for handling acids, alkalis, dyes, food products and corrosive chemical solutions. A hard rubber pump will be shown in operation. In charge of exhibit: A. M. Ackerman.

AMERICAN KRON SCALE CO.—Automatic dial scales. In charge of exhibit: John J. Kelly.

AMERICAN LAFRANCE FIRE ENGINE CO., INC.—Industrial safety devices, fire prevention apparatus, chemical engines and fire extinguishers. In charge of exhibit: H. J. Lovell and James W. Knoblock.

AMERICAN METAL CO., LTD.—Ores and products of zinc, molybdenum, lead, copper, gold, silver, arsenic, selenium; sulphuric acid. In charge of exhibit: H. M. Burkey, E. K. Judd, R. C. Latz and Miss A. M. Stout.

AMERICAN METAL PRODUCTS CO.—Acid-resisting castings and finished parts such as valves and cocks; shafting, sheet, rods. Souvenirs will be presented to purchasing agents and engineers, consisting of chisels of 84 per cent copper with which steel may be chipped. In charge of exhibit: R. W. Alger and C. J. Zaiser.

AMERICAN PULVERIZER CO.—American pulverizers suitable for the chemical industry. In charge of exhibit: Dunning, Luckel Engineering Co.

AMERICAN ROLLING MILL CO.

AMERICAN STEEL & WIRE CO.—Sulphate of iron, both sugar and crystal form; different materials made from sulphate of iron or in which this plays an important part in manufacture. In charge of exhibit: Arthur S. Lutz.

AMERICAN TRANSFORMER CO.

AMERICAN WATER SOFTENER CO.

ANACONDA COPPER MINING CO.—Products and byproducts from the smelting and refining of copper ores; electrolytic zinc; uses of copper in the chemical industry illustrated by equipment loaned for the occasion; Anaconda white lead. In charge of exhibit: S. Skowronski.

ANACONDA LEAD PRODUCTS CO.

ANACONDA ROLLING MILL DEPT.

ANGEL, H. REEVE, & CO.—Filter paper of American manufacture; rubber tubing, glass wool, etc. In charge of exhibit: B. S. Proper and T. L. Harrocks.

ANILINE DYES & CHEMICALS, INC.

ANILINE SALES CORP.

ANTHRAKONE DYE PRODUCTS & CHEMICAL CO.

ANTI-HYDRO WATERPROOFING CO.—Liquid chemical compound for rendering concrete waterproof, dustless, oil-proof, acid resisting and chemical resisting. In charge of exhibit: B. A. Meyer, Thomas Moore, Joseph Meyer, M. R. Duffy, M. E. Townsend, Charles A. Brown.

APEX CHEMICAL CO.—Antimony sulphide and other antimony compounds; sulphonating oils, softening, finishing compounds, etc., for the textile industry; chemical specialties for the leather industry; fabrics and leather which have been treated by these specialties.

ARKELL SAFETY BAG CO.—Complete line of "Arksafe" elastic paper linings for shipping packages, plain and waterproofed. In charge of exhibit: Pedro J. Morales.

ARMSTRONG CORK CO.—Nonpareil insulating brick for furnaces, boiler settings, kilns and other high temperature equipment; Nonpareil high-pressure insulation for steam lines, and other hot surfaces; Nonpareil cork covering for brine and ammonia lines and other cold surfaces; Nonpareil corkboard for cold storage rooms or wherever constant temperature is required. In charge of exhibit: Representatives from New York office.

ARNOLD, HOFFMAN & CO., INC.—Oils, softeners, gums, starches, pigment and other colors for textile sizing, printing, and finishing, and for use in the paper, chemical, leather and other industries. In charge of exhibit: H. H. Hall, C. L. Berntson, E. M. DeBaun, G. D. Curtis, H. P. Geier.

ATERITE CO., INC.—Aterite-trimmed valves and cocks for handling petroleum; Aterite valves, cocks and fittings for high temperature stills and sulphuric acid lines; also valves and fittings for all temperatures of steam, both saturated and superheated. Wrought Aterite in the shape of rods, sheets, wire, etc. In charge of exhibit: Ernest G. Jarvis.

ATLANTIC DYESTUFF CO.—The central feature will be a miniature dye-making plant, in addition to which the company will show its various products. In charge of exhibit: Charles H. Stone, G. R. Stoettner, H. M. Paine, H. R. Ullrich, C. C. Burt and Karl Ruger.

ATLAS ELECTRIC DEVICES CO.—Color Fade-ometers for color testing by standardized radiation. In charge of exhibit: Clarence W. Jameson and Hugh E. Weightman.

BABBITT, B. T.

BACHARACH INDUSTRIAL INSTRUMENT CO.—Pressure recorders and gas meters in actual operation; special demonstration showing the application of Pitot tube to the measurement of gases. In charge of exhibit: Herman H. Sticht, Mr. Lauterbach, and Mr. Bacharach.

BACHMEIER & CO.—Aniline dyes. In charge of exhibit: G. M. Lord, William Baur and H. L. Gettler.

BAILEY METER CO.—Working exhibit of meters for water, steam, gases, and various chemicals. In charge of exhibit: E. G. Bailey, W. R. Little, H. M. Hammond, N. Dmytrow, Jr. and M. Repa.

BAKER, J. G., CHEMICAL CO.

BARBER ASPHALT PAVING CO.—Comprehensive exhibit of native lake asphalts and their products, with special reference to those useful in chemical plants and laboratories. Crude and refined asphalt, mineral rubber, ready roofing, asphalt shingles, preservative paints, high-grade oils for special lubricating purposes, flotation oils.

BARRETT CO., THE—This company has joined forces with the General Chemical Co., the National Aniline & Chemical Co., the Semet-Solvay Co. and the Solvay Process Co. in a series of booths containing an instructive and educational exhibit of their products. In charge of exhibit: H. G. Sidebottom.

BAUSCH & LOMB OPTICAL CO.—Metallographic equipment, consisting of large photomicrographic camera with special microscope designed for metallographic work; optical measuring instruments such as the Duboscq colorimeter, Abbe & Dipping refractometer and saccharimeter, chemical microscope and binocular microscope. In charge of exhibit: E. H. Anthes, I. L. Nixon and W. L. Patterson.

BEACH-RUSS CO.—The following machines will be shown in operation: High-duty vacuum pumps, rotary air compressors, laboratory pumps, acid pumps and heavy liquid pumps. In charge of exhibit: Howard C. Russ.

BEAVER CHEMICAL CO.—Sulphur colors. In charge of exhibit: John E. Rooney and John B. Dunbar.

BECKER, CHRISTIAN, INC.—Analytical and laboratory balances, featuring the chainomatic balances; bullion scales; torsion balances. In charge of exhibit: W. C. Symington, A. T. Millroy and J. W. Wetz.

BECKLEY PERFORATING CO.

BETHLEHEM FOUNDRY & MACHINE CO.—Wide range of castings of Corrosiron. Demonstration by acid test of a comparison of the wearing qualities of Corrosiron against cast iron. In charge of exhibit: J. George Lehman, R. E. Wilbur, A. H. Stevens, R. H. Stevens and George Ettele.

BLACKMER ROTARY PUMP CO.—Models of pumps, with necessary explanatory charts and pictures of the various units made. In charge of exhibit: A. L. Rock and F. P. Goertz.

BLACKSTON'S SON, P., & CO.

BOOTH ELECTRIC FURNACE CO—Booth rotating brass furnace of 500-lb. capacity. In charge of exhibit: C. H. Booth, E. F. Tweedy and F. W. Doran.

BOYER OIL CO., INC.—Vegetable oils such as castor, coconut, cotton, mustard, palm, rape and sunflower, together with the seeds from which they are made and typical byproducts. In charge of exhibit: Messrs. Boyer, Kienle, Blythe, Weber and others.

BRISTOL CO.—Full line of recording and indicating instruments for pressure and vacuum, liquid level, temperature, electricity, time, motion, speed. In charge of exhibit: H. L. Griggs.

BROWN INSTRUMENT CO.—Comprehensive display of indicative and recording pyrometers, recording and resistance thermometers, indicating and recording instruments for pressure, vacuum, speed, time and operation. In charge of exhibit: J. D. Andrews, M. A. Leister, George W. Goodman, R. B. McCafferty, C. D. Porterfield and O. W. Stowe.

BROWN PORTABLE CONVEYING MACHINERY CO—Portable inclined elevator for piling boxes, bags and bales. Portable inclined elevator for loading and elevating loose material. Hand power portable tiering machine for lifting and piling cases, rolls and drums. In charge of exhibit: O. H. Oertel

BUCKMAN & PRITCHARD, INC.—Exhibit of refractory shapes, bricks, cupola blocks and crucible high tension insulators and spark plug cores of zirconium silicate or zircon. Commercial products of ilmenite and rutile, including a newly developed white pigment. In charge of exhibit: George A. Pritchard and H. H. Buckman.

BUFFALO FOUNDRY & MACHINE CO.—Vacuum drying apparatus, evaporators, chemical equipment and sugar apparatus. New developments during the past year in Buflovak and Buflokast apparatus. In charge of exhibit: E. G. Rippel.

BURRELL TECHNICAL SUPPLY CO., INC.—Burrell gas analysis apparatus and other testing apparatus. In charge of exhibit: G. H. Burrell, R. P. Mase and H. J. Segrave.

CALCO CHEMICAL CO.—Dyes and intermediates with demonstration of dyeings on fabrics, paper pulps and lakes. In charge of exhibit: Messrs. Sampson, Sumner, Klein, Bosworth, Ackerman, Paradies and Merry.

CALIFORNIA ALKALI CO.

CANADA CARBIDE CO.

CANADIAN ELECTRODE CO.

CANADIAN ELECTRO PRODUCTS CO., LTD.—Carbide of calcium, acetic acid, acetaldehyde, paraldehyde, U. S. P. and commercial and aldehyde ammonia. In charge of exhibit: H. E. Mussett, Henry Booth and J. C. Fruit.

CANADIAN PACIFIC RAILWAY CO.

CARBORUNDUM CO.—Crude carborundum and aloxite crystals; silicon metal; carborundum and aloxite abrasive products, such as grain, abrasive paper, cloth and wheels; carborundum refractory brick and special shapes; silfrax pyrometer protection tubes and muffles. In charge of exhibit: Otis Hutchins, Dr. Hartman, S. C. Linbarger, C. E. Hawks and W. L. Meek.

CARRIER ENGINEERING CORP.—Complete installation of Carrier humidifying equipment in operation, and typical products into the manufacture of which Carrier equipment enters. In charge of exhibit: J. E. Bolling.

CELLULOID ZAPON CO.

CENTRAL SCIENTIFIC CO.—Constant temperature apparatus consisting of electrically heated and controlled drying ovens, vacuum ovens and water baths; high vacuum pumps; electrically operated laboratory devices; electric furnaces and electro-titration apparatus; oil and fuel testing equipment; physicochemical apparatus. In charge of exhibit: S. L. Redman, O. T. Lewis and A. B. Carter.

CHADWICK-BOSTON LEAD CO.

CHAPMAN ENGINEERING CO.—Automatic floating agitator complete with automatic feed in actual operation. Regulating and recording devices in actual operation on pressure and vacuum lines. In charge of exhibit: W. B. Chapman.

CHAPMAN VALVE MFG. CO.

CHEMICAL CO. OF AMERICA, INC.—Dyes and intermediates. In charge of exhibit: S. Iserman, Chas. Kendall, A. P. Christ, R. H. Steele and F. X. Lehmann.

CHEMICAL EQUIPMENT CO.—Ceco products, comprising acid valves and pumps, priming systems, spray systems, experimental vacuum evaporator. All except the latter will be in operation. In charge of exhibit: H. E. LaBour, R. T. White, F. L. Dunlap and E. M. Baker.

CHEMICAL PUMP & VALVE CO—Centrifugal pumps, packingless valves and fittings for chemical works. In charge of exhibit: A. B. Antisell, F. A. Warter.

CHIRIS, ANTOINE, CO.—Full line of essential oils, synthetic aromatic chemicals, resinaromes, oleo resins, etc.; manufactured in American factories. Also a full line of products from the company's French factories; capesviscose, a self-fixing bottle capping.

CLEVELAND-CLIFFS IRON CO.—Refined wood chemical products; methyl alcohol, methyl acetone, acetone, acetic acid, hexamethylenamine, etc. In charge of exhibit: Charles B. Hall, Austin Farrell and E. J. Hudson.

CLEVELAND INSTRUMENT CO.—Thermo-electric and resistance types of indicating and recording pyrometers; multiple station circular chart recorder. In charge of exhibit: Herman H. Sticht, W. B. North and H. B. Rich.

CLINCHFIELD PRODUCTS CORP.—Feldspar, ground and crude; variety of finished articles using this material. In charge of exhibit: Charles Ingram and Leo L. Hunt.

CLIPPER BELT LACER CO.—Three different types of clipper belt lacing machines; demonstration of belt lacing. In charge of exhibit: William F. Kall.

COMMERCIAL SOLVENTS CORP.

CONSOLIDATED CHEMICAL PRODUCTS CO.

CONTACT PROCESS CO.—Sulphuric, muriatic and nitric acids, fuming sulphuric acid, oleum, mixed acid, salt cake. In charge of exhibit: Dr. von Rucker and T. Smith.

CORNING GLASS WORKS.—Complete line of Pyrex laboratory glassware and apparatus. In charge of exhibit: G. Willis Drake, Frederick Kraissl, Irving B. Cary, F. F. Pfeiffer and A. S. Eggleton.

CRANE CO.

CRANE PACKING CO.—Full line of "John Crane" flexible metallic packings for liquid, vapor and acid service. Demonstration of electrolytic disintegration of tubes and pipes, with methods of packing to avoid this destruction. In charge of exhibit: Julian N. Walton and F. E. Payne.

CRESCENT SALES & ENGINEERING CO.—Crescent roto-piston vacuum and pressure pumps, Crescent vacuum chucks. In charge of exhibit: L. L. Becken.

DAVIDSON, M. T., CO.—Steam pumps for general power plant service and for acid. In charge of exhibit: John Lowe and William E. Brennan.

DAVISON CHEMICAL CO.—Pyrites ore, cinders, sinter, copper precipitate, sulphuric acid, acid phosphate, double superphosphate, magnesium fluosilicate, precipitated silica and silica gel. A working exhibit showing the absorbent qualities of silica gel. In charge of exhibit: E. B. Miller, B. F. Lovelace, Walter A. Patrick, W. D. Huntington, J. R. Wilson and A. E. Marshall.

DELAVAL SEPARATOR CO.

DENVER ENGINEERING WORKS CO.

DERMATOLOGICAL LABS.

DETROIT ELECTRIC FURNACE CO.—Detroit electric furnaces for melting brass, bronze, copper, aluminum, cast iron and steel alloys. In charge of exhibit: E. L. Crosby, E. L. Kavanaugh, H. M. St. John and A. E. Rhoads.

DETROIT RANGE BOILER & STEEL BARREL CO.—"Perfect" metal bilge barrels, black and galvanized; Detroit drums both light and heavy type with removable head. In charge of exhibit: W. B. Goddard, C. C. Choate, H. Ross Mack.

DEVINE, J. P., CO.—Display of vacuum apparatus, such as drum driers, chamber driers and vacuum pumps; also an exhibit of "Kek" pulverizing mills. In charge of exhibit: J. P. Devine, C. P. Devine, L. W. Graves, E. H. Miller and H. C. Mills.

DIAMOND STATE FIBER CO.—Vulcanized fiber in sheets, rods, tubes, cans, sample cases, trunks; condensite celoron waterproofing insulation. In charge of exhibit: Charles M. Bogert.

DINGS MAGNETIC SEPARATOR CO.—Three magnetic separators in operation for the treatment of material which may be submitted. In charge of exhibit: J. R. Manegold, E. S. Hirschberg, J. E. Randall, S. G. Oates and A. H. Ackerman.

DOMINION WATER POWER BRANCH OF THE DEPARTMENT OF THE INTERIOR OF OTTAWA, CANADA.—This bureau will be in charge of engineers qualified to give general and particular information concerning Canada's water-power and economic minerals, both of which are important in the establishment and development of the chemical industry in Canada. In charge of exhibit: J. B. Challies, J. P. Johnston and A. M. Beale.

DORR CO., THE—Working installation of Dorr agitator, tray thickener and pump demonstrating methods of mixing and dewatering applicable to chemical and industrial processes; small working models of Dorr equipment. The special feature will be a miniature sewage treatment plant. In charge of exhibit: P. M. McHugh, H. N. Spicer and H. W. Morgan.

DOW CHEMICAL CO.—Chemicals: pharmaceutical, industrial, heavy; dyes; intermediates; insecticides. In charge of exhibit: G. Lee Camp, Leland I. Doan, Ralph E. Dorland, George Ashworth and Wilson I. Doan.

DRACKETT, P. W., & SONS CO.

DRAPER MFG. CO.

DRYING SYSTEMS, INC.—Small drier for the chemical industry. In charge of exhibit: F. A. Lippert, C. H. Currier and R. E. Lippert.

DUNNING, LUECKEL ENGINEERING CO.—Nelson wood plate and frame filter press for corrosive liquids. American ring pulverizer for pulverizing lime stone, pyrite, salt, phosphate rock, etc. In charge of exhibit: Harry Dunning, W. J. Lueckel and Paul S. Knittle.

DU PONT DE NEMOURS, E. I., & CO.—This company will exhibit products of the following divisions: Lithopone, dry colors and pigments division, chemical products division, acids and heavy chemical division and dyestuffs sales division. Special attention will be given to the display of dyes.

DURIRON CASTINGS CO.—Comprehensive selection of Duriron apparatus, covering standardized designs of regular equipment and new equipment. First showing of the industrial film "The Story of Duriron." In charge of exhibit: Messrs. Schenck, Pitman, Hall, Dart, Pratt, Smith, Daniels, Elkins, Suverkrop, Jaffe, Schatzabel, H. H. Van Etten and O. Jacobsen.

EAGLE PICHER LEAD CO.—Display of lead products, and products of other industries in which lead is used; a model of a sublimed white lead (basic sulphate) plant. In charge of exhibit: H. Gates, A. F. Brown, C. E. Gilson, L. E. Kelly and J. R. MacGregor.

EAST JERSEY PIPE CO.—The centrifugal and extractor department will exhibit a Hercules-Electric hydro extractor and a 7-in. working model machine of the same design. In charge of exhibit: H. H. Stephens.

EASTMAN KODAK CO.—Organic chemicals for research purposes; Eastman tested chemicals for photographic use; exhibits of a physical and photographic nature from the research laboratory.

ECONOMIC MACHINERY CO.

ECONOMY ENGINEERING CO.—Miniature oil warehouse containing economy steel barrel racks and tiering machines; full-size electrically driven tiering machines; full size hand power tiering machines; one unit economy steel barrel rack, full size. In charge of exhibit: T. R. Tordoff.

EDGAR BROS. CO.

EGYPTIAN LACQUER MANUFACTURING CO.—Lacquers, thinners, enamels and similar products, as well as finished articles on which these products have been used. In charge of exhibit: Messrs. Sopher, DeBaun, Popper, Hayward, Henry and Schlott.

EIMER & AMEND—Replaceable unit electric furnaces and hot plates; Freas electric ovens; Hortvet cryoscope; Juerst ebullioscope; Bingham & Green viscometer and plastometer; McMichael viscosimeter; U. S. Navy type emulsifier; Barnstead water still; Wysor polishing and grinding apparatus; Braun pulverizer; Morgan drop weight apparatus; American rotary vacuum pump; MacLeod gage, Columbia University type; Kobe condenser; Fleming and Fisher combustion bulbs; Hortvet butter fat bottle; refractometers; microscopes and Duboscq colorimeters. In charge of exhibit: C. G. Amend, W. R. Eimer, F. Wilbur Schulenberger, Theodore Taistra, I. Banner and Herman Weber.

ELECTRIC FURNACE CO.

ELECTRO BLEACHING GAS CO.—Finished products which have required the use of liquid chlorine in the process of their manufacture. In charge of exhibit: James B. Duggan, S. W. Jacobs, S. I. Escoett, W. A. Kennedy and George R. Ellis.

ELECTROLYTIC ZINC CO., INC.

ELECTRON CHEMICAL CO.—Allen-Moore electrolytic cell. In charge of exhibit: Kent R. Fox and Howard D. Marsh.

ELMORE, G. H.—Elmore continuous centrifugal machine in operation. In charge of exhibit: G. H. Elmore and R. W. Rigler.

ELYRIA ENAMELED PRODUCTS CO.—Elyria enameled stills, autoclaves, open-jacketed tilting kettle complete with agitator, still complete with condenser, receiver and pump. The autoclave and the multiple unit condenser, which will be shown with the 10-gal. still, are entirely new developments. In charge of exhibit: Wm. E. Gray, Wm. E. Gray, Jr., Max Donauer and R. W. Smith.

EMPIRE LABORATORY SUPPLY CO., INC.—Chemical glassware and apparatus; laboratory supplies of all kinds. In charge of exhibit: M. A. Goldstein, E. C. Weiskopf, H. L. Thompson, J. C. Headley, P. Freedman and H. Freedman.

ENGELHARD, CHARLES—Indicating and recording pyrometers, automatic temperature regulators, electric furnaces, impervite refractories, pyrometer tubes, transparent quartz glass, electric resistance thermometers, mercury vapor arc lamps. In charge of exhibit: C. W. Hubbard.

EVERLASTING VALVE CO.

EXCELSIOR DYESTUFFS & CHEMICAL CO.—Dyes and chemicals. In charge of exhibit: Walter Reinicke and Charles Frankel.

FALCON DYE & CHEMICAL CO., INC.—Aniline colors. In charge of exhibit: Dr. E. C. Altvater, Harry Laut and Julius Oettinger.

FLEISHER, W. L., & CO., INC.—Air-conditioning apparatus and a spray drier. In charge of exhibit: W. L. Fleisher, A. W. Lissauer and D. L. Connelly.

FLORASYNTH LABORATORIES—Raw materials for flavoring extracts, flavoring extracts and other aromatic chemicals; betanaphthol benzoate and benzyl benzoate medicinal. In charge of exhibit: Louis A. Rosett, Charles L. Senior and Alexander Katz.

FOAMITE FIREFOAM CO.—Fire extinguishers of the smaller type using foamite and firefoam, with demonstration of the effectiveness of these extinguishers in smothering fire. In charge of exhibit: R. H. Austin.

FOOTE MINERAL CO.—Display of rare and unusual ores, together with chemical products manufactured from the same. A feature of the exhibit will be the demonstration of the refractory properties of zirkite and zirkonalba in the electric furnace. In charge of exhibit: H. C. Meyer and Samuel K. Bell.

FOXBORO CO., INC.—Recording and indicating instruments for pressure and vacuum, hydraulic gages, combinations of recording thermometer and temperature controller. CO_2 recorder in operation, and other instruments. In charge of exhibit: W. W. Patrick and E. P. Grout.

FUEL PRODUCTS CORP.

GARRIGUE, CHAS. F., CO.

GARRIGUE, WILLIAM, & CO.—Oils, fats, glycerine and soaps in various stages of processing. In charge of exhibit: J. W. Bodman, O. H. Wurster and W. E. Sanger.

GEIGY CO., INC.

GENERAL BAKELITE CO.—Bakelite materials with examples of their various applications; operation of molding press giving demonstration of the bakelite molding process. In charge of exhibit: Hylton Swan, H. S. May, L. M. Rossi, C. H. Hall and William S. Gordon, Jr.

GENERAL BRIQUETTING CO.—Briquets made from fine fuels and fine chemical and metallurgical byproducts. In charge of exhibit: A. L. Stillman, J. Sprung and J. E. Stevens.

GENERAL CERAMICS CO.—Models of standard chemical stoneware apparatus consisting of a complete plant for the manufacture of muriatic acid which will be operated at intervals during the exposition; chemical stoneware exhaust fan and an etching machine which will be operated as required: fused silica shapes made at the company's new plant near Perth Amboy, N. J. In charge of exhibit: Percy C. Kingsbury, F. A. Whitaker and R. S. Beecher, A. C. Otto, Hubert Royer and K. J. Peters.

GENERAL CHEMICAL CO.—Working model of the latest type sulphuric acid tank car; 5-ton model of the new Herreshoff for roasting ores, in operation daily; display of reagent chemicals. In charge of exhibit: Messrs. A. W. Hawkes, G. G. Ackerson, C. E. Shean, George N. Vardy, J. H. Eberhardy, M. M. Biddison, J. E. Wilson, R. P. Silva, W. J. Kramer and J. L. Thomas.

GENERAL ELECTRIC CO.

GENERAL FILTRATION CO., INC.—Filtros uniformly porous, acid-proof, artificial stone, filter plates in various shapes and sizes; Filtros acid-proof cement, and acid-proof stoneware girders. In charge of exhibit: F. E. Leiby and W. W. Robacher.

GENERAL FIRE EXTINGUISHER CO.

GEORGIA LEAD WORKS.

GIBSON PRICE & CO.

GLAMORGAN PIPE & FOUNDRY CO.—Working model of continuous gas-fired limekiln and standard flaking and congealing machine; nine compartment filters and standard Duplex exhauster. In charge of exhibit: C. H. Hinnant.

GLASS COATING CO.

GLENS FALLS MACHINE WORKS—Demonstration of rotary sulphur furnace for production of SO_2; model of a Knot & Silver screen for use on either chemical or mechanical wood pulp. In charge of exhibit: Harold D. Wells and Fred S. Chaffee.

GORDON DRYER CORP.—Gordon high-efficiency atmospheric-type drier for drying chemicals, colors, dyestuffs, pharmaceutical and medicinal products. In charge of exhibit: Nathan Owitz, N. W. Park and John Bogge.

GOTTESMAN, M., & CO., INC.—Industrial chemicals for the paper and pulp industry, such as sulphate of soda, sulphate of alumina, bleaching powder, china clay, casein, rosin, blanc fixe and soda ash. In charge of exhibit: Arthur J. Sigel, Guy A. Gardner and E. A. Pita.

GOULDS MANUFACTURING CO.—Line of pumping machinery suitable for use in chemical plants. In charge of exhibit: W. H. Hopper, H. R. Gumbert, W. H. Valentine, W. J. O'Neill, H. J. Angell and E. E. Brereton.

GREELEY PRODUCTS CORP.—Lubricating, vegetable, fish and animal oils, pine products and industrial chemicals. In charge of exhibit: H. A. Carman, H. S. Kenyon, W. R. Boin and B. D. McCampbell.

GREINER, EMIL, CO.—Chemical and scientific instruments and apparatus made of glass. In charge of exhibit: Emil Greiner, Emil Vonhof, P. Todtschinder and M. Kohn.

GRINNELL CO., INC.—Grinnell automatic sprinkler and other Grinnell fire-protection devices. The Grinnell automatic sprinkler will be shown in operation periodically throughout the exposition. In charge of the exhibit: Howard E. Branch, Frank V. Sackett, F. S. Crans, Henry Walsh and Robert Nicholson.

GROCH CENTRIFUGAL FLOTATION, LTD.

GRUENDLER PATENT CRUSHER & PULVERIZER CO.

GUERNSEYWARE CO.—Complete line of chemical laboratory porcelains consisting of crucibles, casseroles, evaporating dishes, beakers, combustion boats, mortars and pestles, porous cells, etc. In charge of exhibit: Allan L. Goulding.

HAMILTON & HANSELL, INC.—Illustrations of electric-furnace installations. Information on general metallurgical processes such as ore dressing, smelting, chloridizing and leaching processes in accordance with the Ramen patents. Models of flue cleaners. In charge of exhibit: H. A. De Fries.

HANOVIA CHEMICAL & MANUFACTURING CO.—Electric resistance furnaces, quartz resistance thermometers, Hanovia quartz mercury arc lamp, transparent quartz laboratory ware and Engelhard pyrometers. In charge of exhibit: A. L. Schweickart, E. Simonds, G. H. Wilson, Leon Witmondt, R. W. Newcomb and C. W. Hubbard.

HARDINGE CO.—Hardinge conical ball and pebble mills for metallurgical, chemical and industrial crushing and grinding, either wet or dry. In charge of exhibit: W. H. Baker, R. B. T. Killiani, Harlowe Hardinge, James G. Parmelee, G. F. Metz and S. R. Swain.

HAUSER-STANDER TANK CO.—Tank of red gulf cypress lined with chemical lead with joints burnt in by hand; vacuum filter tank of long leaf yellow pine; methods of construction of wooden tanks. In charge of exhibit: S. Hauser, Jr. and D. B. Dorfan.

HAYNES STELLITE CO.

HAYS, JOSEPH W., CORP.

HAYWARD, S. F., & CO.

HEPWORTH, S. S., CO.—Mackintosh electrically-driven centrifugal in operation. In charge of exhibit: C. A. Olcott, E. Foster Babbitt and George Fred Brindley.

HERCULES ENGINEERING CORP.

HERCULES POWDER CO.—Dummy explosives, soluble cotton wet with water and soluble cotton solutions; naval stores. In charge of exhibit: W. M. Annette and G. C. O'Brien.

HEROLD CHINA & POTTERY CO.—Complete line of chemical and scientific porcelain ware. In charge of exhibit: H. F. Coors.

HEYL LABS. INC.

HEYDEN CHEM. CO OF AMERICA

HOOKER ELECTROCHEMICAL CO.

HOSKINS MANUFACTURING CO.—Electric laboratory and tool furnaces, indicating and recording pyrometers and chromel heat-resistant castings. In charge of exhibit: W. D. Little, Charles S. Kinnison, F. L. Zimmerman, A. L. Malmstrom and J. E. Hines.

HOYT METAL CO.

HUFF ELECTROSTATIC SEPARATOR CO.—Operating exhibit of the Huff electrostatic separator and Olumb pneumatic jig. A special feature of the exhibit will be the separation of ash and sulphur from coal.

HUNTER DRY KILN CO.

HUYCK, F. C., & SONS—Woolen filter cloth. In charge of exhibit: D. A. MacInnes, E. A. Rees and A. V. Wright.

HYDROCARBON CHEMICAL CO.

IDEAL STENCIL MACHINE CO.

IMPERIAL DYEWOOD CORP.

INDEPENDENT CHEM. CO.

INDUSTRIAL ELECTRIC FURNACE CO.—New type of electric melting furnace for operation on a 220-volt d.c. motor circuit. In charge of exhibit: F. von Schlegell, W. B. Cooley, L. C. H. Groeger and W. B. Lewis.

INDUSTRIAL FILTRATION CORP.—Zenith continuous rotary filter, Zenith continuous rotary hopper dewaterer and Zenith open-tank type filter. The Zenith rotary filter will be in operation in connection with a complete filtration unit for this type of apparatus. In charge of exhibit: William H. Harding, G. D. Dickey, H. W. Conrad and A. W. Wright.

INNIS SPEIDEN & CO, INC.

INTERNATIONAL CARBON PRODUCTS CO.—Graphite and graphite products which have been electrically refined by the Huff electrostatic process.

INTERNATIONAL COOPERAGE CO.

INTERNATIONAL NICKEL CO.—Monel metal, natural nickel alloy, resisting alkalis, most acids, superheated steam, high temperatures and corrosion. In charge of exhibit: E. S. Wheeler, T. H. Dauchy and F. H. Waycott.

INTERNATIONAL SALT CO. OF NEW YORK—Salt in all grades. In charge of exhibit: H. J. Osborn.

IRVING IRON WORKS CO.—Irving-subway metallic flooring and safstep. In charge of exhibit: W. E. Irving, P. L. Price, H. H. Schuldt, A. S. Kennedy and W. H. Lown.

JEWELL POLAR CO.—Water-distilling apparatus, operated by steam, gas and electricity. In charge of exhibit: A. C. Jewell, J. E. Bloeser and P. M. Marks.

JOPLIN WHITING CO.

KALBFLEISCH CORPORATION—General line of mineral acids, some of the allied salts and products particularly interesting to paper manufacturers. In charge of exhibit: A. C. Kalbfleisch, V. P. Davis and C. L. Hutzelman.

KENART SYNTHETIC PRODUCTS CO.

KEWAUNEE MFG. CO.

KING CHEMICAL CO.

KLIPSTEIN, A., & CO.

KNIGHT, MAURICE A.—Acid-proof chemical stoneware apparatus, selected to convey a good idea of the use of this material in chemical industry. In charge of exhibit: Maurice A. Knight, Charles Dennison, Samuel J. Baril and Newton D. Whipple.

KNOXVILLE BOARD OF COMMERCE—Natural raw materials in vicinity of Knoxville, suitable for use in electrochemical and electrometallurgical industries. In charge of exhibit: Harry Clark, John A. Switzer, Walter McIntyre, H. A. Morgan, M. F. Nichols, Charles A. Weller, J. N. Newman and W. R. Pouder.

KOPPERS CO.—Sectional model of Koppers triangular-flued combination coke and gas ovens; photographs of byproduct coke and gas plants. In charge of exhibit: E. L. Crowe and C. R. Meissner.

LAKEWOOD ENGINEERING CO.

LAMIE CHEMICAL CO, INC.—Dyes and chemicals. The feature of the exhibit will be Flaming Red, a new dyestuff used in the paper and silk industry. In charge of exhibit: K. E. Schlossingk.

LAMMERT & MANN CO.—Lammert rotary vacuum pumps, for vacuum or pressure. In charge of exhibit: A. L. Eisenbies, Donald Rosie and R. F. Lammert.

LAUREL SOAP MANUFACTURING CO.—Textile soaps, sizing and finishing material.

LEAD LINED IRON PIPE CO.—Galvanized lead-lined iron pipe, flanged lead-lined valves and fittings, screwed lead-lined fittings, tin-lined iron pipe and fittings. In charge of exhibit: Daniel H. Regan and Frank H. DuBois.

LEEDS & NORTHRUP CO.—Electrical measuring instruments for chemical and metallurgical processes. Features of the exhibit will be: equipment for demonstrating the Hump method for heat treatment of steel; optical and thermocouple pyrometers, including equipment for automatic recording, signaling and control; outfit for electrometric determination of hydrogen ion concentrations; recording and controlling Wheatstone bridge for electrolytic conductivity work; automatic recording and controlling potentiometer for regulating amount of reagent added in an acid-alkaline reaction. Most of the exhibits will be in actual operation. In charge of exhibit: Paul E. Klopsteg, A. M. Redding, I. M. Stein, R. D. Milner, George W. Tall, Jr., G. H. English and E. B. Estabrook.

LIBERTY BY-PRODUCTS WORKS, INC.—Compounds of antimony and chromium; lactolin, soaps and oils. In charge of exhibit: E. A. F. Zillessen, E. J. Zillessen, W. H. Zillessen, August Naab, Jr., A. Washington and P. B. Meerbott.

LINDSAY LIGHT CO.—Display of salts of the rare earths. In charge of exhibit: Dr. McCoy, A. Sinai and Otto N. Berndt.

LIQUID CARBONIC CO.

LOOMIS-MANNING FILTER DISTRIBUTING CO.—Standard filters and a filter in section showing interior construction and details; glass working model showing operation. In charge of exhibit: George H. Powell.

LUNGMOTOR CO.—The Lungmotor for resuscitation in cases of apparent drowning, asphyxiation, electric shock, narcotic poisoning, strangulation and collapse during anaesthesia. In charge of exhibit: L. D. Jones and Max Jacobsen.

LUNKENHEIMER CO.—Valves in bronze, iron and cast steel suitable for various operating conditions and for pressures up to 350 lb. per sq.in. and a temperature of 800 deg.; engineering specialties.

LUZERNE RUBBER CO.—Hard rubber pipe, fittings, buckets, and special parts for the chemical industry. In charge of exhibit: H. E. Case.

MAAS & WALDSTEIN CO.—Wood and metal work showing applications of clear lacquer and lacquer enamel finishes; lacquer and lacquer enamels in glass containers. In charge of exhibit: Harry C. Flannigan.

MAGNESIA ASSOCIATION OF AMERICA—Samples of different kinds of 85 per cent magnesia; diagrammatic chart showing

manufacture in process; miniature samples of 85 per cent magnesia products. In charge of exhibit: C. J. Stover, G. S. Stuart.

MAGNETIC MANUFACTURING CO.—Demonstration of a laboratory-size high-intensity magnetic separator for such ores and minerals as may be offered for treatment. In charge of exhibit: J. P. Bethke.

MANN & COOK.

MATHIESON ALKALI WORKS, INC.—Caustic soda, soda ash, Virginia soda, bicarbonate of soda, bleaching powder, liquid chlorine, chlorine solvents; materials produced from these products. In charge of exhibit: John A. Kienle, John W. Boyer and G. N. Davis.

MEAD & CO.—Mead mills, featuring a laboratory mill. In charge of exhibit: Paul O. Abbe.

MERCK & CO.—Medicinal chemicals and blue label reagent chemicals.

MERRILL CO.—Merco Nordstrom plug valve. In charge of exhibit: C. C. Broadwater, L. D. Mills, F. H. Ricker, H. P. MacGregor and S. J. Nordstrom.

METALS DISINTEGRATING CO., INC.—Zinc dust, lead dust, tin dust, copper dust, litharge. In charge of exhibit: S. G. Schatzberg.

MIDLAND CHEMICAL CO.

MIDWEST ENGINE CO.—In charge of exhibit: F. L. Atwood, D. I. Smith, R. C. Palmer, G. A. Drysdale.

MINE & SMELTER SUPPLY CO.—Wilfley concentrating table, Ruth flotation machine, Dourte valveless pump in operation; Samson laboratory jaw crusher, McCool pulverizer, Heusser balances. In charge of exhibit: E. S. Tompkins and J. C. Beam.

MINER-EDGAR CO.—Cotton solutions for coating split and artificial leathers; solvents for cotton and celluloid; wood alcohol, acetone, methyl acetone; prepared clays for paper and paint manufacturers. In charge of exhibit: Rolland H. French, J. J. Smith, Charles H. Zeiger, George N. Bick, John W. Johnson.

MINE SAFETY APPLIANCE CO.

MINERAL POINT ZINC CO.

MOBILE & OHIO RAILROAD CO.

MOJONNIER BROS. CO.

MONARCH MANUFACTURING WORKS, INC.—Brass, iron, hard rubber and stoneware sprays, for use in sulphuric acid manufacturing plants; lead valves; lead siphons; oil burners, and an automatic acid elevator, which when attached to existing acid eggs elevates acid to any desired height automatically.

MONEL METAL PRODUCTS CORP.—In booth with International Nickel Co., showing monel metal. In charge of exhibit: H. F. Chase and H. A. Cooper.

MONO CORP. OF AMERICA—Automatic recording instruments for analyzing CO_2, CO, SO_2; recorder for oxygen and hydrogen. In charge of exhibit: F. D. Harger and Olaf Rodhe.

MORSE CHAIN CO.—Samples of chains, showing the Morse rocker joint, from ½ in. pitch to 3 in. pitch and in several widths illustrating the chain as used for ½ hp. to 5,000 hp. In charge of exhibit: T. G. Anderson, H. W. Evans, A. B. Wray, V. D. Morse, J. S. White, E. R. Morse and H. M. Rodda.

MOTT, J. L., IRON WORKS.

MULTI METAL CO., INC. New U. S. standard sieve series; wire cloth screens and filter cloth in unusual weaves, meshes and metals. In charge of exhibit: Siegfried Stern, Frederick Stern, Selmar Pullman and Louis Dresner.

NASH ENGINEERING CO.—Hytor compressors and vacuum pumps in operation; Jennings pump, motor and turbine driven, for handling combinations of liquid and gas. In charge of exhibit: Irving C. Jennings, H. M. Wylie and G. B. Wright.

NASSAU VALVE & PUMP CORP.—Chemetal acid-resisting valve and centrifugal pumps. In charge of exhibit; A. T. Haviland, E. J. Walsh, H. C. Evans and C. Schmitt.

NATIONAL ANILINE & CHEMICAL CO.—Scene of wax figures costumed in the latest modes and artistically grouped on the piazza of a country house. All the materials used in this scene will be dyed with the "National" colors. The central setting will be flanked on either side by exhibits of the company's technical products.

NATIONAL BINDING MACHINE CO.

NATIONAL FILTER CLOTH & WEAVING CO.

NATIONAL GUM & MICA CO.—Pulp and other colors; permasol marking ink, crayons, etc.; synthetic perfume bases; adhesives. In charge of exhibit: Messrs. Alexandre, Namy, Harris, Adrizonne and N. A. McManus.

NATIONAL LAMP WORKS.

NELSON, ALFRED W.

NEWARK WIRE CLOTH CO.—Wire and wire cloth, chemists' testing screens, monel metal filter cloth; loom for weaving in operation. In charge of exhibit: A. A. Campbell and E. C. Nichols.

NEW ENGLAND TANK & TOWER CO.

NEW JERSEY ZINC CO.—Flow sheet showing developing of zinc ore into finished products; display of zinc products and descriptive literature. In charge of exhibit: W. Homer Hendricks and S. T. Ballinger.

NEWPORT CHEMICAL WORKS, INC.

N. Y. COLOR & CHEMICAL CO.—Dyes and colors for the textile, paper, leather and lake trades. In charge of exhibit: Messrs. Williams, Jacquith, Taylor, Carter, Richmond, Staneck and Wardlaw.

NEW YORK CONTAINER CO., INC.

NIAGARA ALKALI CO.—Caustic potash, caustic soda, bleach powder, permanganate of potash and muriatic acid.

NIAGARA ELECTRO CHEMICAL CO.

NICHOLS COPPER CO.

NITROGEN PRODUCTS CORP.—In charge of exhibit: J. C. Clancy and A. Nagelvoort.

NITRO PRODUCTS CO.—H acid. In charge of exhibit: W. H. Van Winckel and H. D. Wellmann.

NORTHWESTERN CHEMICAL CO.—Organic esters, salts and acids; synthetic flavoring materials. In charge of exhibit: Robert L. Wilson and Henry J. Beck.

NORTON CO.—Representative shapes of laboratory ware and larger refractories made from alundum and crystolon; grinding wheels and abrasive grain; electrically fused magnesia. In charge of exhibit: C. W. Saxe and R. Kirkpatrick.

OBERMAYER, S., CO. Hott-Patch furnace cement for power and chemical plants. A small electric furnace will be used for demonstration of the product. In charge of exhibit: E. D. Frohman, John L. Cummings, H. E. Beckman and J. M. Hildebrand.

OLIVER CONTINUOUS FILTER CO.—A small size Oliver continuous filter in operation. In charge of exhibit: R. G. Walker, H. A. Morrison, P. M. Depp and W. A. V. Thomsen.

ONTARIO DEPARTMENT OF MINES—Representative ores and minerals from the province of Ontario, with special attention to gold, silver and nickel-copper. Smelter and refinery products will also be shown. In charge of exhibit: W. K. McNeill and W. R. Rogers.

ORGANIC SALT & ACID CO.—Salicylic acid, sodium salicylate, salol, methyl salicylate, acetyl salicylic acid, and other salicylates. In charge of exhibit: Karl Kolbe.

OXYGEN PRODUCTS CO.

OZONE CO. OF AMERICA—Apparatus showing the application of ozone to the purification of water and to the bleaching and deodorizing of liquids for industrial purposes; household ozone water purifier; ozone air ventilators; industrial and therapeutic uses of ozone. In charge of exhibit: William J. Eberle and C. O. Riedel.

PALO CO.—Laboratory supplies and apparatus; filter paper, automatic water stills, Goerz polariscopes, Zeiss microscopes and refractometers, Meker furnaces and burners, Hess-Ives tint photometer, rhotanium. In charge of exhibit: L. A. Phluger and M. J. Seavy.

PARKS-CRAMER CO.—Completely assembled Merrill process system of fluid heat transmission, available for easy inspection; principal parts of the Cramer air-conditioning system. In charge of exhibit: Albert W. Thompson, Alexander B. McKechnie, Thayer Francis and Frank G. Bell, Jr.

PAYNE, STEPHEN T.

PENNSYLVANIA SALT MANUFACTURING CO.—Mineral acids, alums, alumina, lye, gas purifiers, caustic soda and soda products, sulphate of alumina for paper and color making, filtration, dyeing and tanning, chloride of lime, liquid chlorine, chloride of alumina, aluminate of soda and zirconia, Greenland kryolith. In charge of exhibit: Messrs. Hutchinson and James.

PERMUTIT CO.—Demonstrating outfits of Permutit water softeners and filters; photographs and drawings of commercial-size apparatus. In charge of exhibit: A. T. Smith, R. W. Epple, M. F. Corin, J. S. Shedden and C. L. Boyd.

PERRY & WEBSTER, INC.—Consulting and designing engineers, formerly Kalbperry Corp., specializing in design of chemical plants; photographs of varnish plants, using new system of fume recovery. In charge of exhibit: Robert S. Perry, Paul W. Webster and Vern K. Boynton.

PERTH AMBOY CHEMICAL WORKS.

PETERSON, LEONARD, & CO.—Laboratory furniture for industrial laboratories and educational institutions.

PFAUDLER CO.—Acid-resisting fittings for use with the company's glass-enameled steel equipment; glass-enameled steel products. In charge of exhibit: P. S. Barnes, J. A. Cowles, R. L. Jacobs and T. D. Wilson.

PHILADELPHIA DRYING MACHINERY CO.—Three types of driers: Cabinet tray, tunnel truck tray and continuous apron. In charge of exhibit: B. P. Webster.

PHILADELPHIA QUARTZ CO.—Silicate of soda in its various forms, and its application in industry. In charge of exhibit: John D. Carter, C. F. Wolcott, W. H. Buxton, George W. Wait and R. C. Brown.

PITTSBURGH-DES MOINES STEEL CO.

PNEUMERCATOR CO., INC.—Various models of liquid measuring devices. In charge of exhibit: H. S. Parks and William Thomas.

PNEUMATIC SALES CORP., LTD

PORETE MFG. CO.

POWER SPECIALTY CO—Uses of superheated steam in the chemical industry and the special developments of the Foster superheater for chemical manufacturers.

POWERS REGULATOR CO.—Automatic temperature regulators for hot water tanks, dyeing and bleaching machines; automatic water mixers, steam and water mixers, steam pressure reducing valves and other automatic temperature control apparatus. In charge of exhibit: H. W. Feige, F. A. Murray and O. F. Weilbacker.

POWHATAN MINING CO.—Exhibit of Powminco asbestos filter fiber; demonstration showing uses of product in the laboratory. In charge of exhibit: Fred A. Mett.

PRATT ENGINEERING & MACHINE CO

PRECISION INSTRUMENT CO.—CO_2 and SO_2 recorders; single, 2 in 1 and 3 in 1 recorders; gas meters, gravitometers and calorgraphs; single, 2 in 1, 3 in 1, 4 in 1 and 5 in 1 gages, flue gas analyzers and micrometer gages.

PROCTER & GAMBLE DISTRIBUTING CO.—Industrial soap, glycerine, stearic acid, red oil, pichene and stearine pitch. In charge of exhibit: T. E. Watters, H. G. Werner, J. D. O'Farrell, J. D. Cochrane, L. C. Minor and J. O. Pierce.

PROCTOR & SCHWARTZ, INC—Proctor 12-tray laboratory drier; models of Proctor 3-conveyor drier for cotton, hair, wool, etc., and of Proctor 3-truck drier for chemicals, colors, etc.; samples of chemicals, colors, etc., dried in Proctor driers; projectiscope in operation showing Proctor drier installations. In charge of exhibit: E. B. Ayres, H. S. Landell, D. D. Hollenbaugh, E. A. Hults, C. W. Schwartz, 3d, S. Rhoads and Mrs. A. E. Reiter.

PROTECTO SAFETY APPLIANCE CO.

PROVOST ENGINEERING CORP.—Mixing machinery. In charge of exhibit: C. A. Beach.

PYROLECTRIC INSTRUMENT CO.—Pyrometric and electrical precision instruments, including Northrup pyrovolter, Compton electrometer, galvanometers, etc. A new type of resistance box and several other new instruments will be shown for the first time. In charge of exhibit: W. C. Harter and Harry L. Saums.

QUIGLEY FURNACE SPECIALTIES CO—Furnace refractories; hytempite, for bonding firebrick and granular refractories; carbosand for furnace linings and repairs; insulbrix, for insulating furnace walls; heat-treating and powdered coal equipment. In charge of exhibit: W. S. Quigley, H. A. Kimber, J. H. McPadden, W. O. Renkin, F. W. Reisman, H. H. Harris, P. F. McGovern and C. Gantzman.

RARITAN ANILINE WORKS.—Aniline oil. In charge of exhibit: W. H. Van Winckel, H. D. Wellman and A. B. Hamby.

RARITAN COPPER WORKS—With Anaconda Copper Mining Co.

RAYMOND BROS IMPACT PULVERIZER CO.—Quarter-size models of the principal types of pulverizing machines in operation. In charge of exhibit: C. M. Lauritzen, F. I. Raymond, Joe Crites, S. B. Kanowitz and W. M. Cook.

RAYMOND LEAD WORKS.

REFINITE CO.

REPUBLIC FLOW METERS CO.—Steam, water, air and gas flow meters; low differential gas meter, Gebhardt portable indicating steam meter, CO_2 recorders, orifices and Pitot tubes. In charge of exhibit: T. A. Curran and George S. Hendrickson.

RESEARCH CORP.

REVOLVATOR CO—Revolving and non-revolving, hand-power and motor-driven revolvators.

RHODIA CHEMICAL CO.

RICHARDS CO.

ROBERTSON HAMES LEAD WORKS.

ROBINSON, DWIGHT P., & CO, INC.

ROESSLER & HASSLACHER CHEMICAL CO, LTD.—Chloroform, cyanide, metal cyanides, trisalyts, formaldehyde, hexamethylenetetramide, antimony salts, soda prussiate, metallic sodium and sodium peroxide, supplemented by a general line of chemicals. The special feature of this exhibit will be methyl chloride. In charge of exhibit: Herbert Gillis.

ROLLIN CHEMICAL CORP.—Barium, sodium and chlorine products. In charge of exhibit: J. G. Harrison.

ROTO CO.

RUGGLES-COLES ENGINEERING CO—Model of drier and photographs of the installations. In charge of the exhibit: F. E. Finch, J. K. Towers and W. H. Glomb.

SARCO CO., INC.—Steam traps, radiator traps, temperature control apparatus, recording gas calorimeters and CO_2 recorders. In charge of exhibit: E. J. Ritcher, G. W. Bergen and others.

SCHAAR & CO.—Complete line of American-made laboratory apparatus and supplies; Schaar analytical balances. In charge of exhibit: A. E. Schaar and E. W. Ohman.

SCHAEFFER & BUDENBERG.—Recording thermometers and gages; a new type of thermometer not hitherto shown. In charge of exhibit: H. V. Carlier, F. Undeutsch and A. Campbell.

SCHWARTZ SECTIONAL SYSTEM.—Sectional filing cabinets for chemicals, reagents, samples and specimens; Schwartz auxiliary desk and chemistry desk. In charge of exhibit: M. P. Schwartz.

SCIENTIFIC EQUIPMENT CO—Representative line of American-made laboratory furniture and apparatus, as manufactured and sold by the Kewaunee Manufacturing Co. and the Central Scientific Co. In charge of exhibit: J. M. Roberts, S. L. Redman, A. B. Carter, Charles G. Campbell, O. T. Louis, R. S. Blodgett and Charles Ress.

SCOTT, ERNEST, & CO.—Photographs of machinery and apparatus installed by the company for the extraction of oils from nuts, seeds, tankage, fish waste; photographs of Scott evaporator for recovery of glycerine, caustic soda, paper pulp spent liquors, etc.; photographs of vacuum driers; plants for manufacture of ammonia, distilling fatty acids, manufacture of glycol and glycerine. In charge of exhibit: H. Austin, R. W. MacGregor and C. E. Bradley.

SCOTT, HENRY L., & CO.

SEMET-SOLVAY CO.

SEYDEL MFG CO—Benzoates for medicinal use; furamine dyes. In charge of exhibit: Edmund E. Smith.

SEYMOUR & PECK CO—Wooden shipping drums for dry chemicals. In charge of exhibit: C. B. Arnold.

SHARPLES SPECIALTY CO—Models of laboratory and commercial super-centrifuges. In charge of exhibit: Max B. Miller, Aldus Wilbur and Homer Cloukey.

SHAWINIGAN ELECTROMETALS CO

SHAWINIGAN PRODUCTS CO.

SHAWINIGAN WATER & POWER CO.

SHERWIN-WILLIAMS CO

SIDIO CO. OF AMERICA, INC.—Complete line of fused silica ware made in America, for laboratory and industrial purposes. In charge of exhibit: Francis H. Ruhe, Walter J. Fensterer, and G. H. Mueller.

SIMMONS, JOHN, CO.

SLY, W. W., MFG. CO—Operating unit of a dust-collecting, reclaiming and air-purifying system. In charge of exhibit: D. E. Hadley, E. J. Moore and M. M. Lowrie.

SOLVAY PROCESS CO

SOUTHERN COTTON OIL CO.

SOUTHERN OIL & CHEMICAL CO

SOUTHERN RAILWAY SYSTEM.

SOWERS MFG CO.—Operating exhibit consisting of Dopp seamless steam jacketed mixing kettles with different styles of agitators; Dopp seamless jacketed kettle arranged for oil heating; Dopp laboratory vacuum pan. In charge of exhibit: R. C. Boggess and others.

SPARKS, JOHN C.

STAMFORD DYEWOOD CO.

STAUFFER CHEMICAL CO.

STEIN, HALL & CO, INC—Starches, gums and dextrines. In charge of exhibit: L. W. Peabody.

STERLING CHEMICAL CO.

STICHT, HERMAN A., CO.

STIMPSON EQUIPMENT CO.—Mitchell electric vibrating screen and miniature Janney flotation machine. In charge of exhibit: C. W. Stimpson, J. E. Klein and J. A. Lane.

STOKES, F. J., MACHINE CO.—Stokes rotary tablet machine in operation making naphthaline balls; powder filling machine in operation; rotary vacuum drier, laboratory

shelf vacuum drier, copper vacuum still, vertical surface condenser, automatic water still. In charge of exhibit: L. H. Bailey and C. F. Coleman.

STURTEVANT MILL CO.—Open-door ring roll mill, swing sledge mill and steel elevator; consultation on problems of crushing, grinding, pulverizing, screening, mixing, elevating, and conveying. In charge of exhibit: L. H. Sturtevant, W. T. Doyle and H. A. Tomlinson.

SULLIVAN MACHINERY CO.—Operating model of air-lift pump showing the application of the air-lift principle to the pumping of liquids. In charge of exhibit: John Oliphant, L. R. Chadwick and L. E. Gilbert.

SUNBEAM CHEMICAL CO.

SWENSON EVAPORATOR CO.—Two experimental size evaporators. In charge of exhibit: F. M. deBeers, P. B. Sadtler, G. Gordon Urquhart and F. F. Mackentepe.

TABER PUMP CO.

TAGLIABUE, C. J., MFG. CO.—Witham controllers for maintaining uniform temperature in paper machine driers; P & W condensate controller and liquid level controller. In charge of exhibit: Messrs. White, Dooling, Traudt, Dougherty and Wichum.

TAKAMINE COMMERCIAL CORPORATION.

TAKAMINE LABORATORY, INC.—Chemicals: arsaminol, neo-arsaminol, merpotide, merposal, boro tetramine, silver nucleinate, tuyol, hirathiol. In charge of exhibit: Jokichi Takamine, Jr.

TANNER, CHARLES S., CO.—Polyzime, for de-gumming and de-sizing in the textile industry. In charge of exhibit: C. Milton Tanner and William S. Newell.

TAYLOR INSTRUMENT CO.

TECHNICAL PRODUCTS CORP., INC.

TEXAS GULF SULPHUR CO.—In charge of exhibit: A. S. Cosler.

THATCHER PROCESS CO.—Anthraquinone. In charge of exhibit: W. H. Van Winckel, H. D. Wellman and B. Ives Cooper.

THERMAL SYNDICATE, LTD.—Vitreosil, fused pure silica, for acid concentration, cooling and condensation; glazed vitreosil laboratory apparatus; transparent vitreosil tubing and utensils. In charge of exhibit: W. E. Strevig, S. L. Tyler and W. W. Winship.

THERMO ELECTRIC INSTRUMENT CO.—Freas and Thelco constant temperature ovens, incubators and other apparatus for laboratory use. In charge of exhibit: Royal B. Freas, Joseph LaMar and Edwin G. Price.

THOMAS, ARTHUR H., CO.—Laboratory apparatus and supplies. In charge of exhibit: R. M. Miller, H. C. Roak and C. C. Roberts.

THWING INSTRUMENT CO.—Temperature recording and indicating apparatus and some new paper testing instruments. In charge of exhibit: C. B. Thwing, E. J. Albert, H. K. Walton, J. H. Torrey and A. S. Hall.

TITANIUM ALLOY MFG. CO.—Ferro-carbon-titanium; opax, commercial zirconium oxide, for use in the manufacture of enameled ware and terra cotta; samples of material in which opax has been used. In charge of exhibit: William J. Evans and William V. Knowles.

TITANIUM PIGMENT CO.—Titanox pigments and various samples of paint, enamels, rubber, oil cloth, wall paper and printing ink in which these pigments have been used. In charge of exhibit: L. E. Barton and C. J. Kinzie.

T. M. & G. CHEMICAL CO.—Diethyl aniline. In charge of exhibit: W. H. Van Winckel, H. D. Wellman and William B. Whitmore.

TOLHURST MACHINE WORKS.—Operating demonstration of a new type of motor-driven suspended centrifugal machine suitable for heavy service in industrial chemical plants; open-top center slung centrifugal; standard self-balancing centrifugal with griddle bottom discharge; solid curb centrifugal with rubber-lined case and rubber covered basket; laboratory centrifugals. In charge of exhibit: W. C. Dutton, T. A. Bryson, John S. Gage, T. M. Stuart, B. M. Pilhashy and R. K. Cheney.

TYLER, W. C., CO.

UEHLING INSTRUMENT CO.—New CO_2 recording instrument for continuous measurement of percentage of CO_2; Uehling pneumatic pyrometer, draft gages and recorders, draft analyzers, pressure gages and recorders. In charge of exhibit: F. F. Uehling, C. J. Schmid, C. C. Phelps, and Wm. J. Reilly.

UNIFORM CHEMICAL PRODUCTS CO., INC.—Benzidine base. In charge of exhibit: W. H. Van Winckel, H. D. Wellman and C. S. Cooley.

UNION STEAM PUMP CO.—Complete pumping equipment for the chemical industry; vacuum and pressure pumps, steam, belt and motor driven. In charge of exhibit: R. W. Friedman, E. P. Ordway and K. D. Smith.

UNION SULPHUR CO.—In charge of exhibit: W. N. Wilkinson.

UNITED FILTERS CORP.—Working model of an American filter; Sweetland and United filter presses and samples of filter press plates and cloths.

UNITED LEAD CO.—Chemical lead-lined pipe fittings, valves, tanks; chemical lead-covered coils; hard lead centrifugal acid pumps. In charge of exhibit; C. B. Holden, G. H. Checkley, J. W. Spotten, C. R. Andrews, H. Freiherr and H. F. Hempel.

UNITED METALS SELLING CO.

UNITED STATES CAST IRON PIPE & FOUNDRY CO.—Barometric counter-current condenser in section with descriptive diagrams of operation; samples of casting for chemical and sugar industry; cast-iron flanged pipe. In charge of exhibit: H. A. Hoffer, J. D. Capron and C. D. Donaldson.

U. S. INDUSTRIAL ALCOHOL CO.—Photographs showing operation of plant; samples representing different stages in the manufacture of alcohol from crude molasses. Copies for distribution of chart showing uses of alcohol; new motor fuel "Alcogas." In charge of exhibit: B. R. Tunison.

UNITED STATES INDUSTRIAL CHEMICAL CO.—New chemical products, some of which have been manufactured in the United States during the past year for the first time. In charge of exhibit: B. R. Tunison.

U. S. SMELTING FURNACE CO.

UNIVERSAL ANILINE DYES & CHEMICAL CO.—Direct colors. In charge of exhibit: Stephen H. Eller.

UNIVERSAL OIL CO.

VALLEY IRON WORKS.—Autoclaves and sulphonators in laboratory and semi-commercial sizes. In charge of exhibit: Messrs. Senior, Mills and Jacobs.

VAN NOSTRAND, D., & CO.

VAN WINCKEL, W. H.—Aniline oil, aniline salt, thiocarbanilid, diethylaniline, H-acid, benzidine base. In charge of exhibit: W. H. Van Winckel and H. D. Wellman.

VITREOUS ENAMELING CO.

VULCAN DETINNING CO.

WAILES DOVE-HERMISTON CORP.—Bituminous protective coatings and bituminous paints. In charge of exhibit: Willard T. Chevalier.

WALLACE & TIERNAN CO., INC.—Special chlorine control apparatus for use in bleaching paper and textiles, deodorizing, oxidizing and other chemical purposes; chlorine control apparatus for sterilizing water supply, sanitation of swimming pools and disinfection of sewage; valves, gages and flow meters for handling corrosive materials. In charge of exhibit: M. F. Tiernan, Wm. J. Orchard, L. H. Goebel, R. V. Donnelly and H. D. Thompson.

WARNER CHEMICAL CO.—Nelson electrolytic cell. In charge of exhibit: William B. Thom, John A. Chew and S. C. Mastick.

WERNER & PFLEIDERER.—Kneading and mixing machines adapted to the chemical industry; laboratory-size mixers in operation; large-size steam jacketed machine; photographs of large installations. In charge of exhibit: A. J. Vollrath, J. C. Caley, S. D. Gridley and Miss E. Ziegler.

WESTINGHOUSE, CHURCH, KERR, INC.

WESTINGHOUSE ELECTRIC & MFG. CO.—A.c. and d.c. specially impregnated motors, arc furnace regulating and control panels, industrial heating appliances, starting switches, control switches, etc. In charge of exhibit: C. B. Gibson, C. G. Schluederberg and G. H. Jaspert.

WHEELER, C. H., MFG. CO.—Radojet air pump model, showing the inside; single and double stage radojet air pumps; duplex condensate pump; automatic steam pressure and temperature regulators. In charge of exhibit: G. L. Korthing and Charles Lang.

WHITALL TATUM CO.—Nonsol chemical glassware. In charge of exhibit: W. W. Figgis.

WHITLOCK COIL PIPE CO.—Special apparatus for heating water for use in chemical and industrial plants; coils of iron and steel pipe and copper tubing for use in chemical processes. In charge of exhibit: W. H. Ripley, E. B. Cole, S. T. Green, W. A. Evans and C. I. Babcock.

WIDNEY TEST LABS.

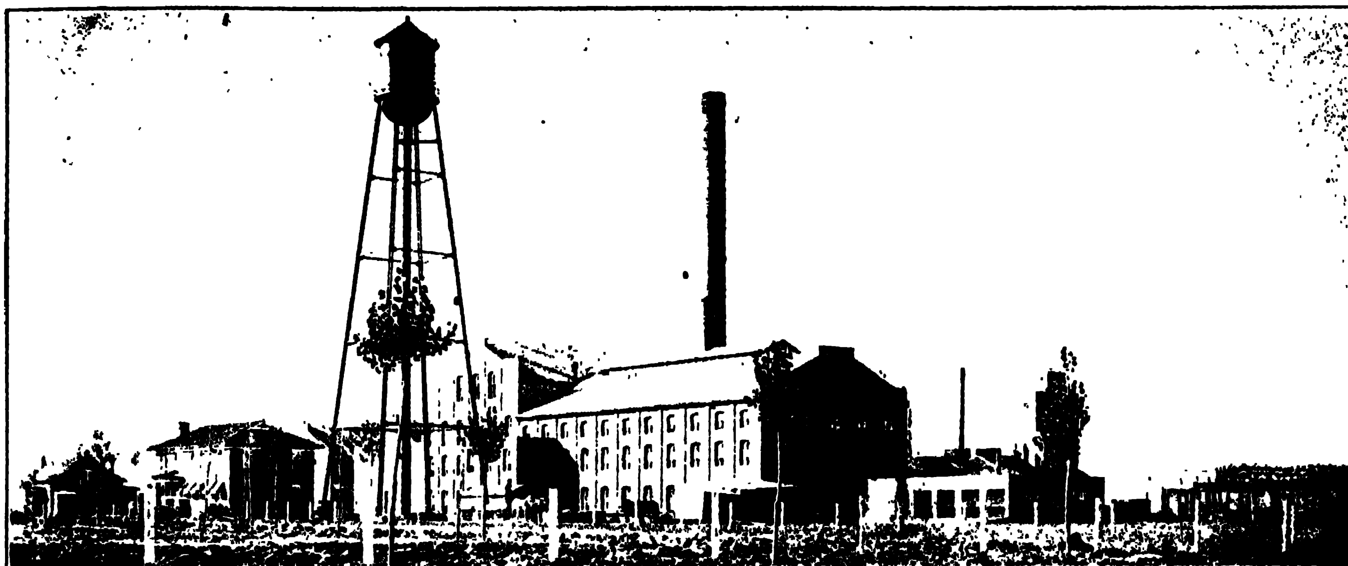
WILLSON GOGGLES, INC.

WOLF, JACQUES, & CO.—Sulphonated oils, softeners and finishing preparations; specialties for the textile trade; hydrosulphites. In charge of exhibit: Alfred Pfister, and Messrs. Deuble, Goss, Henckel, McDonagh, Griffith, Royce and Desmond.

WORTHINGTON PUMP & MACHINERY CORP.

ZAPON LEATHER CLOTH CO.

ZAREMBA CO.—Large-size photographs illustrating characteristic Zaremba evaporator installations. In charge of exhibit: H. E. Jacoby and W. H. Eggert.



Chemical Problems of the Beet Sugar Industry

Attainment of Greater Yields of Sucrose by Better Beet Culture and Improved Refining Processes Possible—Byproducts From Molasses: Potassium Carbonate and Sulphate, Methylamines, Cyanides, Methyl Alcohol, Ammonia and Bleaching Carbon

By H. W. DAHLBERG*

THE chemical and chemical engineering problems in connection with the manufacture of beet sugar are many and varied in character. The extraction of sugar from the sugar beet involves the separation of sucrose from the organic and inorganic impurities with which it occurs in the beet. Since these impurities include all the soluble salts of the soil as well as a large number of vegetable acids and their salts formed during the growth of the beet, the process of sugar manufacture consists of the necessary steps to eliminate these non-sugars and obtain sucrose, $C_{12}H_{22}O_{11}$, in a pure form.

The average sugar beet has the following approximate composition:

	Per Cent		Per Cent
Sugar	16 00	Ash	0.80 to 1.00
Water	77 00	Organic non sugars	1.00 to 1.50
Marc	5 00		

The sugar content and purity of the beet varies considerably with the soil and with climatic conditions. By "purity" we mean the percentage of sugar contained in the total dry substance of the juice from the beet. The purity may vary from 80 to 88 per cent and the sugar content from 11 to 20 per cent or even higher. Beets of the highest sugar content and purity are, of course, the most desirable, as the yield of sugar obtained from such beets is high. A great deal of study has therefore been given to developing strains of beet seed which will produce beets of the desired quality. The fact that the present sugar beet containing 16 to 20 per cent sugar has been developed by breeding and selection from a small, wild beet containing practically no sugar indicates the progress that has been made.

*Research Manager, Great Western Sugar Co.

The process by which sugar is obtained from sugar beets is briefly as follows: The beets are washed, weighed, and sliced, and the slices are treated with hot water in a series of tanks called a diffusion battery. During successive washings the sugar contained in the cells of the beet diffuses through the cell walls and is dissolved in the water, forming "diffusion juice," which is a dilute sugar solution of about 85 purity and containing about 12 per cent sugar. The diffusion juice is purified by successive treatments with lime, carbon dioxide and sulphur dioxide, filtered, evaporated to a sirup and then boiled until sugar crystallizes out. The final products obtained are pure granulated sugar and the byproduct molasses. The latter will be discussed more fully below.

The mineral salts present in the beet are very largely soda and potash, combined with organic and inorganic acids. As they are very soluble and are carried on through the process without much elimination, they are the most harmful of all the impurities. Each part of mineral non-sugar carries with it from 1½ to 3 parts of sugar into the molasses, a byproduct from which no more sugar can be crystallized due to the concentration of impurities. For this reason it is highly desirable to grow the beets in soils and under such fertilizing conditions that a minimum of mineral salts is contained in the beet.

As an example, sugar beets grown in Germany contain approximately one-half as much ash as those grown in the United States, due to soil less rich in soluble salts and a more careful application and control of fertilizers. The result is that the yield of sugar is higher and the amount of molasses produced is much less than in our practice. It must be recog-

nized, of course, that potash and other salts are absolutely essential for the growth of the sugar beet, so that it must always contain an appreciable quantity of mineral impurities.

Mineral Content of Beets, Diffusion Juice and Molasses

The following table shows the analysis of the ash from typical samples of beets and the diffusion juice and molasses produced from them. It should be borne in mind that in making the ash determination the salts of organic acids are broken up and the bases converted into carbonates. As the weight of the carbonates is considerably less than that of the organic salts from which they are derived, the ash content is always less than the actual content of salts.

	Beets	Diffusion Juice	Molasses
Per cent lixiviated ash by weight	0 85	0 53	11 80
Analysis of ash:			
Silica and insoluble	2 64	2 00	86
Iron (Fe)	1 84	.22	11
Calcium (Ca)	59	44	51
Magnesium (Mg)	2 05	3 39	34
Potassium (K)	30 55	31 44	40 40
Sodium (Na)	11 28	11 05	8 68
Chlorine (Cl)	6 87	7 71	9 76
Sulphate (SO_4)	3 61	5 92	10 74
Phosphate (PO_4)	7 42	7 54	40
Carbonate (CO_3)	30 98	30 43	28 74
Undetermined	2 17		
Total	100 00	100 14	100 54

With proper operation of the diffusion battery, from 20 to 30 per cent of the total ash in the beets is eliminated at this stage. As will be seen from the above analysis, the composition of the ash remains about the same in the juice as in the beets. Minor differences are caused by the mineral solids in the supply water. In securing high extraction it is, of course, just as important to have the purest obtainable supply water as it is to have beets low in mineral salts. It has been found that the loss of sugar in molasses is almost directly proportional to the amount of ash in the diffusion juice, indicating that the mineral non-sugars are much more melassigenic than are the organic non-sugars.

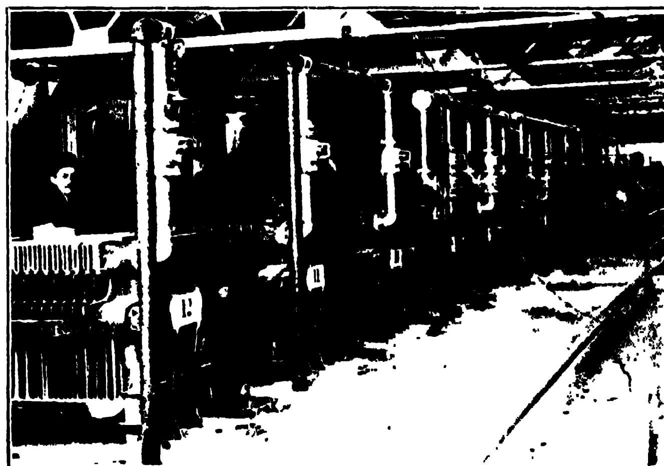


FACTORY INTERIOR: DIFFUSION BATTERY IN FOREGROUND

The problem of a more complete separation of the sugar from the impurities in the beets is one which has received a great deal of study ever since the industry began, but still remains to a certain extent unsolved. If a cheap process of precipitating the sugar in an insoluble form, leaving the non-sugars in solution or vice versa, could be found, the yield of sugar in the form of granulated would be increased about 15 per cent, and the loss in molasses correspondingly reduced.

Molasses

The method of attack on this problem has been to allow the impurities and sugar to accumulate and be concentrated in the form of molasses, a material which contains 50 per cent sugar and 30 per cent non-sugars.



FILTER PRESS STATION

The sugar is then precipitated from the molasses as saccharates and finally obtained as granulated.

Molasses is a byproduct of beet sugar manufacture which offers very interesting possibilities for research work and the production of many further byproducts. As shown by the analysis given below, it is a mixture of a great many chemical compounds. The multiplicity of these has tremendously increased the difficulties of research work on this material, but considerable progress is being made. I might mention that under "Undetermined" may be included as many as twenty different organic non-sugars, gums, etc.

COMPOSITION OF BEET MOLASSES

Moisture	21 00	Invert sugar	0 06
Direct polarization	52 08	Ash	12 17
Sugar by inversion	50·51	Undetermined	15 41
Raffinose	0 85		

As mentioned above, although the molasses contains 50 per cent sugar, the non-sugars present absolutely prevent its crystallization, so no more sugar can be obtained by simple evaporation. Consequently it becomes necessary to use a precipitation process, such as the Steffens process, whereby the sugar is precipitated as tricalcium saccharate, and filtered from the mother liquor, called waste water. The Steffens process consists of dilution of the molasses, adding to the 5 per cent sugar solution finely powdered lime at a low temperature and with rapid agitation, until nearly all of the sugar is precipitated. The saccharate is filtered, washed and carbonated to liberate the sugar, finally giving a juice of about 90 purity, from which granulated sugar can be obtained.

One of the serious objections to this process is the relatively low purity of the saccharate produced, causing a reintroduction of impurities into the process. These impurities consist of a number of organic compounds which are precipitated by lime the same as sugar, and accumulate in the final molasses to such an extent that the yield of sugar from the Steffens process becomes too small to be profitable. When this occurs it becomes necessary to discard all of the molasses in process in the sugar factory and thus eliminate the objectionable impurities. The impurity which causes the most difficulty is the so-called "raffinose," as determined by the Clerget inversion method. This so-called "raffinose" is evidently in part true raffinose, and in part consists of other optically active compounds which have not been isolated and identified. Wherever the term "raffinose" is used in this paper it represents this unknown compound or mixture of compounds and not true raffinose.

Raffinose

Several peculiarities have been noticed regarding the accumulation of "raffinose." One of these is that the calcium saccharate produced from molasses containing "raffinose" almost invariably shows an increase in raffinose, the total quantity present being 20 to 40 per cent greater than in the molasses itself. As yet no satisfactory explanation of this increase has been found. Another peculiarity is the fact that in climates where the beets are not exposed to freezing temperatures, as in California, no raffinose accumulates in the molasses, eliminating the necessity for discarding. Factories in localities with low temperatures during the manufacturing season, such as Colorado, Utah and Michigan, using the Steffens process, find it advisable to discard 25 to 40 per cent of the tonnage of molasses worked by this process. An analysis of discard molasses shows the accumulation therein of raffinose and organic compounds, the latter listed as "undetermined."

DISCARD MOLASSES

Moisture	20 13	Invert sugar	0 00
Direct polarization	56.90	Ash	11 87
Sugar by inversion	49 02	Undetermined	14 78
Raffinose	4 20		

There are two processes which may be used for the recovery of sugar from discard molasses—i.e., strontium or barium oxide form saccharates of higher purity than does lime. Several sugar companies are now experimenting with these two processes. The principal difficulty to overcome is the high cost of converting strontium or barium carbonates back to the oxide, as is necessary because of the original cost of these reagents. The conversion has been made in electric furnaces with some success, but at an excessive cost. The strontium process has been used extensively in Germany for many years, but has not yet been made a commercial process in this country. Both processes have the advantage over the Steffens process of producing a concentrated waste water which can be worked up for potash and other byproducts at less cost.

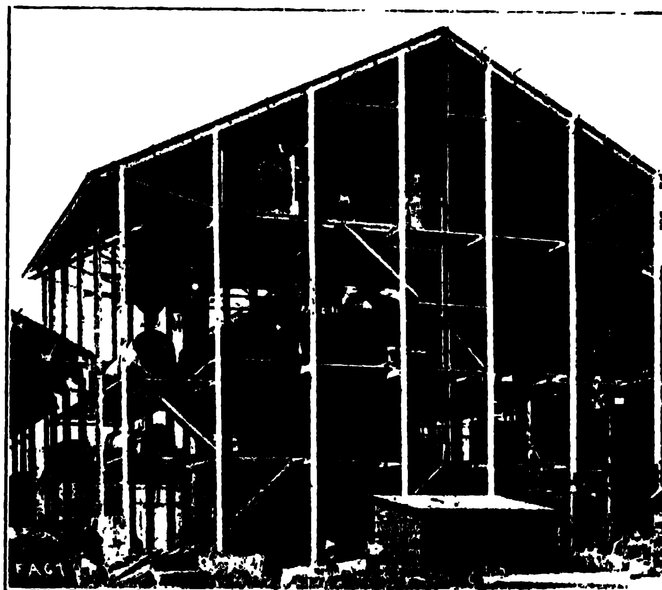
Byproducts From Molasses

The ash in molasses contains nearly 50 per cent of potash as K_2O and therefore is a valuable source for this material. Before the war this potash was not recovered by the sugar companies of the United States, it being impossible to compete with the price of potash imported from Germany. During the last three or four years, however, large installations have been made to recover potash from beet molasses, and the recovery is being done very successfully. The Great Western Sugar Co. of Colorado now produces about 6,500 tons of ash of 40 per cent K_2O content annually. This is done by evaporating the waste water from the Steffens process in multiple-effect evaporators, burning the thick liquor in special furnaces, leaving the ash as residue. This material is now sold for fertilizer use, but may ultimately be refined and part of the potash secured as potassium carbonate, a more valuable product. In the process of refining, a considerable quantity of vegetable carbon is obtained, which may be utilized for the decolorizing of sugar solutions.

By the present process of burning the waste water liquor, nearly all of the nitrogen contained therein is lost. As the original molasses contains 1.5 to 2.0 per cent total nitrogen, most of which stays in the waste water, the recovery of the nitrogenous compounds offers great possibilities. Progress is now being made in the recovery of methylamines, cyanide and ammonia from this waste liquor. This will be done by destructive distillation, absorption and purification of the gaseous products.

A large portion of the nitrogen in molasses occurs in the form of betaine or trimethyl-glycocol, $C_5H_{11}NO_2$. This can be obtained in considerable quantities from beet molasses as beautiful crystals of betaine hydrochloride, a compound which is used to some extent medicinally for treatment of digestive disturbances.

On subjecting the betaine and other nitrogenous compounds to destructive distillation, a mixture of mono-, di- and tri-methylamines with ammonia is formed. Di-methylamine is a valuable raw material in the dye industry, and some of the addition products of the amines are attracting attention as accelerators in vulcanizing automobile tires. Constant research work is being carried on to determine the best methods to secure high yields and purities of the above-mentioned products from molasses. This is necessarily a slow process, involving, as it does, research in pure chemistry and the solution of the chemical engineering problems



SUGAR FACTORY UNDER CONSTRUCTION, SHOWING VACUUM PANS, CRYSTALLIZERS AND CENTRIFUGALS

encountered in developing the commercial process from the methods found successful in the laboratory. Some of the products are being made from molasses waste liquor in Germany, but very little information as to methods is available. It is also to be remembered that processes using excessive manual labor might be commercially successful abroad and fail in this country because of high labor costs. Consequently it is desirable to develop processes which are as nearly mechanical and automatic as possible.

Future Research Work

I will suggest several lines of research work to complete our present knowledge and develop a well-rounded process for the utilization of molasses. Such a process would yield the following known products, and it is possible that many others would ultimately be obtained:

Sugar	Methylamines
Potassium carbonate	Sodium cyanide
Potassium sulphate	Ammonium sulphate
Sodium carbonate	Methyl alcohol
Vegetable carbon	Vegetable tar

The individual steps in this process would be: 1. Recovery of sugar as strontium or barium saccharate. 2. Distillation of concentrated waste water. 3. Recovery and separation of methylamines, sodium cyanide, ammonium sulphate, methyl alcohol and tar as products of distillation. 4. Refining of crude still residue for the potash and sodium salts.

Still further products can doubtless be obtained by the distillation of the tar. The vegetable carbon may be used as a decolorizing medium or in the manufacture of shoe blacking.

Another line of work which has been suggested is the decomposition of waste water by electrolysis, which might yield caustic potash and valuable organic acids. With the advances which have been made in electrolytic cells and electrochemical processes during recent years, this line of attack offers attractive possibilities.

In the event that the extraction of sugar from molasses is not sufficiently profitable, a substitute process would be the production of yeast, alcohol or acetic acid. This is, of course, a commercial process now.

A highly desirable research work that should be taken up as soon as possible is the isolation and identification of the so-called "raffinose" and other optically active compounds. This will involve methods for the exact determination of each, and also methods for their removal from molasses without any destruction of sugar. I wish to emphasize that this problem is no mean task, and that some of the keenest minds in the sugar industry, both here and abroad, have already spent years in doing the pioneer work. Although the results of this work have been of great value, scarcely more than a beginning has been made.

A chemical engineering problem which deserves attention is the burning and grinding of lime under such conditions that it will give the maximum results in the Steffens process. A study of the values of various limes shows that the physical characteristics of any lime are almost as important as its chemical purity. For this reason two limes produced from the same lime rock and chemically active to the same extent may give rather widely different results in the precipitation of sugar. A very desirable quality in lime for the Steffens process is that it shall be light and fluffy in character.

The filtration and washing of the large quantities of calcium carbonate and saccharate produced in beet sugar factories is worthy of more study. Although gratifying progress has been made during the last ten years, the industry is still in need of filtering apparatus which will give minimum sugar losses with low costs for labor, filtering media and evaporation of wash waters.

A byproduct of interest to the chemist is beet pulp, the residual beet slices after the sugar has been extracted. This material has considerable food value and is fed in either a wet, fermented state, or as a dry material. During fermentation of the wet material a very large loss of food value takes place, and the time may come when the chemist will develop uses for pulp which will utilize all of the values contained to a greater extent than is now being done.

In this discussion I have attempted to cover in a general way the lines along which scientific research and development is needed in the beet sugar industry, without going into any exhaustive treatment of the problems which we have to meet. It is perhaps not too much to say that in dealing with the byproducts of the sugar beet "only the surface has been scratched." Any success that the scientific men of the industry may attain in this direction will come with frank and open discussion and interchange of ideas and elimination of the secrecy which has hampered the development of so many chemical processes.

Denver, Col.

Chemical Control in the Sugar Industry

In the Aug. 7, 1920, issue of *The Louisiana Planter* S. J. Osborn, of the Great Western Sugar Co., writing on "The Chemical Control of the Sugar Industry," states that: While the sugar manufacturing process is not a highly complicated one, as chemical processes go, it is doubtful if any other manufacturing process is so closely and thoroughly controlled at every step by the chemical laboratory. The laboratory is called on for information and advice in solving the numerous technical problems which arise, and its assistance can be of the greatest value. One of the problems of the chemical department is the question of the extent to which work that does not have an immediate application shall be carried out.

In companies of sufficient size the chemical control work is handled by a specially organized chemical department entirely independent of the operating department, although the two naturally enjoy intimate relations and must work in close co-operation to achieve the best results. This system has many advantages. Not only does it relieve the operating department of responsibility for a highly technical line of work, but it puts the results on a basis where they are free from even any suspicion of bias or irregularity, and facilitates the introduction and use of uniform methods in analysis and control.

An important factor in the development and application of chemical control in all branches of the sugar industry is the extent to which rapid and reliable control methods have been worked out.

The chemical department of a sugar plant usually has a wider field than that its name might imply. It issues and is responsible for almost all of the important operating reports, other than the financial, and keeps a detailed set of records with the help of which the operating efficiency of the plant might be improved.

The Problems of the Petroleum Industry

Greater Supplies of Crude Oil Required to Meet Future Demands—Better Utilization of Supplies Necessary—Pyrolysis of Fuel Oils Into Gasoline—Substitutes for Petroleum Products—Chemical Synthetic Products From Petroleum

By WILLIAM A. HAMOR*

BENJAMIN SILLIMAN, JR., who conducted the first technochemical investigation of crude petroleum, in 1855, remarked that it was a raw material from which might be manufactured very valuable products. With an industrial history covering a period of but sixty years, crude petroleum now is recognized as a resource of the highest economic value to society because it is essential to agriculture, manufacturing, commerce and the pleasures of life. It is the source of gasoline, which is responsible for the development of the internal-combustion engine, the increase of the use of which has strengthened the entire aspect of modern civilization; it gives the world its supply of illuminating oils, which, by bringing a cheap light to millions of people, have constituted America's greatest gift to the uncultured peoples of the globe; and it provides the lubricating oils upon which the complex mechanical equipment of today is dependent for its operation. Then, too, part of the industrial activity of our country rests upon another petroleum product, fuel oil, which also is required for the operations of an oil-burning navy.[1] The fact that crude petroleum forms the basis for a chemical products industry of almost unlimited possibilities of development, and as distinctive as the coal-tar industry of the present, brings out, in addition, its predominant importance among mineral raw materials.

A substitute has been found for crude petroleum, but shale oil, to which reference is had, is a chemical product and therefore is subject to economic limitations not applicable to a substance which may be mined and handled so easily as crude petroleum. Indeed, the availability and magnitude of the petroleum resource have given confidence for the extensive mechanical developments essential to its use; and accordingly the employment of petroleum is established among the practices and requirements of modern life. As pointed out by Gilbert and Pogue,[2]

> Any tendency toward disuse of its essential products, either through undue increase in price or from decline in production, will mark a turning point in material comfort and industrial advantage, the deferring of which becomes an object of universal concern. As the petroleum deposits of the United States have been drawn upon with extraordinary rapidity and the supplies have already suffered serious depletion, the matter of their approaching exhaustion assumes the light of immediate importance. The comforting assertion that such considerations may be safely left to future generations does not apply to petroleum.

Crude petroleum now is being taken from the ground in the United States at a rate approaching 400,000,000 bbl. per annum. This is five times the rate in 1901 and twice that of 1909.[3] At the close of 1919 approximately 4,986,300,000 bbl. of crude oil had been produced in this country since the first well was drilled at Titusville, Pa., in 1859. This is about 43 per cent of the original recoverable content, as estimated by the United States Geological Survey. All this oil that has been mined in the United States in sixty years would be taken out in thirteen years at the present rate of production. Impressive as this fact may be, it is not so disturbing as the realization that the recoverable crude petroleum in this country, according to the conservative estimate, would probably be practically exhausted in seventeen years if the 1919 rate (nearly 380,000,000 bbl.) of production could be maintained for so long, while a reserve of 7,000,000,000 bbl., the moderately liberal estimate, would disappear in eighteen and one-half years.[4] If an improbable excess of 2,500,000,000 bbl. over the estimated amount is present, this excess would be sufficient to sustain the present draft for six and one-half years additional.

What improvements will in the next ten years be made in the process of extraction of crude oil from the ground, and what the effects may be in recovering the great amounts of crude petroleum not "available" or recoverable by present methods, remains to be seen. It is probable that not much over 20 per cent of the oil underground is brought to the surface. It is most important that studious attention be given to the problem of the more complete extraction of the petroleum than is possible by the methods now in general use. Records of wells should be kept, surface and underground geology should be correlated, oil-sand should be examined, and if possible underground losses should be determined. The estimated available supply should be increased in this way to the maximum. It is noteworthy that while the petroleum industry has been supplied with technical means whereby certain wastes in production may be combated there has been provided no adequate machinery for applying this knowledge.

Fortunately, however, the crude petroleum cannot so soon be taken from the ground. Even unparalleled prices for crude oil, and exploratory work far more extensive than that now in progress, cannot within the next generation disclose all the oil pools in the strata; and although devices for more rapid extraction may be invented and applied, the fields which remain to be discovered cannot be drained so rapidly. Oil pools will be found, finally by accident, long after the search has waned, and even in the next century. These are some of the reasons why the production of natural petroleum in the United States must pass its peak at an early date—probably within five years and possibly within

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[1]Forty-eight per cent of the power used by the British Navy in the European war was derived from petroleum and the fleet steamed 7,000,000 miles per month. In 1918, 3,000,000 tons of fuel oil were shipped from the United States to the Allied navies.

[2]U. S. National Museum, Bulletin 102, I, ii, p. 29.

[3]See "World's Production of Petroleum," U. S. Geological Survey, Jan. 22, 1920.

[4]Dr. David White, of the United States Geological Survey, has furnished these data.

three years—while the long sagging production curve may be carried out beyond the century. It is certain that this country must in the near future lose its supremacy in the petroleum world and become more and more dependent on the oil resources of other lands,[5] except in so far as the situation may be saved by the successful production of artificial petroleum (crude shale oil) by the destructive distillation of American oil-shales.

To depend on oil-shale, however, is to trust to uncertainties both as to costs and as to ultimate results, and is at best to superimpose on our present social and industrial fabric an enormous and complex new industry rivaling in part our coal-mining, salvaging but a part of our present petroleum industry, and requiring many years for its development. Sooner or later—perhaps within five years—a commercial shale-oil industry may be born in this country, but that it can originate soon enough or become large enough to offer any considerable contribution before our domestic petroleum production is already on the wane seems improbable. Finally, if shale oil yielding the principal and indispensable petroleum products cannot successfully be produced and marketed as cheaply as natural petroleum

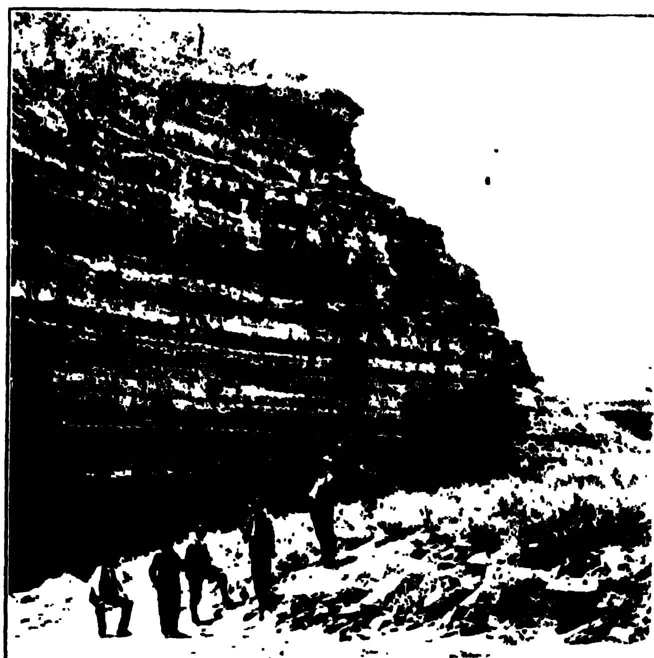


FIG. 1. OIL SHALE ON WILLOW CREEK, SOUTHWESTERN UINTA COUNTY, UTAH

from other countries, the public cannot be expected to build up and sustain a shale-oil industry, unless it be under subsidy as a protective measure.

To date approximately 140 shale-oil companies, many of which claim to own or control novel distillation processes, have been formed in the Western oil-shale fields; but so far none of these organizations has assumed a position of commercial importance. However, research of a fundamental character is being carried out by various large petroleum interests and by the Bureau of Mines. It is hoped that the Bureau of Mines will serve the useful function of investigating new types of retorts and of determining the most profitable use and method of treatment of any particular oil-shale. This valuable pioneering work would bear fruit ultimately in the production of a notable volume of shale oil.

A British oil economist has calculated that by 1925 the petroleum requirements of the United States will exceed 500,000,000 bbl. and that at a later date our country will become more and more dependent upon British supplies. An American authority, W. C. Teagle, president of the Standard Oil Co. of New Jersey, has estimated that in 1925 the requirements of the petroleum industry in this country will approximate 650,000,000 bbl., an increase of more than 220,000,000 bbl. over the requirements of 1919. Unless conservation of petroleum through curtailment of use—for example, as fuel burned under steam boilers to generate steam—is forced automatically by the scarcity of crude oil and consequent prohibitive prices, or is sooner and more wisely brought about artificially by regulation, it seems probable that the demands of the American petroleum industry will considerably exceed 600,000,000 bbl. or possibly 650,000,000, as estimated by Teagle, in 1925, although by that time our exportation of refined oils to some of the foreign markets will probably be reduced by the competition of foreign oils nearer at hand and more cheaply produced.

A drain of over 500,000 bbl., even if the yearly effectual demand be not further increased, would, if taken from the oil fields of the United States, probably exhaust the petroleum resources remaining available in the ground in fourteen years, or in sixteen years if it is assumed that the recoverable petroleum possibly amounts to so much as 8,000,000,000 bbl., which seems very improbable to geologists. It is fortunate for the country that the petroleum cannot be extracted so rapidly. On the other hand, it also seems quite improbable than an annual production of natural petroleum amounting to so much as 450,000,000 bbl. can be won in any year from our domestic oil fields, the peak of whose production is likely to be passed by 1925.

All circumstances being considered, it must be expected therefore that, unless our consumption is checked, by 1925 the United States will be dependent on foreign oil fields to the extent of 150,000,000 bbl., and possibly as much as 200,000,000, of crude oil each year, except in so far as the situation may by that time, perhaps, be helped to a slight extent by shale-oil. Add to this probability the other greater probability that within five years—perhaps three years only—our domestic production will begin to fall off, with increasing rapidity, due to the exhaustion of our reserves, and it becomes evident that, except for such relief as may come from shale-oil production, the future of the United States in petroleum will yearly become more and more completely dependent on supplies to be brought from foreign fields.[6]

As the outlook now must be viewed, it is practically certain that after a time the United States will be buying petroleum from commercial rivals in quantities greater by far than ever have been sold to them, to make no mention of the prices paid. But, while this may be impreventable, it should be escaped as far as

[5]On the restrictions imposed by certain foreign countries upon citizens of the United States in prospecting for or acquiring lands containing petroleum, see Senate Document 272, May 17, 1920.

[6]United States interests are practically supreme in the commercial control of the petroleum resources of the Western Hemisphere, dominating the petroleum industry in the United States, Canada, Mexico and Peru, and holding substantial interests in Trinidad and Venezuela and in the prospective petroliferous areas in Central America and Colombia. Their only competitors are British and British-Dutch interests, which control the petroleum situation in Trinidad and are not only strongly intrenched in Mexico and Venezuela but are aggressively seeking to enlarge their holdings in those countries and to gain footholds elsewhere.

possible. If our nation is to have these oils as cheaply as they are sold in the home countries; if our industries, our transportation, our navy and our standards of living are to be safeguarded in advantages as great as those of our rivals, and if our merchant ships are to obtain their fuel oil at prices as low as those paid by rival ships, the oil supplies needed must be in our control. Our prosperity and our prospects, so far as they may be affected by this important commodity which influences the daily life of every citizen, must not be subject to prejudicial regulation or discriminative restriction by any foreign power. Only by assuring American control over the petroleum supplies required by the United States can the protection of our future be guaranteed.

Experts believe that the most conspicuous developments affecting the sources of the world's supply of petroleum in the next decade will occur in the countries that border the Caribbean Sea and the Gulf of Mexico. Within the last four years the annual production of petroleum in Mexico has increased from 21,000,000 bbl. to 56,000,000 bbl.[7] and the potentialities of future production in that country have been demonstrated. It is estimated by T. C. Thomson[8] that the ultimate expected production will equal, if not surpass, the whole production of the United States. Its product, originally considered valuable only as a source of fuel oil, now is yielding, by modern refining methods, increasingly important percentages of illuminating oils and gasoline. The hindrances to enormously increased production are unsettled political conditions and inadequate facilities for marine transportation, but these obstacles doubtless will be surmounted within the next few years.

To summarize, the future domestic supply of crude petroleum will not be equal to the future home demands. This problem can be met by:

(1) Obtaining greater supplies of crude oil—
  - (a) By increasing the importations from foreign oil fields.
  - (b) By actively participating in the development of foreign oil fields.
  - (c) By the establishment of a shale-oil industry on a commercial basis as soon as is practicable.
  - (d) Through increased recovery from our oil fields, resulting from more efficient operating methods, and especially the elimination of wastes in production.

(2) A better utilization of the crude now available, principally—
  - (a) By the pyrolysis of fuel oils into gasoline.
  - (b) By the development of gasoline substitutes.
  - (c) Through the development and use of Diesel-type engines utilizing the heavier fuel oils.

Problems in the Production of Crude Petroleum

Among the development and production problems which require more study are the dehydration of emulsified petroleum and the prevention of its formation in oil wells. It has been learned that probably all emulsions in wells are formed after the oil has left the sand, and their formation often can be prevented. The systematic investigation of methods for excluding water from oil and gas wells, of the effect of water on the production of oil wells, and of casing and tubing problems, would lead to findings of technical value. Work on the employment of safety devices in the oil fields, the possible substitution of explosives safer than nitroglycerine for shooting oil wells, and the effects of shooting on wells, would be of utility. Scientific inquiries for determining the capacities and characteristics of oil and gas sands, the proportions of petroleum not being recovered by present methods of production, and the laws governing the expulsion of petroleum from the oil sands have been started by our energetic Bureau of Mines. There is little information on this subject, and it will not be possible to interpret data and to judge the value of various methods of production until the underlying geochemical laws are better understood. Procedures for stimulating production and increasing the recoveries of petroleum from the sands, including the effects of vacuum pumping, use of compressed air or gas, and use of water flooding, present other opportunities for research. In this connection, pumping problems and equipment, including the use of automatic air and gas pumps, electrical equipment, and air lifts should be given attention.

Storage and transportation problems include losses of oil in storage, prevention of fires at tanks and wells,[9] the flow of oils in pipe lines, and the construction of storage tanks and reservoirs.

Some Problems in Refinery Technology

Petroleum industrialists frequently have availed themselves of the service of scientific research[10] both in the development of processes and in the perfecting of the necessary mechanical equipment. In fact, marked success has attended scientific progress in the refining of petroleum, and the largest refineries now concede that chemistry is the source of specific information for the petroleum industry and gratefully acknowledge that the efficiency of their plants has resulted largely from properly conducted scientific investigation. Those companies which stand well to the fore maintain one or more research laboratories, and industrial research has left its mark on their development. It is, however, essential, particularly for the future welfare of the industry, that there be an increment in investigational activity. This may be brought about in a measure by the organizations represented in the petroleum industry, especially the American Petroleum Institute, and by the Bureau of Mines; but there must be more coöperation between petroleum industrialists and the universities and scientific societies if the desirable fruitful research is to be stimulated.

The need of continuous study and research and training in hydrocarbon chemistry and in petroleum technology cannot be over-emphasized.[11] The lack of reliable general information has worked handicaps on the petroleum industry, which is, in many ways, groping in the dark. Similar errors are made repeatedly in the same territory by different operators, and both in

[7]In the same period our imports of Mexican crude petroleum have increased from 15,175,061 bbl. to 45,893,945 bbl.

[8]*J. Inst. Pet. Tech.*, vol. 5, p. 56.

[9]On oil fire hazards, see Bulletin 170, Bureau of Mines.

[10]A good illustration of what research has done in working out refining problems is had in the case of liquid petrolatum. At the beginning of the war a great shortage of this product occurred, since its manufacture had been carried on solely by the Germans from Russian petroleum stock, which was thought to be the only suitable basis. After scientific inquiry the manufacture of liquid petrolatum was begun on American oils, and the present American product is superior to the old German "paraffinum liquidum" in a number of respects.

[11]It is gratifying to note, however, that at least one American institution now is supplying trained petroleum chemists to the industry. Reference is had to the University of Oklahoma, where Prof. F. W. Padgett is giving systematic instruction in hydrocarbon chemistry and refinery technology.

drilling and in refining the various factors having a known influence are understood imperfectly in their relation one to another. Geology, the real foundation of a study of production, is insufficiently applied or understood by the average producer, and in consequence much of the production is accidental rather than scientific. When a producer finds petroleum he is simply a producer, and not a marketer, for he has usually no knowledge of the value of his product other than the posted price. He knows only in a rather vague



FIG. 2. A BATTERY OF 1,200-BBL. CRUDE OIL STILLS OF THE LATEST DESIGN

way what characteristics are valuable; and when he has sold his crude oil he frequently is concerned no longer with the petroleum industry. The refiner usually has only the knowledge gained by an apprenticeship with an older refiner, and is therefore nescient regarding the chemistry of refining.

Petroleum marketers consider that the greatest need of those engaged in the petroleum industry today is uniformity in methods of testing and in the physical instruments employed therein. Constant progress is being made in the analytical chemistry of petroleum and its products, but much research will be necessary before precise and detailed procedures are worked out which will be satisfactory for general adoption. It is not practicable to issue standard test samples, as is the case for the iron and steel industry, but there can be laid down definite, standard instructions for carrying out the various operations involved.

A large literature already exists on the subject of analytical naphthology owing to the activities, among others, of the Bureau of Mines and the Bureau of Standards in the United States and of the National Physical Laboratory in England. What is needed now is the welding of these researches into a comprehensive whole by an international body of experts, which, sitting permanently like the pre-war International Petroleum Commission, shall institute researches into new methods of procedure and revise existing technic.

From the industrialist's viewpoint, the great problem in the petroleum industry is flexibilty in refining, in order that there may be produced only those products which are in demand. In other words, there is wanted a suitable process which will enable the refiner to manufacture only the products for which there is a big market—say gasoline and lubricating oils. Research has been begun which has for its object the production of the desired finished oils, and only these, by purely physical methods, thus dispensing with chemical treatment.

Considerable investigation has been devoted to working out processes for the dehydration and desulphurization of crude oils and for the pyrolysis of heavy oils (particularly the conversion of such oils into motor fuel). Findings of importance have resulted from these investigations, but the ideal processes remain to be found, especially methods for converting products of the destructive distillation of residuum or heavy oils into saturated hydrocarbons. If hydrogenation could be conducted successfully on a commercial scale the customary treatment with sulphuric acid could be dispensed with. Hydrogenation with platinum black or nickel could be accomplished if an antidote were known for the poisonous effect of sulphur compounds on the catalyst. Another matter of interest here is the polymerization of olefines; this subject requires the consideration of research.

Automotive engineers should have available exhaustive data regarding the specification and use of petroleum products for internal combustion and lubrication purposes. Lubricating oils for special purposes have not received due scientific attention, and, as a result, the selection of a lubricant is more frequently casual than scientific. Lubrication is a special problem of colloid physics.[12]

It is singular that the subject of refining has attracted so little notice. In the chemical treatment of petroleum products systematic investigation, with the object of ascertaining the most favorable temperatures for the acid treatments of petroleum distillates, would be of practical value as affording an indication to the refiner how to proceed under all circumstances. Another well-known problem in refining is the chemical treatment of lubricating oils in such manner as to minimize the losses and to prevent the emulsions which result when sulphuric acid is used. The production of persistent emulsions in the refining of petroleum is a problem to be attacked from the colloid-chemical point of view. An economic process is needed for isolating pure naphthenic acids of high molecular weight from

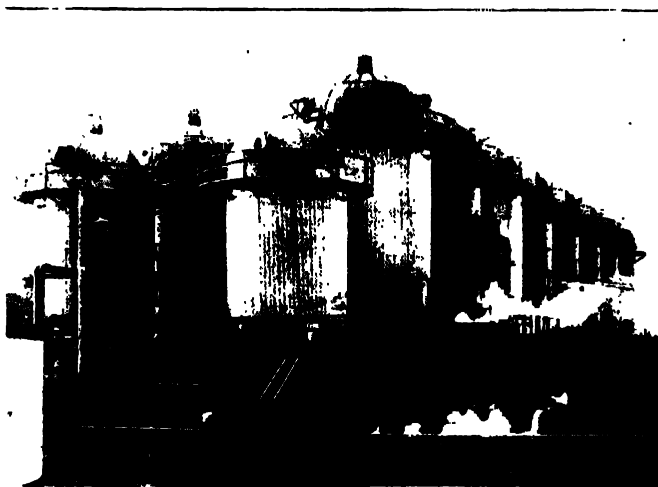


FIG. 3. A BATTERY OF AGITATORS, EACH OF ABOUT 1,200-BBL. CAPACITY

[12]In fact, W. B. Hardy (*J. Soc. Chem. Ind.*, vol. 38, 1919, p. 7T) has shown that we may look with confidence to colloid chemistry to assist us in finding the lubricants of the future.

waste lyes. A related problem is the utilization of the esters from the naphthene carbo-acids contained in the residue from the alkali treatment. A question of interest here is: What is the cause of the cacodor of naphthenic acids, and how may these products be deodorized most effectively and economically?

The following are some of the many other problems confronting petroleum technologists: A more rational utilization of the butanes and pentanes in natural gas gasoline and in light petroleum fractions; does the hot still metal exert any catalytic action in the pyrolytic decomposition of residues; the minimization of the decomposition of sulphur compounds during the distillation of petroleum containing asphalt; what role do sulphur compounds take in the condensation of petroleum to asphalt; increasing the efficiency of tower stills, condensers, and heat exchangers; the rapid and effective revivification of spent fullers earth; the separation of the aromatic and cyclic unsaturated hydrocarbons from the paraffine and naphthene hydrocarbons by a more satisfactory reagent than those now in use; the fractionation of petroleum residues containing paraffine wax into a distillate and undecomposed amorphous wax; the elimination of gummy or asphaltic portions from wax distillate by a distillation or mechanical procedure; what constituents of a mineral oil are responsible for the lubricity thereof, and can the lubricating properties of an oil be increased in the light of this knowledge; the prevention of the oxidation of mineral oils in transformers; products which will make emulsions with water without any oil coming to the surface; and a rational plant for producing oil gas from tar and carbon monoxide from the residue, the mixed gases to be suitable for use in gas engines. Then, too, notwithstanding the many processes which have been patented, the "solidification" of petroleum and its products is still under investigation.

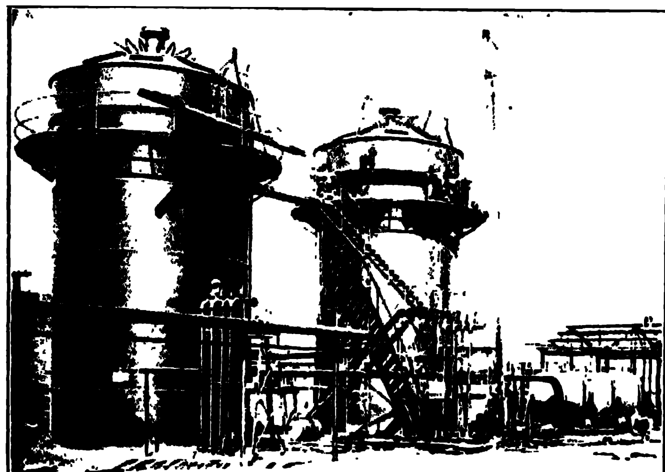


FIG. 1. TWO AGITATORS OF THE LATEST TYPE, 20 FT IN DIAMETER AND 41 FT. 10 IN. HIGH

The collection of data on the physicochemical properties of petroleum and its products for the use of refinery chemists and engineers is one of the most important inquiries which could be instituted, and it is hoped that the Bureau of Mines will cover this field in its broadest practical aspects. The data obtained on the pure hydrocarbons which exist in crude petroleums also would be of value for purposes of comparison.

"Cracking," or pyrolysis, is regarded as the leading potentiality in petroleum refining, no less so because it permits the production of the main products according to demand, without sacrifice of byproduct possibilities. The importance of the whole matter may be evalued by having regard to the fact that at present, even with "cracking" well launched into practice, less than one-half of the petroleum produced is manufactured into products representing an ideal apportionment of the raw material into its components. The manufacture of gasoline may be doubled eventually or even more greatly multiplied without increasing the production of crude petroleum.

The research activity on the subject of "cracking" has been notable, and the volume of patent applications shows no signs of diminution; in fact, the number of permutations and combinations of the variables borders on the infinite, and accordingly, while modifications of outstanding novelty will be rare, a variety of processes remain to reach the Patent Office. At the present time investigators are endeavoring to obviate the defects in nearly all the methods now in use, which are: (1) the accumulation of carbon, (2) loss of oil as fixed or permanent gas, (3) low yields, and (4) the formation of undesirable impurities.

The inclination to look upon the unsaturated products of "cracking" as valuable for synthetic chemistry is becoming pronounced. The fact that under high pressure the point of molecular scission is directed to the middle of the hydrocarbon chain, while at low pressure the point of rupture is displaced more toward the ends of the chain, holds out additional promise for the working out of commercial processes for the manufacture of isoprene, etc., from petroleum.

An insufficient amount of work is being done in a systematic way to show how to economize in the use of gasoline. A thorough investigation of carbureters and fuels, and certified tests of the performance of all makes of automobiles, would be of value in economizing in the use of gasoline, and giving the public as much service as possible for a given expenditure. The Bureau of

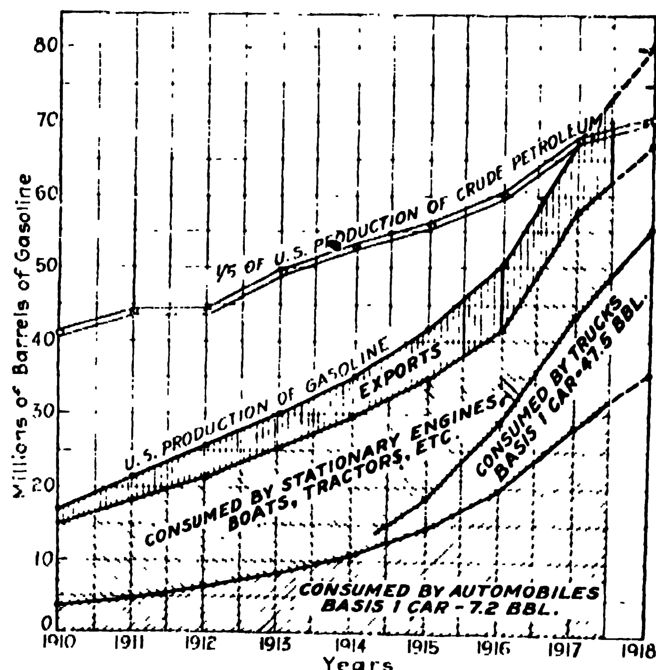


FIG. 5. CURVE SHOWING THE GROWTH IN DEMAND FOR GASOLINE COMPARED WITH THE GROWTH IN OUTPUT OF CRUDE PETROLEUM

Mines and the Bureau of Standards have studied different phases of this question, but neither has been able to conduct as much research as should be done. With over 7,000,000 of gasoline-driven automobiles in daily use, and motor gasoline constantly rising in price, the American public cannot afford to have the Government fall short in a matter of so great economic importance and of serious personal concern to so many.

A very pertinent question is, Should a higher final boiling point for gasoline be permitted? A final boiling point of 230 deg. C. would increase the available supplies by a considerable percentage, while greater efficiency in fractionation would result probably in an additional 10 per cent increase in yield.

Petroleum Substitutes

Even with the most efficient use of the remaining supply of petroleum and an appropriate development of shale oil in prospect, the petroleum situation can be improved additionally by a progressive utilization of substitutes for gasoline and fuel oil, so as to give better economic balance by relieving the products upon which fall the heaviest demands. Two substances, benzol and ethyl alcohol, are suitable for assisting gasoline, and offer the advantage of a record of successful use in motor engines in Europe prior to the war, and of a marked extension of utilization there under the rigorous conditions of the present, while coal and hydro-electricity may be brought to the aid of fuel oil.

Substitutes for Gasoline

The subject of gasoline substitutes is one of particular interest, although definite information concerning it is decidedly limited because of the paucity of research which has been made public. The first point of importance to mention here is that motor fuel is essentially a source of energy and that the energy must come from somewhere. Interesting stories regarding the discovery of new fuels appear from time to time in the newspapers, these fuels often being prepared by adding a small quantity of some secret compound to water. That these "fuels" are one and all without particular value is established by the fact that water contains about as little available energy as any substance which could be selected.

With respect to the real possibilities of gasoline substitutes, it now seems probable that later on shale oil may become an important source of motor fuel. Oil-shale probably will not assume any considerable industrial importance in the immediate future, but its potentiality as a resource gives a comfortable feeling of assurance that the use of motor vehicles will not have to be discontinued when crude petroleum becomes too valuable for fuel purposes. Substitutes for gasoline should receive every encouragement if produced and marketed in an intelligent and scientific manner; for our country needs to increase its motor fuel resources and no step in this direction should be hindered. It should be recognized, however, that petroleum gasoline is a type of fuel for which present equipment has been designed and for which it is eminently satisfactory. It is believed, therefore, that when striking claims are made for the superiority of any gasoline substitute these should not be taken too seriously. The substitute fuel should be given a fair trial, but the user should be satified if it is as good as gasoline and should not expect it to be remarkably superior.

The type of gasoline substitute which is of most importance at the present time is the mixture of hydrocarbons, including benzol, toluol and xylol, obtained as a byproduct in the coking of coal. During the war the benzols were used largely in the production of explosives and other munitions, but since the termination of hostilities a considerable supply has been rendered available for motor fuel. In fact, several companies are marketing benzol mixtures, generally mixtures of the benzols with petroleum naphtha. These products have been used under widely varying conditions, and in most cases favorable results have been obtained.

The use of light oils from coal as motor fuel does not, however, offer an ultimate solution of the motor fuel problem, since the total production of these hydrocarbons is rather limited. The quantity of light oil produced from coal in byproduct coke ovens during 1919 has been estimated at 90,000,000 gal., or about 2.3 per cent of the total amount of gasoline produced in 1918.[13] The actual figure for hydrocarbons suitable for motor fuel is even less than that for total light oil produced, and it appears, therefore, that, as a motor fuel resource, the benzols are of relatively small importance. To illustrate, it may be stated that since 1916 the production of gasoline has practically doubled, while the quantity of coal mined has increased only about 17 per cent. The real importance of the benzols as motor fuel occurs in districts adjacent to byproducts coking operations, where a reasonable proportion of the local gasoline supply may be filled by coal byproducts.

In a certified dynamometer test by the Automobile Club of America 90 per cent benzol showed 12.3 per cent less fuel consumption than gasoline. At the same time the horsepower was increased, depending on the speed. At 2,000 r.p.m. this was 19.4 per cent greater than that of gasoline. The higher ignition point of benzol also eliminates "knocking" (pre-ignition). It is known that the benzols, if properly used, are very satisfactory motor fuels and that there is no difficulty in finding a market for the entire supply.

Ethyl Alcohol as a Motor Fuel

Denatured ethyl alcohol has possibilities for the future and is being developed to a certain extent. It is interesting to note in this connection (1) that fuels with ethyl alcohol base have recently been used with success in motor vehicles in this country, in Europe, and especially in South Africa; and (2) that new sources for the production of ethyl alcohol are being discovered constantly. In addition to the generally known vegetable sources, methods have been developed for the production of ethyl alcohol from sawdust[14], from refuse of cane-sugar manufacture, from waste sulphite liquors, from calcium carbide, and recently, in England, at the Skinningrove Iron Co.'s works, from coke-oven gas.[15] As the largest and best-known field of the consumption of ethyl alcohol in this country has been destroyed for the time being, its use for power purposes would not meet with the competition which it formerly would have had and the price of ethyl alcohol should not be high, especially as compared with the prices of gasoline now prevailing and expected in the near future.

[13]Even if all our coke were manufactured in byproduct ovens the amount of benzols recoverable would be only about 10 per cent of the annual consumption of gasoline.

[14]It is possible to get 10 to 12 l. of alcohol from 100 kg. of sawdust. There appear to be possibilities in the development of the production of alcohol from wood.

[15]Bury, *Iron and Coal Trades Rev.*, Dec. 19 and 26, 1919.

There are certain difficulties in the way of the wide use of ethyl alcohol as a fuel, which are of a non-technical nature and hence will not be discussed here. It may be stated, however, that the discovery of a cheap, positive and reliable denaturant would go a long way toward making possible the wide adoption of alcohol for power purposes; and that the development of cheaper methods of production and of suitable types of engines are also problems of pertinence."[16]

Alcohol-benzol-naphtha mixtures are in use and have been found to be satisfactory in the present types of automobile engines. "Alcogas" is another product which has aroused interest among automotive engineers.

It would be desirable to institute broad researches (1) on the combustion of alcohol and alcohol mixtures, and (2) on lessening the cost of denaturing. In connection with (1) the operation of a fleet of cars and trucks fed with such mixtures would provide data of importance.

Fuel Oil Substitutes

Fuel oil has come into extensive use in the United States, especially in the far West, as a substitute for coal.[17] It is more convenient than coal and therefore is adopted by industries wherever its price is low enough to permit its use. Its employment in this way cannot be sustained, in view of the slowing rate of petroleum production and the counter-demand that will come in increasing measure from the further development of pyrolytic practice in refining and from the wider adoption of the Diesel type of internal-combustion engine. It soon will be necessary, therefore, in any event, to bring coal and hydro-electric power to the aid of a growing number of those activities now dependent upon oil fuel; and the whole matter may be facilitated by constructive action in respect to coal and water power, to make their service more immediately available.

The use of the tar obtained in byproduct coking (9 to 10 gal. per ton) for fuel, especially in steel manufacture, has increased rapidly during the past few years, and many of the larger steel companies, operating their own byproduct coke plants, do not sell any of their tar for distillation purposes, but use it exclusively for fuel. In open-hearth practice the consumption of tar per ton of steel is reported to be 10 per cent less than the consumption of fuel oil. It is used advantageously in combination with producer gas. The resulting flame has a much better melting efficiency than that of straight producer gas, and the increase in the capacity of the furnace is much greater than would be accounted for on the basis of the heating value of the fuel used. These considerations are of great moment, in view of the increasing price of fuel oil and at a time when the maximum output per unit of investment is essential. The price of approximately 4c. per gal., that has until recently been paid by tar-distilling companies for crude tar, is much too low to meet competition with the real fuel value, and the future is bound to see a scarcity of tar for distillation, which will result in a considerable increase in price.

Increasing the Usefulness of Fuel Oils

It is of interest to note what has been done recently to supplement mineral oils or to increase their usefulness through research. The work has been carried on in several directions, of which the following may be mentioned, without, however, indicating the relative importance of the various remedies.

Processes have been devised for making stable mixtures of tars with mineral oil by using pitch-containing tars, asphaltic residuum and a suitable distillate. It also has been found that fuel oils or residues may be reduced in viscosity by piezochemical means.

During the war the Submarine Defense Association developed the so-called *colloidal fuel*, a mixture of oil and pulverized coal wherein the coal is held in suspension in the oil through the presence of a peptizing agent, called by its inventors the "fixateur." The addition of 1 per cent of "fixateur" to a mixture of 60 to 70 per cent of oil and 40 to 30 per cent of coal dust forms a sort of colloid suspension which remains homogeneous for long periods. It is claimed that this product may be used for oil-fired furnaces in about the same manner as fuel oil, and that it provides (when high-grade coal is used) a fuel of even higher calorific value per unit volume than the original oil.

Next, in particular reference to motor cars, may be mentioned the possible use of *engines of the Diesel type*. Numerous attempts have been made in this direction without noteworthy success, which has been explained by the statement that the Diesel-engine manufacturers are too busy to undertake work on the problem, while motor-car manufacturers do not know enough about Diesel engines. The use of modified Diesel engines on motor cars would relieve the situation to the extent of permitting the use of unrefined oils, instead of only such products as gasoline and kerosene.

The Use of Oil in Gas Manufacturing

It cannot be gainsaid that the use of gas oil, a high-grade fuel oil, in the manufacture of "city gas" is a practice which is unjustifiable on the basis of resource economy. Approximately 6 per cent of our petroleum production is employed for this purpose, and the product is used for cooking and lighting by millions of people and by the industries in a number of ways. A large part of this gas is made by the use of oil to enrich blue watergas of low heating value. Recently this gas oil has become scarcer, and it is likely to become still more expensive and perhaps impossible to obtain in sufficient quantity. This condition will necessitate the use of lower grades of oil, or the production of lower grades of gas, or a change of manufacturing equipment at enormous expense. Individual gas companies cannot investigate so fundamental a question comprehensively; and individual cities or states cannot assume the responsibility of solving the problem for the entire country. The proper agency to take up this question is the Federal Government, with the co-operation of the gas companies and the oil companies and the state and municipal authorities. Such a broad and constructive study would be of high importance and would receive the concurrence of all important interests. It should include research on raw materials, manufacturing methods, and the relative usefulness of the various grades of gas that can be produced.

Research on Chemical Products From Crude Petroleum

Some petroleum economists take the view that later on, when there is evidence that crude petroleum will be unable to compete with its substitutes, it will be

[16]On the comparative fuel values of gasoline and denatured alcohol in internal combustion engines, see Bulletin 43, Bureau of Mines.

[17]The substitution of petroleum for coal has gained considerable headway in the large textile and paper mills, and even in small industries in the New England section.

possible to obtain so many more valuable products from its distillates that the use of any one of these as a fuel will be condemned from the standpoint of conservation. Petroleum then will constitute the basis of a chemical products industry which will be as distinct in scope and activity as the coal-tar industry of the present time. In fact, several of the prominent refining companies have in progress investigatory work which will enable them to accumulate a reserve of technical knowledge respecting the manufacture of various chemical products from crude petroleum.

Some attention has been given to the production of drying or siccative oils from petroleum. It is claimed by the De Bataafsche Petroleum Maatschappij that an oil, the drying properties of which are comparable with those of linseed oil, may be obtained by chlorinating a mineral oil fraction of the specific gravity 0.885 at 15 deg. C., in such a manner that 1,000 l. of it absorbs 800 kg. of chlorine, and then heating the chlorinated product with the addition of zinc dust to 290 to 300 deg. C., until the chlorine has been expelled quantitatively as hydrochloric acid. The problem is to produce an oil economically which will be devoid of tackiness. Artificial resins also may be obtained by the chlorination of petroleum and its distillates; but the reduction of the time of the reaction and the purity of the products present important difficulties. The systematic study of the action of reagents on petroleums—a field which merely has been entered—will provide material for the solution of problems of this character. A subject which already has received some investigation is the conversion of chlorparaffines into esters.

A problem of constant interest is the synthetic preparation of fatty acids from petroleum and certain of its products; for when an economic process is available for the manufacture of these acids a working basis will be had for the production of edible products, some of the acids obtainable being convertible into glycerides. Considerable attention has been and is being given to the study of this problem.

The Russian naphthochemist Zelinskii has been one of the pioneers in the application of the Grignard reaction for the production of fatty acids from petroleum, and so long ago as 1902 he took out a German patent (No. 151,880) for the chlorination of certain petroleum fractions. The fraction 132-145 deg. C. of a Russian petroleum was chlorinated, treated in ethyl ether solution with magnesium and carbon dioxide, and the resulting magnesium salt decomposed with dilute sulphuric acid. An acid, $C_{10}H_{18}O_2$, was obtained which, on heating with glycerine at 250 deg. C., yielded a di-glyceride and a tri-glyceride to the extent of 60 per cent of the theoretical, according to Zelinskii[18]. In normal times, however—that is to say at pre-war prices—this could not have competed with natural fats[19]; but, according to reports, it was otherwise under war conditions, and it has been said that the Vereinigte Chemische Werke a. G., of Charlottenburg, Germany, was able to manufacture fat on a commercial scale by the Zelinskii process.

Chemists who have attempted to repeat Zelinskii's work have found that the yields are very small[20]. The reasons for this are several, the principal among which are the following:

(1) The formation of the magnesium complex is very slow with derivatives containing more than eight or ten carbon atoms.

(2) It is well known that the higher magnesium alkyl halides react with a second molecule of the original alkyl halide to give a hydrocarbon and magnesium halide; for example:



$$C_7H_{15}MgBr + C_7H_{15}Br \rightarrow C_{14}H_{30} + MgBr_2.$$

(3) Brooks has found that the halogen derivatives of petroleum hydrocarbons of ten to twenty or more carbon atoms are unstable and slowly break down on standing at room temperature to give free halogen acids and hydrocarbons which appear to be mainly saturated ring compounds.

(4) Stadnikov[21] has demonstrated that the alkyl magnesium halide and ether complex breaks down in a variety of ways. For example, Stadnikov showed that a complex made from magnesium propyl iodide, carbon dioxide and benzhydrylbutyl ether yielded a mixture of several hydrocarbons, free carbon dioxide and mixed ethers, only a trace of acid being obtained.

Schultz in 1912-13 studied the oxidation of mineral oil fractions; but the percentage of fatty acid obtained was stated to be very small, the main oxidation products being aldehydes. Some of the best results are said to have been obtained by the oxidation of paraffine[22]. The Chemische Fabrik Troisdorf (Drs. Hülsberg and Seiler) has patented the following method: Air or oxygen is led into a vessel containing melted paraffine, for about fifty hours, at a temperature of 100 to 120 deg. C., mercuric oxide or previously oxidized paraffine being utilized as a catalyst. It is said that the products consist partly of oleic acid and partly of volatile substances, but nothing definite has been divulged respecting the yields of oleic or other fatty acids. A somewhat similar method is that of the A. G. für Mineralölindustrie vorm. (David Fanto & Co.), of Pardubitz, Bohemia. It has been stated that this firm has been working on a large scale, since 1915, a process which consists mainly in blowing air into paraffine for fifteen to eighteen days at a temperature of 130 to 135 deg. C. (See also English Patents Nos. 131,301, 131,302, 131,303, and 133,027.) The yield is calculated at about 60 per cent. According to reports, a fatty acid, $C_{11}H_{22}O_2$, of melting point 53.7 deg. C., thus has been obtained, together with an iso-palmitic acid, $C_{13}H_{22}O_2$, of melting point 38.4 deg. C., and lignoceric acid, $C_{24}H_{48}O_2$, of melting point 80 deg. C.

The methods so far known are considered to be of practically no value for preparing fatty acids from petroleum, even for the purpose of laboratory research. In illustration, it may be mentioned that hydrogen and fatty acids result from the fusion of the higher alcohols with potassium hydroxide, but only the higher primary alcohols give good yields. The secondary alcohols are slightly oxidized under these conditions and yield mostly condensation products, while the higher tertiary alcohols break down, giving acids having a less number of carbon atoms. Moreover, it has been shown that the alcoholates of the higher alcohols react with carbon monoxide under high pressures, but the principal products formed are esters of formic acid and not the higher fatty acids. The known methods for preparing alcohols direct from petroleum olefines yield only secondary and tertiary alcohols. And then no methods for

[18]See *Z. angew. Chem.*, vol. 16 (1903), p. 37.
[19]Colletas, *Mat. Grasses*, vol. 7, (1914) p. 4,1
[20]Brooks, MET. & CHEM. ENG., vol. 18 (1918),

[21]See *Ber.*, vol. 44, p. 1,157; vol. 47, p. 2,133; *J. Russ. Phys. Chem. Soc.*, vol. 47, pp. 1,122, 2,037, and 2,115.
[22]Cf., however, Wegrzyn, *Petroleum*, vol. 13, p. 24, who made entirely unsuccessful attempts to obtain fatty acids from solid paraffine.

adding halogens or halogen acids to the saturated or unsaturated hydrocarbons are known which give satisfactory yields of primary derivatives.

A variety of methods also have been proposed for oxidizing saturated and unsaturated hydrocarbons by air in the presence of various other substances and many wet methods have been tried, but in general the results are carbon dioxide, water, resinous or asphaltic material, and traces of the simple fatty acids, such as acetic, propionic, butyric, etc., which usually have not been obtained in quantities sufficient for positive identification. Our knowledge of hydrocarbon chemistry is unsatisfactory, and hence in real need of the revision of research. The commercial production of fatty acids from petroleum may some day be accomplished, but not by the methods of synthesis now known and not until there has been obtained a much more extensive and quantitative knowledge of the nature and behavior of hydrocarbons, such as constitute petroleum oils.

The lowest boiling fraction of petroleum, of the composition C_5H_{12}, may be used for the preparation of isoprene: by systematic chlorination, isomerization and liberation and addition of hydrochloric acid, the three hydrocarbons present (iso- and normal petane and tetramethylmethane) all can be converted into isoprene. But much more investigation will be required before carbon complexes.

It is thought that a simple, direct process for obtaining the butadiene hydrocarbons from petroleum soon will be found, and thus a good route to synthetic rubber will be opened up. Pyhälä has shown that the fraction of Baku petroleum boiling between 98 and 106 deg. C. yields up to about 20 per cent of its weight of adipic acid, which, by way of the amide, can be converted into butadiene.[33] This method of preparation is, however, hardly possible from a commercial standpoint, and butadiene usually is obtained technically from benzene or phenol.

It is of interest to mention in this place that the emulsions obtained with the turpentine-like and other hydrocarbons of petroleum by the aid of certain emulsifying agents are similar to rubber latex and can be worked up into rubber-like products.

Finally, it may be noted that the production of dyestuffs from petroleum is an open field for research exploration. Kharitchkov[34] has found that the nitro-derivatives obtained by treating machine or spindle oils with warm nitric acid (specific gravity, 1.50) are related to the nitro-compounds obtained by nitrating polynaphthenic acids and used in the preparation of dyestuffs. Nitro-products which yield with alkalis brown substantive dyestuffs and with sulphur and alkalis brown to brown-violet sulphur dyestuffs have been obtained by the nitration of the higher fractions from Galician petroleum.[35] The preparation of aromatic hydrocarbons from fatty hydrocarbons—especially the preparation of benzene and its homologues from petroleum—requires investigation along broad lines, although the subject is not of technical interest here at present. Crude petroleums from some Bornean and Persian fields are aromatic-rich and provided toluene for TNT manufacture during the European war.

While one-fifth of the domestic consumption of petroleum is utilized as fuel, most of the crude oil is refined into products which possess wider usefulness and higher value to society than the raw material, and refining practice is in continuous flux to adapt petroleum to a varying and widening demand. Under present technical procedure, however, petroleum yields only several hundred substances of commercial importance, but no limit can be set to the number of useful products that scientific inquiry may wrest from this raw material. Indeed, the field of petroleum byproducts represents one of the most attractive research opportunities that exist in this country today. It has been observed by Gilbert and Pogue[36] that-

> In this connection an interesting vision opens up as to how a great oil byproducts industry, through the values accruing to successive refinements of products, may be led to contribute more than it now does to the expense of petroleum production, relieving to that extent the cost distributed among the products universally used in bulk, such as gasoline. It would seem that a far-sighted economic policy, properly directed, might eventually contribute to a lowering cost for motor fuel, just as a proper shaping of coal economics could be made to relieve the focus of expense now exclusively borne by fuel coal—the two conspiring to lower the cost of living.

The time may be foreseen when, through the accomplishments of technochemical investigation, the petroleum industry will yield a range of fuels for the internal-combustion engine only; kerosene in quantity narrowing to that desirable for country use and export trade; lubricating oils adjusted to the growing demands of mechanical power; and an ever-widening range of chemical products supporting a great petroleum byproducts industry, rivalling if not exceeding the coal-products industry in importance. In respect to the last, it should be emphasized that the United States today faces an opportunity similar to that which twenty years ago confronted both Germany and the United States as regards the manufacture of dyestuffs, explosives, fertilizers, drugs and other chemicals from the non-fuel components of coal.

The Need for Petroleum Section of the American Chemical Society

The recognition of the high value of science to industry has led to the adoption of systematic procedure in the collection and diffusion of technical information, and the tendency in all civilized countries is more and more in the direction of increased specialization. For example, the very comprehensive subject of chemistry no longer is represented by a unicameral society or by periodical literature dealing with it in an all-embracing manner; and while the multiplication of organizations and journals is attended with obvious disadvantages, it is recognized generally that these are offset largely by the resulting benefits, and that the interest of those engaged in any important industry can be promoted most satisfactorily by affording facilities for assembling under a distinctive banner.

The position to which the petroleum industry has attained, technically and scientifically, is such that the creation of a separate organization for the benefit of those chemists who are engaged actively in it is fully justified. In 1913 there was formed in England the Institution of Petroleum Technologists, constituted principally of chemists and chemical engineers employed in the petroleum and shale-oil industries; but so far nothing has been done, in a national way, in the United States.

The several petroleum refiners' associations afford

[33]*Petroleum,* vol. 9 (1914), p. 1,376.
[34]*Chem. Ztg.,* vol. 37 (1913), p. 869.
[35]See Freund, *Z. angew. Chem.,* vol. 25, p. 1,058.

[36]U. S. National Museum, Bulletin 102, I, 11.

ample machinery to care for questions of general policy, internal and external, affecting the petroleum industry of this country. These are, however, strictly trade organizations. Without the desire to inflict any additional cares upon the industry, which now has its hands full in supplying pressing commercial needs, opportunity is taken here to indorse the formation of a petroleum section of the American Chemical Society, a move recently proposed by a group of chemists professionally interested in petroleum and its refining.

To rest content with the present status of the petroleum industry would not be characteristic of this nation, which is justifiably proud of its initiative, resourcefulness and inventive spirit. New lines must be developed and advances must be made in technical methods, if we are to progress adequately. No surer provision could be made for these efforts than the semi-annual gathering of the research men from the various petroleum laboratories, into the atmosphere of a great assemblage of chemists. The presentation of papers and their discussion would establish facts of value to all, broader viewpoints would be obtained, and sympathetic personal relationships formed which would stand to good advantage.

It is natural perhaps that each commercial organization should desire to retain for itself the benefits of research conducted under its auspices, yet, carried too far, it is a short-sighted policy in view of the varied workings of different minds. Community of knowledge as to scientific achievements, safeguarded by the critical discussion of experimental results, has proved to be so valuable a means of technical advancement that it should not be neglected in the petroleum industry.

The objects of a petroleum section of the American Chemical Society should be along the following general lines:

(1) To enable chemists and technologists engaged in the petroleum, shale-oil and natural gas industries to meet and to correspond, and to accumulate trustworthy information regarding the occurrence and production of petroleum, oil-shale and natural gas, the conversion of the raw materials into manufactured products, and the characteristics and usages of these products, together with their transport and storage.

(2) To promote the better education of persons desirous of becoming petroleum engineers, refinery engineers or hydrocarbon chemists, and to elevate the professional status of those employed in the industries mentioned by establishing a high standard of scientific and practical proficiency.

(3) To encourage research in hydrocarbon chemistry.

(4) To co-operate with the American Petroleum Institute and with the National Research Council, and to collaborate with the American Society for Testing Materials in its work on the standardization of bituminous and petroleum products.

Petroleum and the European War

It has been said that the success of the Allies in the European war was due largely to the supply and utilization of petroleum. Certainly, as Dunstan has remarked,[27] without mineral oil warfare would have remained in a mediæval condition and an impasse might have resulted. As we now know warfare, it is impossible to conceive of strategy and tactics deprived of oil-fired ships, motor transport, aircraft, tanks, and flame projectors, while industry at home lacked internal-combustion engine fuel and lubricants. The vital importance of the reaction of petroleum on the great struggle was pointed out clearly and forcibly at the annual dinner of the Institution of Petroleum Technologists last year.[28]

The principal problems confronting the Allies were:

(1) Whether the world could produce the aggregate supplies that were required for the service of the war.

(2) Whether the processes of refining could be so adjusted that increased quantities of heavy fuel could be obtained as well as of gasoline, particularly of the high grade required for aviation purposes.

(3) Whether sufficient tankers, cars and receptacles could be provided to transport and distribute by sea and land the necessary quantities of each product.

All these problems were solved satisfactorily—a fact which reflects the greatest credit to the large petroleum companies as well as to those who acted for the governments.

An enormous amount of intensive research was initiated throughout the war, and it is not too much to state that a wider and deeper knowledge of naphthology is one of the good results of the conflict. Immediately after this country entered the war the splendid facilities of the laboratories of the important refining companies and of the Bureau of Mines were offered to the War Department for experimental work, and the acceptance resulted in considerable investigational work. Perhaps the most valuable contributions were made on fuels for airplane motors, products of "cracking" processes, lubricating oils and the inspection of fuel oils. The standardization of motor gasoline and lubricating oils, and specifications therefor for Government purchase, emanated from the committee on the standardization of petroleum specifications of the Fuel Administration.

[27] "Reports of the Progress of Applied Chemistry," vol. 4 (1919), p. 66.

[28] J. Inst. Pet. Tech., vol. 5 (1919), p. 221 et seq.

Need for Petroleum Production Engineers

The United States Bureau of Mines points out strongly the need for petroleum production engineers who shall apply their scientific and geologic training to oil field development work and to the improvement of the processes of extraction from the ground of all the recoverable oil.

One of the hard problems to contend with at the oil wells is that usually there exist strained relations between the technical and non-technical men, although there is no logical reason why most cordial relations could not be established between the petroleum engineers and the other employees. A little leniency ought to be shown on both sides. It would be a good policy for engineers to discuss with the drillers the daily well reports.

According to Bulletin 195, "Underground Conditions in Oil Fields," the duties of experienced petroleum engineers might be outlined as follows:

(1) Keeping of records.
(2) Preparation of data, such as production records, well logs, structure contour maps, cross-sections, etc.
(3) Correlation of surface and underground geology.
(4) Water problems.
(5) Casing depths.
(6) Underground losses.
(7) Oil sands; location of productive sands, their thickness and quality of oil.
(8) Well depths.
(9) New well locations and extension of the field.
(10) Future well production.
(11) Gaging of oil wells.
(12) Perforations and setting screen pipe.
(13) Fluid levels and tubing depths.
(14) Shooting of oil wells.
(15) Methods of extracting more oil from the oil-bearing formations.

Physical Chemistry and Technology

Progress of Technology Dependent on Existing Physicochemical Knowledge Being Interpreted and Applied as Well as Augmented—Empirical and Scientific Solution of Problems—Physicochemical Data—Co-operative Research

BY EDWARD W. WASHBURN

THE writer has given elsewhere the following definition for the term physical chemistry: "Physical chemistry, sometimes called also theoretical or general chemistry, treats of the fundamental laws and principles and the important theories and systems of classification which have been formulated in order to give scientific expression to our knowledge of the physical and chemical behavior of material substances." Scientific expression of our knowledge of any subject is that expression of it which enables the human mind to acquire this knowledge in as complete a form as possible with a minimum expenditure of effort. Such a definition, in a sense, might be said to include the whole of both physics and chemistry and it is, of course, impossible to draw any sharp line between the two sciences or between either of them and that borderland region to which the term physical chemistry is ordinarily applied.

With such a definition of physical chemistry, it would seem almost unnecessary, if indeed not quite superfluous, to dwell upon its importance to the whole field of chemical technology, and therefore in responding to the editor's request for a contribution on this topic, I shall attempt only to set forth briefly two outstanding features of the work of the physical chemist in its relation to industrial progress.

These two features may briefly be described as follows: (1) Knowing how to find, interpret and apply existing knowledge; and (2) knowing how to set to work in a scientific manner to acquire necessary new knowledge; the term *scientific* being here employed with the significance attached to it in the definition of physical chemistry given above.

THE USE OF EXISTING SCIENTIFIC KNOWLEDGE

A good working knowledge of physical chemistry enables the industrial scientist to make use of a wealth of scientific data which would otherwise be largely unintelligible to him, the bearing of which upon his own problems he would otherwise be unable to perceive. How many chemical engineers, for example, without a working knowledge of physical chemistry would, if faced with the problem of perfecting a process for the production of pure hydrogen on a large scale, expect to find information worth considering in papers bearing such titles as "The Phase Rule Diagram of the System Iron-Oxygen," "The Electromotive Force of the Cell Zn-Saturated Solution of ZnO in NaOH-NaOH-H_2," "The Free Energy of the Reaction Between Steam and Metallic Iron," "The Free Energy of the Water Gas Reaction" or "Selective Catalysis"; or having such an expectation, how many would be able to understand and make use of the information there given? It is unquestionably possible even at the present day to publish in a scientific journal of wide circulation a contribution containing results of fundamental importance to an industry representing investment of many millions of dollars and to have this contribution remain entirely unknown to those engaged in this industry.

During the last few years we have been hearing, and rightly so, a great deal about the importance to our national welfare of greatly increased facilities for scientific research, but in urging the importance of such research to the industrial progress of the nation we should not forget that such progress does not result from the mere acquirement of new knowledge. The acquirement must be followed by utilization. I think it may be safely stated that the amount of progress, if it could be measured, which would result during the next decade from a complete utilization by the industries of the country of the scientific knowledge already extant would be quite as great as that which will result from the new discoveries of research workers, important as the latter are sure to be. In urging, therefore, the importance of scientific research, it should be remembered that such research will promote industrial progress only in so far as industry supplies the machinery for putting the new knowledge into effect, and in so far as any industry fails to apply extant scientific knowledge, just so far are the results of future scientific research likely to be barren of practical results in that industry.

It so happens that some of the most backward of the industries in making use of modern scientific knowledge are to be found among those industries which were earliest developed by mankind, such for example, as the tanning industry, the textile industries and the glass and clay products industries, while others of this group, such as the brewing industry and metal-working industries, have made extensive use of the modern scientific methods. Such a backward condition, while deplorable from the modern scientific viewpoint, is a perfectly natural one, because the progress, in many ways remarkable, which has nevertheless been attained in these "backward" industries, represents the accumulation of centuries of hard experience, gained by the slow processes of trial and error, in many instances, long before the development of science itself. Knowledge gained in this way tends to produce extreme conservatism in those who possess it, together with a general skepticism regarding the value of anything which a chemist, who knows nothing about the industry, can accomplish. Fortunately, this condition has now largely disappeared, the last ten years having seen a great change in the attitude of many of the older industries toward the value of applied sciences.

The training of the physical chemist, including as it does (or should) the fundamentals of chemistry, physics and mathematics, as well as those of that borderland science more strictly included under the term physical chemistry itself, is peculiarly adapted to the production

of a mind trained to appreciate, understand and apply a wide range of scientific knowledge. Thus while each industry will naturally employ specialists in those branches of chemistry or physics touching most closely upon its own special field, *every* industry could to advantage make use of the services of a physical chemist, and no industrial research laboratory is complete which does not have available the services of at least one physical chemist. It is true that there are physical chemists and physical chemists and the writer knows of no safe criterion of selection other than the Biblical one, that a man should be judged by his works, and as long as there continues to be an inadequate supply of well-trained men in this field, there will inevitably be disappointments in what some of them will be able to accomplish.

The most important feature in the training of every physical chemist is the development of the reasoning powers, the powers of analysis, the ability to weigh and judge and to bring to bear upon a problem the attitude of mind and the scientific instinct of the chemist, the physicist, the mathematician, and finally, when it comes to a question of industrial application, also of the engineer. This is admittedly a large requirement, but in so far as it is attained the ideal physical chemist will be produced.

One maxim which should be impressed upon all students of physical chemistry is the following: *No one can safely use a mathematical relationship, the derivation of which he does not entirely understand.* Nor is it sufficient that he should once have understood it; the essential features of that derivation and all the factors which it involves must be kept constantly in mind. There are unfortunately in the literature numerous examples of attempts to apply some equation or law of physical chemistry to a case which does not come under it at all, or which fails to meet one or more of the assumptions upon which the law is based. In fact it is always safer to derive the desired equation for the particular case at hand rather than try to adapt a more general relation to a special case. It is because of this lack of a thorough understanding of the laws of physical chemistry that so many chemists go wrong when they attempt to apply these laws to particular cases. In fact, it is so easy to go wrong in this particular —to forget for the moment the precise significance of some term in a thermodynamic relationship, for example—that instances of this character can be found in the writings of the most eminent authorities in this field. There is, of course, no absolute guarantee of avoiding occasional mistakes of this character, but the chemist who can go back to first principles is less likely to err than the one who attempts to use a relationship in a mechanical fashion. The philosophy of science as treated by such writers as Poincaré, Mach, Enriques, Russell, etc., should be included in the education of every candidate for a doctor's degree in physical chemistry.

The Acquirement of New Knowledge

We may distinguish two classes of methods of attacking a research problem. One of these, the empirical or cut-and-try method, tries one thing after another, systematically and intelligently, it is true, in the hope that the desired solution may eventually be hit upon. The scientific method, on the other hand, first studies and analyzes the problem in the light of all the data which physics and chemistry can supply and finally outlines a method of attack which will yield as complete a knowledge, both qualitative and quantitative, as may be, of the factors involved in the problem, the why and wherefore of these factors, and their relation to other associated questions, and when the solution is finally obtained there is a reasonable degree of certainty that it is the best one, everything considered.

The Empirical Solution

The first method is easier to carry out, requires the consumption of less gray matter, and has many times been productive of important results, although the percentage of successes may seem larger than it is, because the failures are usually not recorded. The first method may, moreover, yield much quicker results than the second, but on the other hand, it may never yield any results at all and if, as is sometimes the case, it is carried out on a factory scale, it may prove exceedingly expensive. If the investigator is lucky, however, he may hit upon a solution in the factory itself, and if so, he may feel well satisfied with himself, as a "practical" man, who has found a "practical" solution to a "practical" problem without wasting a lot of time and money on "highbrow stuff." The fact that he may have more or less stumbled upon a solution and that he frequently has not the ghost of an idea (or else a very wrong idea) of what was back of his problem, or why his solution was a solution, or how long it will remain a solution ought to warn him that hand-to-mouth research, even when successful, still leaves much to be desired.

The Scientific Solution

The scientific method, while slow perhaps, is reasonably sure, its results are of permanent value and carry with them a feeling of confidence and surety which those of the empirical method largely lack. In practice, the two methods, of course, merge into each other more or less. Whenever the scientific analysis of a problem shows that little or no help is obtainable from existing scientific knowledge, recourse must naturally be had to the empirical method or else a new domain of science must be opened up and explored, and naturally few industrial problems can wait for the progress in pure science which might be required before the scientific method could be strictly employed. This was approximately the state of affairs a few years ago with respect to those industrial problems which today would be classed as problems in colloid chemistry.

Physicochemical Data

The physical chemist who undertakes to apply his science to industrial problems will often find himself confronted with the following situation: The scientific analysis of the problem is fairly easy—sometimes, in fact, ridiculously simple. The principles involved and the manner of their application are quite obvious, but when he sets to work to solve the problem he finds that the literature fails to give him the necessary physicochemical data in numerical form. A phase rule diagram is missing, the free energy of some reaction has not yet been determined, certain data on specific heats or solubility or what not are lacking. A whole set of problems in pure science is uncovered the solution of which must precede the attack on the main problem by other than an empirical procedure.

The writer was called upon recently for advice in connection with the production of a material which should be suited as perfectly as possible to withstand

certain conditions. On investigation, it was clear that the direction in which the solution of the problem was in all probability to be found could be perfectly definitely stated in approved physicochemical terms, using the letters, *a*, *b*, *c*, etc. (or α β γ, if preferred) to represent certain quantities, but that was as far as physical chemistry could go. The numerical values represented by the symbols had never been determined and although their determination offered no particular difficulty from a scientific point of view, a rather lengthy and, for the company's interest, expensive investigation would have been required. Moreover, while it was evident that such an investigation was of fundamental character to this branch of the company's activities, it was just as important and fundamental to a great many other companies engaged in the same business and it was not clear that the financial gain would be sufficient to justify the expense being borne by one company.

Co-operative Research

It is just here on problems of this character that co-operative research needs to be developed. The resources of the universities and of endowed research foundations are not sufficient to keep the progress in pure scientific research up to the demands of the industrial world. Either the industries must themselves enter this field on an extensive scale (as some of them have already done) through co-operative research organizations, or in their own research laboratories, or they must come more strongly to the aid of universities, or preferably both. In fact, if the latter course is not pursued, they will soon destroy the possibility of entering upon the former.

Influence of Mathematical Speculations on the Progress of Chemistry

The May, 1920, issue of *Chimie et Industrie* publishes *in extenso* the lecture given by Prof. Henry Le Chatelier before the French Society of Industrial Chemistry on the great importance of applying higher mathematics to the study and interpretation of chemical reactions and on the furtherance of chemical research work.

He dwells strongly on the needs of the higher general scientific education for the chemist and cites cases where work on chemistry of the greatest industrial importance was brought to successful results not by men who had received only a purely chemical education but by those who had received a solid theoretical education in well-known engineering schools. This is illustrated by the work of men like Osmond, Deshayes, Charpy, Guillet, Bied and Taffanel, all graduates from the Paris schools of Polytechnics, Centrale or Mines, where they could not have received sufficient experimental training but where they acquired a solid scientific education which soon enabled them to become leaders in the chemical research field. If engineers could become so successful chemists, how much greater expectations might be surmised were the chemists to possess also the fundamentals of higher mathematics.

He proposes the formation of special schools of chemistry on lines similar to those of the Paris special school of electricity where only bearers of diplomas from well-recognized educational institutions shall be enrolled. Thus only will it be possible to train a growing number of men theoretically and practically well prepared to direct the chemical industries.

He suggests a program for the organization of the staff of chemical plants. This program calls for a director who shall have the above-outlined theoretical and practical education and whose duties shall be to submit to the chief of the laboratory chemical problems and act in a consulting capacity for the solution of such problems. The chief of the laboratory shall outline and direct the laboratory work, devise the appropriate experimental methods, apportion the work among his assistants, control the exactitude of the experimental results, and interpret these results. At present there are no special schools from which men prepared for such work might be recruited. The laboratory assistants shall be experimenters in physics or chemistry, specialists in their line of work. They could be recruited in a satisfactory manner from the now existing schools of chemistry. The help for doing the more or less routine work could be recruited from those with some easily acquired experience in the required line of work.

Prof. Le Chatelier considers the problem of training men for the task of chief of a laboratory of prime importance and dwells especially on their need for quite a thorough knowledge of special mathematics. He illustrates with facts the application of the notion of continuity to the interpretation of the theory of solubility, the utilization of geometric representations especially for the outline of programs of experimental work, the generalization in solving chemical problems by the use of logarithms and a better co-ordination of experimental results and minimizing the experimental errors by applying the fundamentals of the calculus of probabilities.

It is especially in the practical application of chemical mechanics that mathematical knowledge is of great importance. All the laws of chemical mechanics are exclusively of mathematical origin. The number of these laws is small, but their rigorous exactitude makes them particularly useful. He passes them in review and illustrates their importance by enumerating some of their applications. Thus:

The law of factors of equilibrium has served to explain the function of catalyzers in chemistry as being similar to that of lubricating oils in mechanical apparatus.

The law that two systems in equilibrium with a third are in equilibrium with each other and reciprocally has been successfully applied by van't Hoff to the study of the vapor tension of efflorescent salts.

The law of the stability of equilibrium has been used in solving the problems of a better utilization of the sensible heat of gases and is applied to the now rapidly growing industry of synthetic ammonia.

The law of phases has enabled van't Hoff, Bakkhuis, Roozeboom and their pupils to solve the complicated systems of acid solutions of iron chlorides and of the sea water salt solutions. The same law led van't Hoff to establish his dilatometric method to the solution of chemical problems.

The law of iso-equilibrium established by Clapeyron in the particular simple case of vapor tension has been generalized by Thompson to fusion phenomena. This law, combined with the law of mass action of gaseous systems, has been successfully applied to the synthesis of nitric acid by the electric arc.

He concluded with the plea for changes in the educational programs of colleges and universities and for the formation of special schools of chemistry for the theoretical and practical training of chief chemists and chiefs of chemical laboratories.

Relation of Chemical Engineering to Sewage and Trade Waste Treatment

A Brief Outline of the Methods of Sewage and Trade Waste Treatment—The Activated Sludge Process and the Chemical Engineering Problem Involved in Pressing and Drying the Sludge

BY R. H. EAGLES*

THE development of municipal sewage disposal in the United States has made great strides in the past decade by virtue of the progressive and forward-looking spirit of our fast-growing cities. Impetus has been given to the movement by the natural influence of the many public welfare campaigns for which this country is distinguished.

In Great Britain and Continental Europe, where residential and industrial habitation is extremely dense, adequate sewage disposal equipment is a universal necessity, because the public waterways—the natural scavengers—cannot stand the concentrated load of raw sewage which they must otherwise carry.

American engineers are anticipating this condition and are devoting their energies to the development of a standardized system or systems which can be applied to any set of local conditions with pre-assured success. The matter of operating expense is in most cases the governing factor, and this has given rise to many efforts to recover commercially the valuable elements which are known to be present in the wastes. Attempts along the latter line have been only partly successful to date in that the valuable constituents have been reclaimed in concentrated form as solids, but the final economical preparation, in marketable form, has proved the stumbling block.

It is toward the solution of this problem, which is in reality of a process nature, that the services of the chemical engineer should be impressed. He alone of the engineering profession is best adapted by training and experience to work out the details which involve principles of physical chemistry and the mechanics of pressing, conveying and drying. He is also well equipped to prepare his product in the best shape—chemically and physically—to assure its ready demand and highest value.

METHODS OF SEWAGE TREATMENT

To be specific, one of the most important problems facing sewage treatment development today is to find a satisfactory means of dewatering and drying activated sludge and converting it into a marketable fertilizer. Before elaborating on this problem a brief sketch of sewage treatment methods may be of interest.

When the disposition of domestic wastes by water carriage came into general use it immediately presented the problem of reseparating the waste materials from the water at a community or municipal plant. This became necessary for the protection of public health from drinking water pollution and for æsthetic reasons involving the visible evidence of wastes in the public waterways. In the case of towns and cities located on the seacoast the simplest method, and one which is still generally in use, lay in carrying the wastes into the sea, where the extremely high dilution soon obliterates all traces of pollution.

The objectionable constituents of domestic sewage consist chiefly of unstable organic compounds in solution and suspension. The compounds undergo more or less rapid decomposition and furnish nuclei for the propagation and subsistence of disease-producing bacteria which are also present.

Among the methods of sewage treatment which have been used, either alone or in combination, are the following:

1. Mechanical Fine Screening.
2. Sedimentation.
   (a) Straight sedimentation with sludge removal.
   (b) Imhoff sedimentation, with self-contained sludge digestion.
   (c) Septic tank sedimentation with self-contained sludge digestion.
3. Chemical precipitation (followed by sedimentation).
4. Sand filtration.
5. "Sprinkler" or "trickling"- aërating filters.
6. Contact beds.
7. Chlorination.
8. Electrolytic oxidation.
9. Activated sludge.

The various features and combinations which apply to these methods are too numerous to describe, but it is the purpose of this paper to present some of the features which may be of active interest to the chemical profession.

THE ACTIVATED SLUDGE PROCESS

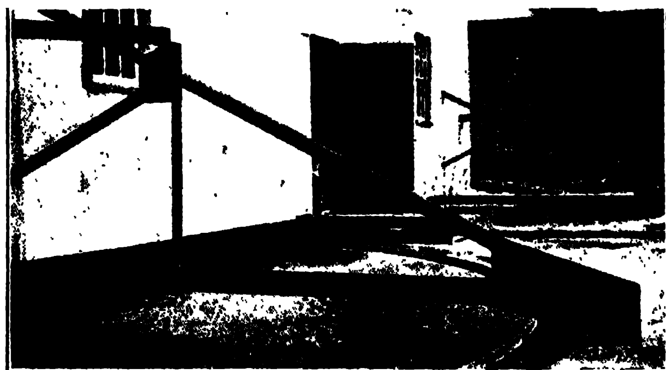
The activated sludge process of sewage disposal has come into prominence within the last few years. It employs the use of aërobic, or oxygen-consuming, bacteria for the purification of the sewage. The biologic growth is first developed and cultivated, and it then propagates and is kept alive by the constant addition of fresh sewage, the impurities of which supply the food, and air, which is used both for agitation and as a supplementary food. This method has proved highly satisfactory as regards the production of a clear, stable effluent, and it has reduced in many cases a sludge containing considerable fertilizer value in the form of nitrogen compounds. The control of the bacteria and the means of increasing their nitrogen-retaining ability extend into the field of chemistry.

Another phase of the activated sludge process

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which should receive the attention and study of chemical engineers is the design of apparatus which will economically introduce the air and maintain a prolonged, intimate contact with the fresh sewage and the bacterial flocs. The greatest cost of the process is that of supplying compressed air. Many experimenters have relied too much on the use of the air to effect agitation and circulation, in addition to supplying the really minute oxygen requirement of the bacteria.

It has been calculated that the actual oxygen requirement could be theoretically satisfied by the addition of 0.05 cu.ft. of air per gal. of sewage treated. The average optimum practice of a number of experimental stations in this country and England has shown a requirement of 1.5 cu.ft. per gal., or thirty times theoretical.



CLARIFYING TEXTILE MILL WASTE WATERS AND REMOVING THE IMPURITIES AFTER CHEMICAL PRECIPITATION AND COAGULATION

A more recent modification developed at a test plant at Mount Vernon, N. Y., has reduced this requirement to 0.5 cu.ft. per gal., one-third the usual amount, but still ten times theoretical. The reduction at this plant is due partly to a mechanical design which insures prolonged and intimate contact of the air bubbles with the sewage, at the same time utilizing the maximum mechanical efficiency of the air for circulation purposes.

Here again is an inviting field for chemical engineering research. It is, strictly speaking, the problem of absorption of a gas in a liquid, the elements being air and sewage.

This leads to a closely allied feature of the process which has not yet been perfected—namely, the matter of air diffusion. Various types of porous media such as filtros tile, basswood blocks, cement and sand preparations have been tried with varying degrees of success, the desideratum being an air bubble of sufficient fineness to prevent its coalescing because the minute bubbles offer more contact surface. Practice in this country has inclined to the use of filtros tile as the best-adapted medium, but it is an open question whether ejectors or some type of spraying device may not economically substitute for diffusion media entirely.

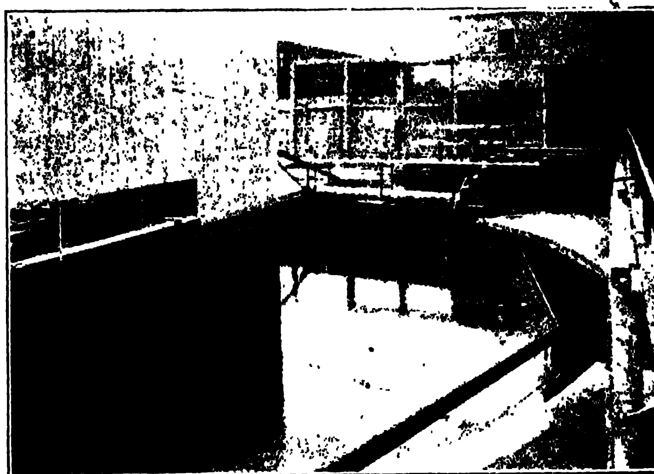
By far the most important problem in connection with the activated sludge process, as mentioned before, is the disposition of the resulting sludge. The activated sludge itself is a biologic growth of flocculent structure, and under proper conditions should contain from 3 to 6 per cent nitrogen on dry basis, expressed as ammonia. In view of the present market price and demand for nitrogen fertilizer it is readily seen that a promising field of investigation is opened up in the commercial reclamation of the sludge.

Problems of Pressing and Drying the Sluge

The flocculent nature of the sludge prevents its concentration by straight sedimentation, although it can be reduced to 97 per cent moisture by mechanical dewatering devices, as has been demonstrated by the use of a Dorr Sewage Clarifier at the Milwaukee test plant. Centrifuging will further reduce the water content by approximately 90 per cent, but the definite advantage to be obtained by this expensive intermediate step has not yet been demonstrated. The use of filter presses of various types has been tried with mediocre success. The sludge flocs on pressing revert to a jelly-like mass which clogs the pores of the filter cloth, resulting in an expensive and inefficient procedure. The sludge decomposes rapidly to an unfilterable mass, and this factor must be carefully watched.

Various experimenters have been using filter presses even under the trying conditions and producing a filter cake with moisture content sufficiently reduced to permit of feeding to a drier. Mechanical conveyor difficulties have been encountered, and an appropriate drier has not yet been determined.

It may be said without exaggeration that further development of this very desirable method of sewage purification will be held at a standstill pending a successful method of pressing and drying the sludge. It is not unreasonable to expect that helpful suggestions, and possibly a successful solution of the problem, will come from the chemical engineering profession, where similar problems have been encountered and solved.



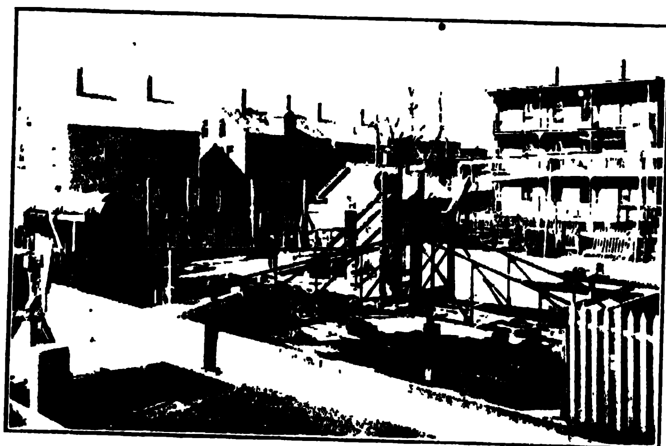
TANNERY SEWAGE CLARIFIER IN OPERATION, REPLACING AN OLD "FILL AND DRAW" SYSTEM

Sedimentation

The foregoing will serve to point out the immediate problems of the activated sludge method of sewage treatment. Another distinct system of treatment which is coming into prominence, particularly in England, is the use of straight sedimentation for the removal of all solids which will settle, followed by treatment of the clarified sewage by biologic or chemical final purification. The settled solids are removed in the form of thick sludge for disposal by biologic diges-

tion or by natural draining and carting-away methods. This system offers the advantage of low operating costs, but does not offer the recovery values of the activated sludge process because the nitrogen values must finally be carried away in solution, preferably as innocuous nitrates.

A careful study of sedimentation principles is entailed by this system, which may be said to lie within the field of physical chemistry. The mechanics of



TANNERY SEWAGE CLARIFIER (UNDER CONSTRUCTION) CLOSE TO RESIDENCES. NO FLIES, ODORS OR OTHER NUISANCE RESULTS FROM ITS OPERATION

performing efficient sedimentation and provision for continuous withdrawal of thick sludge are features of great importance.

Sewage treatment by chemical precipitation has been used in many localities, the reagents usually being lime or lime and copperas. The method entails a high operating expense, with slight prospects of recovery values, and cannot be said to possess attractive possibilities. The use of chlorine gas, however, for disinfection of the final clarified effluent is common practice and is satisfactory in meeting certain local conditions.

Treatment of Trade Waste

The field of industrial trade waste treatment is replete with possibilities which should attract the attention of chemical engineers. Broadly speaking, all methods of industrial waste water treatment are dependent on definite chemical reaction, or on the close delineation of physical chemical conditions. A number of unsuccessful trade waste treatment plants can be pointed out where the failure is directly traceable to the fact that an attempt was made to apply one of the standard methods of domestic sewage treatment to the problem, in contravention to basic chemical principles. The field belongs rightfully to chemical engineers, who can trace the offending elements in the waste waters back to their source and can regulate the other wastes or prescribe chemical additions to react with the offending elements or convert them into a physical state suitable for separation from the innocuous waters.

It would be difficult to describe standard methods of trade waste treatment because they will vary widely with local conditions at different plants even in the same industry. In general the following will apply:

(a) Sizable suspended solids—removed by screening or sedimentation.

(b) Colloidal solids—removed by addition of chemical coagulants and electrolytes, followed by sedimentation.

(c) Dissolved solids—removed by chemical precipitation, followed by sedimentation.

(d) Color, odor—removed by chemical precipitation, or sand filtration, etc.

Trade waste treatment naturally involves a constant overhead expense to the manufacturer without material gain except in cases where byproducts can be recovered. It is therefore essential that operating costs be reduced to a minimum, and this can be accomplished only by the careful study of the chemistry of the plant itself with a view to bringing into use every potential coagulant which might otherwise be thrown away without utilization, and the regulation of the internal plant routine to make the waste water conditions as uniform as possible. It also means a careful survey of the pollution conditions to ascertain the minimum degree of purification which will suffice.

The mechanical methods of dosing waste waters, the design of adequate sedimentation units to produce uniform clarification and a minimum volume of sludge, the use of carefully determined chemicals where necessary, are all essential factors which tend to make the field of trade waste treatment a distinct profession, merging the experience of the chemical and sanitary engineers.

With the close of the war has come a renewed siege of anti-pollution campaigns on the part of the various health authorities. These campaigns are doubtless justified where an economical system of overcoming the pollution evil can be offered. All public-spirited citizens will welcome the restoration of our rivers and waterways to their original clean condition because they are the natural parks and playgrounds of the populace at large. If they can be cleaned up without placing an excessive burden on the industry, which also has a right to exist, all energies should be bent to that end.

It is apparent that the chemical engineer has a definite interest in matters pertaining to sewage and trade waste treatment, and it is to be hoped that this interest will soon manifest itself in distinct contributions to the art as now practiced.

New York City.

Purification of Sewage With Activated Sludge

Activated sludge has the property of purifying raw sewage in the presence of air and it is generally admitted that this remarkable purifying action is exercised according to the mechanism of nitric fermentation. R. Cambier has studied this subject and presented the results of his work before the French Academy of Sciences (*Comptes rendus*, March 15, 1920, pp. 681-684). He subjected raw sewage in the presence of activated sludge to forced aëration at temperatures between 0 and 55 deg. C. and found that the most appropriate working temperature is between 20 and 25 deg. C., that the presence of nitrous acid is not appreciably manifested below 30 deg. C. and that activated sludges are capable of transforming nitrites into nitrates at ordinary temperature. If a mixture of activated sludge and sewage after nitrification is left to settle for three hours and the supernatant clarified liquid decanted, the liquid separated from the centrifuged residue is found to be poor in nitrates but containing 10 mg. of ammonia per liter and that the nitrifying capacity of the sludge is not altered.

Putting the Vegetable Oil Industry on a Scientific Basis

An Outline of the Vegetable Oil and Fat Industry in Which Attention Is Directed to Problems Connected With the Production of Crude Oils and Fats, Laboratory and Refining Problems, and Research Opportunities in Manufactured Products

BY HERBERT S. BAILEY*

UNTIL comparatively recent times we have been accustomed to look upon certain fats and oils as suitable only for technical purposes, while others were classed as edible. This distinction was to a certain extent geographical. The Russians, for instance, used linseed and sunflower seed oils for food, while in England and America these were of importance only in the paint and allied industries. The Eskimo dines daily on whale blubber and the African soaks his food in palm oil, but in the countries of the temperate zone whale oil has been associated with insecticidal sprays, and palm oil with tinplate manufacture.

With the recent developments in the art of refining, deodorizing and hydrogenating, these sharp lines of demarkation between edible and technical oils have largely disappeared. There are of course a few oils, such as castor, which are still taboo in civilized kitchens, and the sad lesson which Germany learned just before the war, when the poisonous hydnocarpus oil or Marotti fat was used in margarines, has made us hesitant about using new products in foods. Hydrogenated whale oil is today a regular constituent of some of the Continental butter substitutes and the writer has seen samples of fish oils which were as sweet and palatable as any of the commonly accepted edible vegetable oils.

The fact that nearly all fats and oils can be made edible does not mean, however, that they are now or will be in the near future employed promiscuously in food products. There are at least three basic reasons why some oils will remain in the technical group. One of these is psychological, one chemical and the third economic.

In the edible oil trade the conservatism of the non-scientific men at least is marked and it is more difficult to bring about a change in raw material even than in plant practice. Naturally, also, few manufacturers of food products care to risk the effect of the prejudice which would appear toward their goods if it were known that they were putting fish oil or horse tallow into their wares.

Because of their peculiar chemical composition, oils with good drying properties, like linseed, perilla and tung, are naturally more valuable to the paint maker than the lard substitute producer. Similarly the medicinal oils, such as cod liver, chaulmoorgra and castor, will be used largely by physicians, but because of the comparatively small demand of this trade, where the production is large the excess will go into technical lines.

Economically it is not profitable to subject some oils to the high refining necessary to convert them into satisfactory food products. Until the relative values of the fats and oils classed as technical and those at present used as food change, there is little prospect of any radical departure from the present grouping.

There was during the recent apparent shortage of oils a considerable volume of interesting and more or less valuable research on the utilization of well-known oils for new purposes and of little-known materials as sources of new oils. In these reconstruction days, however, the most fertile field of investigation is in improving the old or devising better new methods for the treatment of our common oils for the purposes for which they are already used. This will be especially true of oils such as soya bean and whale, which are on the border line between the technical and food groups, not quite the equal of linseed for paints or of cottonseed for lard substitutes.

The Scope of the Fat and Oil Industry

The various divisions of the fat and oil industry are so numerous that no single research laboratory, much less an individual investigator, can hope to cover them all. Dividing the field along the lines of the successive steps followed in obtaining the finished products from the raw oleaginous materials, we may start with the four main divisions:

A. Methods for obtaining crude oils from raw materials.

B. Subsequent treatment of the crude products.

C. The manufacture of derived products.

D. The utilization of byproducts.

Under the first of these headings will fall the various procedures for separating oil or fat from substances in which they occur in nature. At present there are but three methods of any consequence: Boiling out with steam; pressing out with hydraulic or tortional pressure; extraction with volatile solvents.

REFINING OPERATIONS

Having obtained the crude oils, it is necessary to subject them to one or more of the following treatments before they are suitable for human consumption:

1. Washing, filtering or settling, as applied to the virgin oils such as olive and peanut.
2. Refining with an alkali or acid.
3. Bleaching with an absorptive material such as fullers earth or carbons, or by chemical agents.
4. Deodorizing.

Technical oils usually require some sort of purification before they go into the finished products; thus, for paint and varnish making, linseed oil is settled or filtered to remove the mucilagenous materials, and bleached if intended for especially light colored products.

DERIVED PRODUCTS

Under the head of derived products might properly be discussed research related to the manufacture of boiled and bodied oils; lubricating greases, soaps, linoleum, rubber substitutes, stuffing grease; leather dressings, patent and artificial leathers, and many other lines in which fats and oils are used. Of perhaps more

*Editor, Chemists' Section, *Cotton Oil Press*.

general interest are the manufactured food products, lard and butter substitutes and the so-called synthetic milks. In these industries there are various steps between the crude materials and the finished articles of commerce, but only a few of the more obvious research problems in this field will be suggested in this article.

Problems Connected With the Production of Crude Oils and Fats

Steam or Water Extraction

One of the primitive methods of obtaining oil is that of merely boiling the oleaginous raw material with water. This process is still used by the natives of the tropics in making their "chow" oil from the fleshy portion of the palm fruit. A modern adaptation of this process is found in our packing houses, where the fats are removed from animal tissues by steaming in tanks under pressure. That there is a possibility of increasing the efficiency of the present practice or improving the quality of the resulting fats is doubtless true, but these problems after comparatively little preliminary laboratory work would best be handled in the plant.



A PRIMITIVE OLIVE OIL MILL

Extraction With Pressure

By far the larger part of our vegetable oils and a proportion of the animal fats are obtained by pressing, usually hot, the finely ground seeds or tissues containing them. The opportunities for the research chemist in this field are more limited than for the oil technologist who has mechanical genius, nevertheless there is still room for the chemical laboratory to be of great assistance to the crude oil mill. The time is coming when oil seeds will be purchased on the basis of their oil and food value, and the lucky chemist who devises a simple, rapid and yet reliable method for determining the oil content of the crude mill grist will win for himself a place beside Babcock, who did so much for the dairy industry. That a chemical treatment of some of the oil seeds may materially facilitate the pressing of the oil from them is probable—in fact, one such process has already been patented. Another problem for the laboratory is the process of fixing or, better, destroying the color bodies in the meals before they are pressed, thereby reducing materially the subsequent losses which now occur in the refining process.

Extraction With Volatile Solvent

It is in the extraction of oils and fats by means of volatile solvents that we find some of the most promising problems for the research chemist and oil technologist. While much work on extraction processes and suitable solvents has already been done, it is surprising how little reliable information is available in the literature. The chief objections to extraction systems at the present time are: The commonly supposed fire hazard, accompanied as it is by increased insurance rates; the loss of solvent in its removal from the oil and percolator residue; and the character of the products obtained.

To decrease the fire risk, it has been proposed to use di- or tri-chlorethylene, chloroform, or other non-flammable solvents, and there is still opportunity for investigators to find extraction liquids which will have all the advantages of benzene and gasoline without their disadvantages.

Research Must Be Carried to Semi-Commercial Stage

The points which must be borne in mind in such research are not only the power of the solvent to extract the fat or oil but the ease with which the solvent can be completely eliminated from the extract and spent meal and, what is often overlooked, the quality of the extract. Some solvents which in the laboratory in glass vessels have appeared very promising, when used in iron percolators on a large scale have been most disappointing. The meal in the plant equipment either packed so that it would not percolate or if extracted in tanks provided with agitators could not be properly mixed with the solvent. Again in some instances the meal, which on an experimental scale worked beautifully, when treated in 10-ton lots extracted so slowly or held the solvent so tenaciously that the operating department turned down the whole extraction proposition and "cussed" out the research laboratory as a lot of academic theorists.

One may obtain an oil—from cottonseed for instance — with some solvents, in glass flasks, which refines and bleaches with entire satisfaction, but the "stuff" turned out on a plant scale by an apparently identical procedure either will not refine at all or the losses more than counterbalance any advantages to be gained by extraction instead of pressing. These past failures, however, should not discourage further research but rather stimulate it and be a warning to those in charge of such investigation to fully test their discoveries on a semi-works scale before risking them in a full commercial trial. We shall have more to say about this point later.

Does Oil Extraction Differ From Inorganic Leaching?

A fundamental knowledge of the process of extraction is highly desirable at the present time. The commonly accepted view seems to be that there is a radical difference between leaching out an oil from the more or less completely ruptured tissues in which it occurs and the washing of an inorganic precipitate free from a soluble salt. Is this actually the case or do the same laws which have been found applicable to the inorganic leaching processes hold equally in the extraction of plant and animal constituents with solvents? This is a basic problem and one which might well be given serious study by some of the research laboratories of our universities. If we knew how to calculate the optimum conditions of pressure, temperature, size of particles and extent of draining in each percolation, from the solubility of the pure oil in the solvent at different temperatures and pressures, much of the present cut-and-try so-called research on this problem could be relegated to the "tank house."

Laboratory and Refining Problems

In a broad sense the term refining may be used to cover all those processes for the removal of free fatty acid, color, odor and other objectionable qualities from crude oils usually under the supervision of the refinery superintendent. Here we are dealing largely with strictly chemical or physical processes, therefore in this branch of the fat and oil industry the laboratory finds a most fertile field for research. The application of scientific knowledge to oil-refining is now woefully small, but the bearing which recent discoveries in the realms of colloids and catalyzers has to the operations is realized by many of our chemists and we may confidently expect some most important applications of this knowledge in the near future.

Refining Processes

Taking up the various refining processes, we find, first, the washing and clarifying of those glycerides which nature has given to us in a condition for use without chemical treatment. Aside from the biochemical problems of keeping the fat- or oil-bearing tissues sweet and free from any decomposition so that their products will be neutral and devoid of objectionable odors, there is little obvious opportunity here for investigations of a scientific character. However, in the preservation of such perishable materials as copra and fish refuse, which are usually allowed to decompose partly before being pressed, there is a chance for some valuable research work. That coconut oil can be made from properly prepared copra or even the fresh undried fruit so sweet and palatable that it requires no subsequent treatment has already been demonstrated. The cod liver oil obtained from sound livers is also said to be superior to any of the so-called refined oils, and doubtless in the pressing of olive oil, the premier of virgin oils, there is some opportunity for scientific study.

Oil refining in the restricted sense—the removal of free fatty acids and some color by treatment with chemicals—is doubtless receiving more attention from the research organizations of the industry than any other single phase of their activities. This is due partly to the realization by the refinery of their inability to obtain even under apparently identical conditions the same results with any two batches of oil in the plant kettles. Also the knowledge that about half the loss in refining is the result of saponification and occlusion of neutral oil makes it desirable to find as quickly as possible means for overcoming these difficulties.

Decolorizing and Neutralizing

With most crude oils the refining process has a two-fold object, the neutralization of the free fatty acid and the removal of a part of the coloring matter. To accomplish this, alkali, usually caustic soda solution, is mixed with the crude and the soap thus formed is separated from the refined oil. There are many individual phases of the process which will bear considerable further investigation, but they are all comprehended in the study of the interrelation of temperature, strength of refining alkali and excess of alkali over that needed to neutralize the free fatty acids. The separate factors have all been studied many times both in the works laboratories and the refineries, but apparently we are still a long way from having any definite conception of the fundamental chemical and physical principles underlying the entire process. Probably the colloid chemist can best solve these problems, as at least a part of the coloring matter is a colloidal suspension in the oil, and obviously where it is a question of separation of soap from occluded oil a knowledge of the behavior of colloids will be very helpful.

Another angle from which to attack the refining problem is a search for reagents which will destroy or remove the color of the crude oil without injuring it. Perhaps more important is the neutralization of fatty acids without saponifying the neutral oil. We know that boric acid will coagulate some of the color bodies of crude cottonseed oil and that carbonates do not saponify glycerides as easily as caustic alkalis, but so far no one has devised or at least not divulged a commercially practical scheme for taking advantage of these facts.

Bleaching With Fullers Earth and Chars

Passing on to the next refining operation, that of bleaching, which is now usually effected in the edible oil trade by means of fullers earth, and in the paint and varnish business by merely heating or by subjecting the oil to the action of the ultra-violet light, we find another most promising field for investigation. The work of the Chemical Warfare Service on carbons for gas masks has stimulated the search for a char which would be so superior to fullers earth that it would pay to use it even if it were more expensive. Unfortunately some of the work on bleaching chars has been undertaken without a full realization of the fact that their action is specific. Investigators have taken carbons which were found especially valuable for gas masks and been surprised when they proved useless for the bleaching of oils. Some manufacturers of carbons do not hesitate to recommend their wares for removing the color from soya bean oil because they have proved satisfactory in bleaching glycerine or sugar house products. It is not at all unlikely that the selective decolorizing effect of carbon may be so specific that different oils will require different chars for the best results. Since many of the common oils contain more than one chromogenic body, in some instances a mixture of different carbons and fullers earths may bleach better than any single material. So far we have little scientific basis for any workable theory of the bleaching effect of absorptive materials. It is simply a question of trying out on each oil as many chars or earths as are available. Such tests, of course, should be made under different conditions of temperature and time and the loss of oil due to absorption determined in each experiment. Research of this type, however, while sometimes of more monetary value, will never deserve the recognition due to that which has for its ultimate goal the determination of the laws which underlie these processes.

Causes of Objectionable Odors and Flavors Unknown

The last step in the making of edible oils is the removal of objectionable odors and flavors by deodorization. This is in principle simply steam distillation of those substances which impart to the oil a disagreeable or too pronounced flavor. We say those substances which give the oil flavor, because we know practically nothing about what they are, or whether they exist at all in the oil as it occurs in nature. Whether there are many or few organoleptic bodies in a single oil and whether any of these are common to a number of oils is still a mystery. In fact, all we do know is

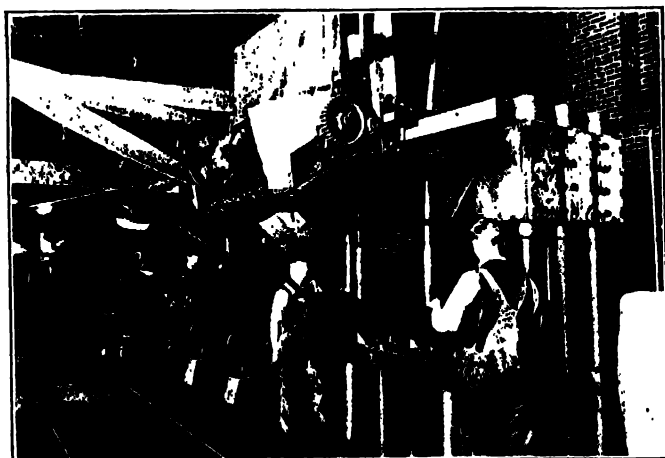
that if an oil is blown under vacuum with superheated steam, free acids, if present, and other substances, some of which give an aldehyde reaction, are carried off and the remaining oil is nearly tasteless and odorless. The practical results of the process are very satisfactory, except that in time the objectionable flavor may return, and in some instances steamed oils are more "tender"—that is, spoil more readily—than those which have not been so treated. It would seem that while there is undoubtedly opportunity to discover new and improve old deodorizing methods, the most interesting problem here is the identification of the flavors of the common vegetable oils.

Clarifying Technical Oils

The technical oils as a rule require some clarification and often bleaching before they are suitable for use. In the paint and varnish trade the principal oil, linseed, is usually "tanked" for a time to allow the separation of the albuminous matter. Attempts, some of them quite successful, have been made to hasten the process by the use of centrifugal separators or special heat treatments. Since this mucilagenous matter is in a very finely divided if not actually colloidal state, it is probable that the colloid chemist can help materially in finding means of expeditiously coagulating and getting rid of it. At any rate there is a real problem here that is deserving of someone's attention. The man who tackles this research will deserve the gratitude of the paint chemist if while he is devising means for removing this so-called "foots" he will find out what it is and why even a very small amount of it will ruin paint.

Bleaching Technical Oils

To obtain a light-colored linseed oil, it is often merely necessary to heat it to the proper temperature and a similar change takes place with many soya bean oils,



MODERN OLIVE OIL PLANT
Left, filling cloths. Center, forming cheeses. Right, pressing cakes.

but every little while one meets with an oil which does not respond to the heat treatment. What is it that causes this difference between two samples which so far as the chemist can tell by his analysis are identical? Also is there any simple method to remove the color substance, apparently present in some oils and not in others, that darkens instead of bleaches when heated?

At one time sunlight was used by at least one of our large American castor oil producers to bleach his off-colored oils, and of course this is still common practice with yellow palm oil and many waxes. Recently the ultra-violet light has been suggested and we are informed is actually used on a commercial scale for bleaching linseed oil. That its use may be extended to other oils is possible and of sufficient promise to warrant considerable research.

Chemical bleaches, such as acid bichromate, have been successfully employed with technical and even food oils, and there is no reason to believe that other reagents not yet studied might not be considerably more satisfactory than any of the present processes.

Research Connected With Manufactured Products

Action of Driers

During the recent high prices for linseed oil the possibility of using cheaper substitutes received considerable attention. This led to a greater interest in the semi-drying oils and driers in general. Important advances have been made in the last decade in the use of driers and some valuable scientific work has been done on the chemical reactions taking place during the drying of oils, but the question of how and why some metallic salts make an oil in which they have been dissolved dry to an elastic film has not yet been fully answered. There is a generally accepted belief among paint and varnish makers that a mixture of manganese and lead driers is better for linseed paints than either one alone. We also know that with soya bean oil cobalt salts give better results than lead and manganese. There are, however, several metals—for instance, vanadium and titanium—which have not yet been properly investigated.

A still more interesting set of problems in the field of driers leads into the study of optimum conditions under which to add the metallic salts to the oils. It is generally believed that it is the metal irrespective of the acid radical with which it is coupled that causes the oil to take on oxygen, but many paint and varnish makers still persist in using the difficult soluble substances, such as "shot manganese," instead of the acetate or fatty acid soaps. Apparently the temperature at which the drier is added to the oil and especially the heating or blowing the oil has received preceding the addition of the drier affects the quality of the finished boiled oil. Under some conditions the oil will dry with satisfactory speed but to a tender, cheesy film, and much is still to be learned about all these points. This rather superficial discussion of the drying oil problem will, it is hoped, suggest some lines of research which may lead to interesting and valuable studies.

China-Wood Oil

Tung or china-wood oil, that freak among drying oils, is of itself worthy of further investigation, although already much has been learned about its behavior toward heat and driers. The varnish maker knows that he must heat this oil just as near the jelling point as possible, to make it blend properly in the varnish, but he has no means, except the rule-of-thumb "string catching" of it to tell when this point has been reached. There are two possible ways in which the research laboratory can save him many gallons of jellied or undercooked oil, one by giving him definite directions as to how long and at what temperature he should heat each lot, and the other by discovering some process by which tung oil can be properly polymerized without the danger of setting it into an insoluble jell. This latter

is much the more promising, as there is such a difference in the behavior of different lots of tung oil that there is little chance of controlling the boiling process better than it is at present by the knowledge of a skilled varnish maker.

Polymerization by Blowing and Heating

Blown and heavy bodied oils are, it is supposed, polmerized gylcerides, but they are usually made by blowing the raw or refined oils with air at a more or less elevated temperature. That many oils can be polymerized by heating them out of contact with any appreciable amount of oxygen has been proved by carrying on the operation in nearly full sealed tubes. It is also known that by a combination of heating and blowing simultaneously or successively at different temperatures a great variety of products can be obtained from the same oil, but very little study has been given to the chemistry of these processes.

Rubber Substitutes—Lubricating Greases

By two or three American manufacturers of rubber substitutes much valuable research has been done on the vulcanizing as well as on the polymerization of oils, and the quality of some of their products would indicate that with just a little more study products of great commercial value in the rubber trade might be produced.

Recent work on the relation of colloids and jells to lubricating greases and soap has opened up a splendid field for a number of investigations, many of which will have a direct application to these industries. In England last year the "germ theory" of lubrication was brought out, and while some of the articles on it sound a bit more commercial than scientific, the fact that fatty acids have a surprising effect on the interfacial tension between mineral oils and aqueous solutions makes the "theory" worthy of further study. If glycerides or fatty acids can be proved to impart to mineral oils valuable lubricating properties which they alone do not possess, the demand for castor, rape and lard oils, and horse and other tallows in lubricants may be materially increased.

Artificial and Patent Leather—Lard Compounds

In the artificial and patent leather factories and, in fact, wherever nitrocellulose solutions are used or blown oil coatings are applied to flexible backings one will not have to search far to find both practical and theoretical research problems. In these fields again the materials with which we are dealing are probably in a colloidal condition, and a working knowledge of this phase of chemistry will be of great assistance to the investigator.

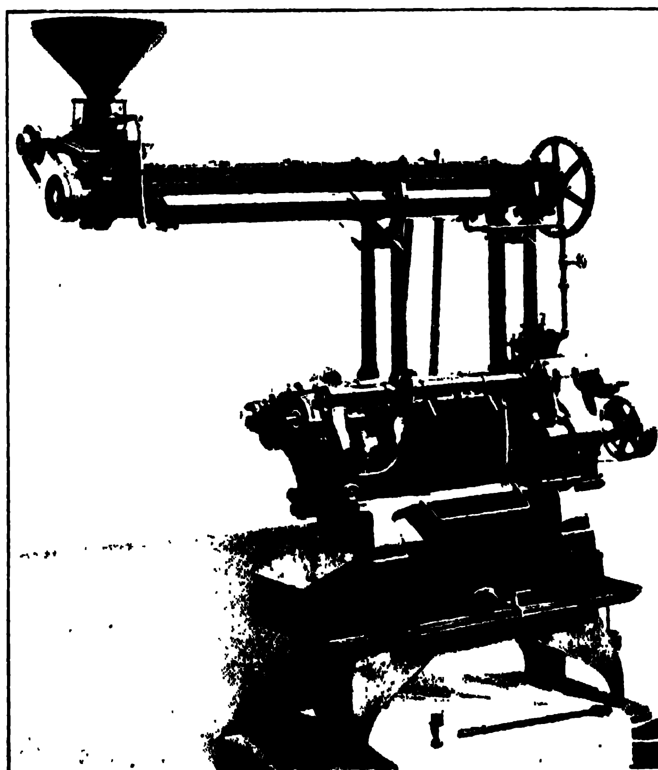
Turning now from the technical field to human foods, we come first to the production of lard substitutes. This industry consumes today in the United States just about half of the total vegetable oil produced in the country. Obviously, therefore, improved methods for decreasing the cost of manufacture or improving the quality of lard substitutes are of vital importance.

The processes for making lard substitutes, or "compounds" as they are commonly called, have reached a high degree of perfection and many of the brands on the market are at least equal if not superior to hog lard, but there is still plenty of opportunity for high-class research in this branch of the industry. The use of hardened vegetable oils in compounds is now common practice and food chemists would be disappointed if they did not find at about this point in the discussion mention of hydrogenation.

Although this process of making hard fats from liquid oils has been a favorite hunting ground for chemists and patent lawyers in recent years, none of the present processes is perfect, except on the patent side perhaps. The complete removal of the catalyzer, metallic or colloidal nickel, from the hardened oil is troublesome at times, and it is doubtful if more than a few of the hydrogenators know how to get the maximum hardening effect with the minimum expenditure of time, heat and labor. It is also within the realm of possibility that a catalyst cheaper and better than any of those at present in use will be discovered.

To many manufacturers the phase "continuous process" has a very pleasant sound, and if a really satisfactory continuous hardening process is perfected to replace the present batch processes, chemists will undoubtedly share the honors with the mechanical engineers. In addition to the conversion of the unsaturated glycerides into hard saturated ones, there is every reason to believe that with the proper choice of a catalyzer and operating conditions it will be practical to transform the flavor and color bodies of some oils into unobjectionable substances.

Aside from the flavor in compounds, which depends on the fats and oils used in making them, the most important qualities are color and consistency. The exact determination of these characteristics is at present impossible, and an interesting piece of research is to be found in devising methods for evaluating these properties. Of more immediate monetary value would be a method for predetermining from an analysis of the components used in making a batch of lard substitutes the color and especially the melting point of the finished product. Since the snowy whiteness and to a large extent the creamy consistency of the compound as marketed is the result of whipping air into the chilled



A SEMI-WORKS OIL EXPELLER

mixture of fats, it is of interest to know what effect, if any, this air has on the keeping qualities. One of the very common objections to lard substitutes is their tendency to become streaky or opalescent in spots. This is commonly ascribed to improper closing of the package and apparently is connected in some way with the gradual escape of the incorporated air. When once melted and allowed to cool again slowly, compounds usually separate into a mush, of crystals and more or less liquid oleans. Hog lard under ordinary kitchen conditions does not do this, and these facts offer a starting point for an investigation which would have as its objective a lard substitute with all of the desirable properties of true lard and without any of its undesirable ones.

Butter Substitutes

In the butter substitute factories the opportunities for research are even more promising than in the compound plants, as flavor and physical consistency are there of greater importance. So far margarines, especially those containing only vegetable fats, do not withstand satisfactorily changes in temperature, and it is necessary for the makers to change their formulæ to correspond with the climate in which their products are to be marketed. Butter has a long melting range in comparison with margarines, or, to say the same thing in the cook's phraseology, butter, although soft enough to spread as it comes from the ice chest, does not run until it has been in the hot kitchen for some time, but margarines either become quickly a mass of soupy grease in the summer or when taken from the refrigerator are so brittle that they crumble when one attempts to cut them.

Like butter, the substitutes are mixtures of glycerides, ripened in milk and, after cooling below their melting points, worked to remove the excess of water. The margarine fats in distinction from those of butter must be chilled very quickly to get a homogeneous mixture which will not be granular or streaked in the prints. So far no one has discovered any method by which the fat and milk mixture can be so completely blended that margarine could be churned from the buttermilk as in butter making. It is not essential, of course, that the problem of producing a margarine with a long melting range be solved in this particular way, and it may very well be that some mixture of glycerides will be found, either by combining natural fats and oils or hydrogenating them, which will by the present process yield a slow melting product.

The biochemist has, in the margarine maker's laboratory, a great opportunity for research along the lines of still further improving the flavor of these foods, and especially in finding means, other than by the use of preservatives, for preventing the comparatively rapid spoiling of his products. As the population of this country increases, the difficulty of obtaining a plentiful supply of milk is becoming greater and the demand for a milk substitute more apparent. While perhaps this is not a problem for the oil chemist, still it is so closely related to the margarine industry that it seems worth while mentioning.

Problems in Soap Manufacture

Nothing has been said so far of the specific problems connected with soap making, and space will not permit going into these in any detail, even if the writer were competent to do so. The demand for South American tallow and similar hard fats by the soap manufacturers during the war, and the fact that many of them are users of large quantities of hydrogenated oils, are indicative of their need for a plentiful supply of raw materials which will make hard soaps. Another thing that causes the soap maker trouble is the keeping properties of his wares; white soaps have a great tendency to turn yellow or dry out and crack, thus becoming less attractive to the purchaser. The increase in the price of sugar makes desirable some substitute for this substance in transparent soaps, and in the bleaching and purifying of garbage grease and refuse fats there are still unsolved problems.

Organization of Research Laboratory

A few of the fundamentals of successful research may properly be mentioned in concluding this sketch of the numerous possibilities open to the scientific investigator in the fat and oil industry. The director of an industrial research laboratory should be a man with a broad knowledge of chemistry, but not necessarily a specialist in any one line. He should have a wide acquaintance among the leaders in his profession and know where to turn for specific information on any problem, and also to which college to go for a new man to handle a special line of work. He must be politic but by no means "spineless," so that when his laboratory has devised a process with real merit he can get for it a fair trial by the operating department.

His assistants may well be of two types—first class analysts and men with the research instinct. Many a costly plant experiment has been a failure because of slipshod analytical control work, often due to the all too common notion that it is a "routine job" to do careful chemical analyses and therefore beneath the dignity of a research man. Where the force of assistants is large enough it is well to have in the organization specialists in the different chemical fields of colloids, catalyzers, microchemistry and biochemistry.

In addition to the usual laboratory equipment and such special apparatus as may be needed by the specialists, somewhere between the "lab table" and the plant there should by all means be a "semi-works." This plant, which will necessarily change more or less with each problem, becomes the common meeting ground for the investigator and the operator. It may well be under the direct supervision of the director of the research, but the mechanical department should also be conversant with its equipment and the operating department be cordially invited to make use of its facilities. The large chemical industries have learned that processes worked out on the "gram, centimeter, second" system seldom function according to schedule when translated directly to the factory scale, and have invested thousands of dollars in their semi-works. It is absolutely necessary if a research laboratory is to make good in anything but strictly scientific fields that its discoveries and inventions be carried through the stage where they are perfected in regular plant type—but small-size—equipment. The individual experiments at this semi-works plant should be under the direction of the chemist who developed the laboratory process.

With such a personnel and equipment and the elimination of all petty jealousies between the research laboratory and the production department, a research laboratory will bring as large financial returns in the fat and oil industries as in any of the other fields where chemistry is involved.

Savannah, Ga.

More and Better Tools Wanted

A Plea for Reliable Tabulated Physical and Chemical Constants, Especially for Melting Points, Vapor Tensions, Specific Heats, Latent Heats of Fusion and Vaporization, Thermochemical Data, Thermal and Electrical Conductivities and Thermal Emissivity

By J. W. RICHARDS*

THERE are essentially three kinds of research: (1) Investigation of chemically pure materials, the purest obtainable, in order to determine their chemical and physical properties with the highest accuracy, as a basis for scientific study of the influence of impurities.

(2) Investigation of the materials of engineering practically available. These are rarely of the highest purity of singleness of composition, but are such as are available in industry for engineering and technical use. Their study seldom results in laying bare the laws of nature, because of the complexity of the material and the number and amount of the impurities present in the commercial material. Such study is, however, of the highest practical importance in giving the engineer and technologist necessary data to use in his practical work with the actual materials at his disposal.

(3) Use of the data obtained in (1) and (2), principally the latter, to achieve engineering and technical results—i.e., build structures and use materials for all possible purposes, to devise processes and in general to attain engineering and technical ends.

Need for a Compendium of Reliable Physical and Chemical Constants

The tools of the engineer and technologist are thus very largely the information gathered by researches (1) and (2). The repository of such information is the technical literature, particularly the tables of physical and chemical constants and handbooks of engineering data concerning properties of engineering materials. When we come to consider the present available data which may be classified under (1) and (2), the engineer who understands how to use such data and knows what he wants is continually confronted by great lack of information—in other words, the real engineer needs more and better tools of this kind with which to do his real engineering and technical work.

The writer is convinced, perhaps because of his greater activity in this field, that data of the class (1) are woefully deficient and fragmentary. The best compendium of such information is in the revised Landolt and Börnstein "Physikalische und Chemische Tabellen," revised up to 1912. This has been supplemented by the "Tables Annuelles des Constantes Physiques et Chimiques," of which three volumes have appeared to date and the fourth is in preparation. These, and similar books and tables, are collections of the most reliable data accumulated in the last century or more by industrious scientific men. The data are of all degrees of reliability and of all degrees of incompleteness in any particular line. The quickest way to get an idea of the state of matters is by discussing a few concrete examples.

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Most of the data of the melting points of thermal compounds are marked by inaccuracy of the instruments used in determinations. Pyrometers of an accuracy of, say, 1 per cent at 1,000 deg. C. are of very modern construction and use. Many of the data prior to 1900 are only approximate, and for temperatures above 1,500 deg. C. are still liable to considerable error. Not only that, but the materials worked with have frequently been impure instead of the highest obtainable purity, and results for this reason also have been erroneous. The melting points of many common compounds have not yet been determined. At the present time many of the data on melting points may be said to be fairly satisfactory, but many also need revision and improvement.

Boiling Points

As ordinarily understood by this term, boiling point under normal atmospheric pressure is intended. The proper conception, however, should be that of vapor tension, and the data investigated should be the vapor tensions of substances in the solid and liquid states at all temperatures; the usual boiling point is merely one point in the vapor tension curve. Now, technologists and engineers have occasion to use in many problems vapor tensions of compounds at different temperatures and within wide limits of temperature. An inspection of the best available tables will show very meager data published in comparison with what is wanted. One hundred times as much information as is now in print could be used by industrial chemists and technologists in their everyday work; I am afraid that continued absence of such information for so long engenders the unfortunate feeling among some practical men that such data can be dispensed with or are unattainable. They really are neither the one nor the other; we ought to have them.

Specific Heats

When we consider the immense amount of thermal work done, by combustion of fuel or use of electric energy, to heat materials to high and low temperatures, including keeping our buildings warm, etc., it is lamentable how many data concerning the quantity of heat required to bring materials up to any given temperature are so imperfectly known. Most of the specific heats given in tables were determined between ordinary temperatures and 100 deg. C., the boiling point of water, and were, therefore, true only for this range of temperature. A few substances have been investigated to higher temperatures, but these are exceptions and not the rule; many have not been investigated at all. The engineer is confronted with a woeful lack of data on specific heat of substances at moderate and high temperatures, also of specific heats of liquids and

gases. It would be making a liberal statement to say that the tables contain 10 per cent of the accurate information in this line which engineers and technologists could use.

Latent Heat of Fusion

Considering again the immense amount of materials which are melted in the world by use of fuel or electric energy, it is lamentable how little data tables contain concerning the energy required to convert substances from solid to liquid state. Even the latent heat of fusion of iron and steel is in doubt, the guesses at it varying from 33 to 60 units, yet we ought to have accurate figures of the latent heat of fusion of pure iron and pure mixtures of iron in varying quantities. such as steels and cast irons. Similar criticism could be made of other metals and compounds which are melted industrially by the millions of tons, and yet the exact heat necessary to melt them is undetermined.

Latent Heats of Vaporization at Varying Pressures

Immense quantities of water are evaporated in steam boilers, and the latent heat of vaporization of water is fairly accurately known. Immense quantities of other materials are also evaporated or vaporized in other ways than in boilers, such as being distilled or vaporized from high-temperature furnaces; in many of these cases the actual energy of vaporization involved is practically unknown. The books of tables contain some scattering data; the chances are nine out of ten that when they are consulted for latent heat of vaporization the datum desired is not in them. There is a sad lack of information in this line, not only of the latent heat of vaporization at normal boiling point, but still less concerning the latent heat of vaporization at higher or lower pressures. Yet all of these come into account in technical calculations and are tools which the technologist should have in order to do his work properly.

Thermochemical Data

While we are thankful for the many heats of formation and combination contained in thermochemical tables, yet the requirements of practical use call for very many more, which have not so far been determined. As an example, we know the heats of formation of about forty-two alloys—many, however, unconfirmed and of uncertain reliability. All the alloys classified as brass are represented in these data by only two determinations, neither of which is really within the limits of commercial practice. Heats of formation of the many important steel alloys are practically unknown; the same is true of ordinary ferro-alloys. The heats of combination of metallic oxides forming various industrial slags are only to be approximately guessed at; the actual values for practical use are unknown. The heats of combination of metallic sulphides to form mattes are not known in even a single instance. The heat of formation of the common material FeS_2 is undetermined. A whole corps of competent thermochemical experimenters could be busied for years on the data which are unknown and badly needed in this field.

Thermal Conductivities

The proper calculation of heat losses through furnace walls and in all other kinds of apparatus requires correct values for thermal conductivities for different materials at different temperatures. The literature contains a few such determinations, usually limited to low temperatures. For every one of such existing determinations there are a dozen unknown which are badly needed in thermal engineering.

Electrical Conductivities

The electrical conductivity has been determined for many metals and a few alloys at ordinary temperatures, and in a few cases up to 1,000 deg. C. There exist only a few determinations on these substances in the liquid state, and such data are of great use in electric-furnace calculations. Similarly for compounds of the metals, refractory materials used for furnace walls, fused salts, etc., existing data are meager and need to be largely increased.

Electric-furnace engineering will never reach a satisfactory basis until there are many more data at hand concerning electrical and thermal conductivities at high temperatures.

Thermal Emissivity

The property of materials to radiate heat at ordinary and at high temperatures has been determined accurately in only a very few cases. A systematic study in this field is sorely needed. The results would be of great value in calculating radiation losses from all sorts of furnaces, rate of cooling of materials in the air, applying corrections to the radiation pyrometer, and several other chemical and metallurgical problems. There is a splendid field for laboratory research on thermal emissivity.

Other Constants Needed by Chemical and Metallurgical Engineers

This article is already too long, and yet only a fraction of the different fields have been mentioned in which experimental work is pressingly needed, results of which would be put to immediate practical use by chemical and metallurgical engineers. To barely mention a few other lines, without further elaboration, we will cite:

Viscosity of liquids and melted materials of all kinds, such as metals, slags, mattes, glasses, enamels, fused salts, etc.; surface tensions of all sorts of liquids and substances in the melted state; mechanical properties of metals and alloys at all temperatures up to their melting points (tensile and compressive strengths, elastic limit, elongation, contraction of area, fatigue tests, hardness, etc.); mechanical properties of structural materials useful in furnace construction, especially compressive strength at high temperatures; capillary constants for molten substances; dielectric constants of solids and liquids, particularly at high temperatures; critical temperatures and pressures of metals and metallic compounds; coefficients of linear and cubical expansion, from lowest to highest temperatures, in solid and liquid state; solubility of gases in metals and other substances, particularly in melted metals at high temperatures; velocity or rate of ignition of combustibles at different temperatures; temperatures of decomposition of metallic compounds; decomposition pressures of compounds at different temperatures; reaction gas pressures from mixtures of metallic oxides and carbon at different temperatures, etc.

May an awakening soon come!

Metallurgical Laboratory,
Lehigh University.

Future Rubber Research

An Appeal for More and Improved Methods of Testing Rubber and Its Products as a Guide to Compounding—Need for Study of Fabric and Design of Products—Continuous Vulcanizing and Temperature Control Essential

BY ANDREW H. KING

FOR some time rubber research has been almost entirely in the hands of the chemists. In some respects the progress has been very satisfactory. But since chemical specialists have predominated, the present status of the industry may be described as lopsided. There are now many pressing problems which are essentially of a physical or a mechanical nature. Without detracting in the least from the good work of the rubber chemists, the writer wishes to point out a few of these problems.

Rubber testing is beyond question in most serious need for scientific attention. The methods in vogue today were largely forced on the manufacturers of hose, belting and other mechanical goods by the consumers for their own protection. Naturally these methods were not devised for the scientific exploration of the properties of a compound, but only enough data were desired to show that one article corresponded in value to one previously furnished. It is to the everlasting disgrace of these manufacturers who when compelled to go one mile with the consumers refused to go with them the Biblical twain. However, since it was formerly so easy to jumble a number of materials together and produce sort of a grab-bag product just good enough to get by, this condition can be easily explained if not fully understood. The writer has seen old formulas for hose, tubes, etc., which contained as many as twenty different mineral fillers and half a dozen different rubbers.

Five years ago almost the only criterion for comparing the relative values of compounds was tensile strength. Ultimate elongation was considered, but usually as of secondary importance. Recently an attempt has been made to measure the residuum of plasticity present in all stocks. The Davies-North method of determining permanent set may not be the last word—undoubtedly is not—but it is at least a step in the right direction. This is the quality the old line compounder measured with his fingers because his testing machine would not show it to him.

Wiegand at St. Louis last April emphasized very strongly the importance of stress-strain curves. It has been recognized for years that Hook's law does not apply to rubber. The ratio of stress to strain is itself a variable. The area under the stress-strain curve may be measured with a planimeter and from it the energy expended in stretching the test piece may be calculated.

Wiegand obtains his stress-strain curves with a Scott machine and two observers. It is a rather expensive method, but there is no testing machine which will serve. For that matter, the makers of testing machines have been more energetic in selling their product than in developing it to fit the needs of the industry. For example:

(*a*) All American machines are built to apply load to the piece at a rate of 20 in. per minute. Now it happens that a constant rate of elongation is not nearly as desirable as uniform increment of load. Machines should be built to give so many pounds per sq.in. increment per minute.

(*b*) The charting devices on all American machines plot increased load against jaw separation, which because of slippage is variable and has no bearing on the properties of the stock. The design of a good charting device depends largely on getting the proper grips, which unfortunately do not exist today.

In Europe the Schopper machine, which requires ring test pieces, is in use. American factories have declined to use this machine because of the difficulties of obtaining proper test pieces and the fact that due to unequal inner and outer circumferences the stress is not applied evenly and consequently the piece fails by tearing. However, it seems to me that we have been straining at a gnat and swallowing a camel.

In the matter of hysteresis, which is of maximum importance, there is no machine available except the Schwartz. This is, however, too light for high tensile strength compounds and has not the proper grips for straight test pieces. It is also unsuitable because of the method of applying the load. It seems remarkable that no one has yet published a description of a good hysteresis machine. Hysteresis is probably a measure of internal friction, a property which is now giving the solid tire men some worry.

Hardness is another quality as yet not satisfactorily measured. Some of the difficulty is in the matter of definition, but one machine which purports to measure it by deformation has so much friction in its bearings, etc., as to render all results worthless.

For resistance to abrasion we are also without satisfactory methods of measurement. Only makeshift apparatus designed after the grindstone are available.

Resistance to repeated stretching and to tearing are also important. The makers of testing machines are not yet aware of it.

Then there is the question of an accelerated age test. There are no methods which are quite satisfactory. For that matter, how much do we know about the aging of rubber and rubber articles? For my part I am willing to admit that in many cases I have no idea what causes it or how to stop it, let alone how to measure it.

It is my firm conviction that if we can catalog and evaluate the properties of rubber the designing of compounds for special purposes will be rendered much easier and surer than it is today.

In order to understand these phenomena better optical or other methods which will show us exactly how the particles of filler are contained by the rubber and something as to the structure of the rubber itself are quite necessary. Schipple's volume increase with

elongation may be one way. Metallographic methods ought to be of great value.

One could go on indefinitely pointing out work that should be done, but since space is limited this must be taken up later.

Compounding

Compounding was once the mystic art of the rubber industry. It is becoming, and rightly so, much less secretive. Some day American rubber men will understand that our national reputation hinges on all American products being absolutely satisfactory. The ceramic industry, which was formerly in the same boat with rubber, realizes this fact and co-operation is the watchword now.

However, we cannot get very far with a study of compounding until the physicist gives us better and more accurate methods of testing. Also compounding experiments should not be carried on solely from the physical standpoint. The information regarding the change in coefficient of vulcanization must be obtained simultaneously. It is remarkable how few rubber companies keep an accurate check on free and combined sulphur in their compounds. The steel companies are forced to maintain large routine laboratories for sulphur, manganese, fixed and graphitic carbon, etc. Sulphur plays the same part in rubber as carbon does in steel, yet we are indifferent to its variation. This is in most cases due not to the compounder but to a stingy policy of the directors, who may be excellent men but are ignorant of the fundamental reaction of their industry.

North's paper on compounding ingredients which was read at St. Louis last April was a good beginning. Other rubber laboratories should contribute their bit and soon we would begin to have some valuable fundamental information which is lacking at present.

In accelerators I believe we have enough for the present. Let us thoroughly investigate the few which we now know to be of value before going into this subject much deeper.

Fabric

Cotton fabrics are employed throughout the rubber industry. Yet how much do we know about them? For example, fabric must be held in place by rivets of rubber which are forced between the threads. It is almost impossible to make rubber stick to cotton threads. Why?

The internal friction of the fabric in a tire generates a large amount of heat. How can this be cut down or eliminated? Cord tires heat up less, but even they are not entirely satisfactory in this respect.

There are any number of problems directly bearing on the rubber industry which are not being worked on, at least they have not been described.

Design

In matters of design we are not exactly in a sound position. In tires nothing essentially new has come out for a long time.

A question which has never been satisfactorily answered is that of the stresses in these articles. The writer is of the opinion that in general the tires, etc., just happened to be put together and no special study of the forces encountered was made. In other words, many tires, etc., are poorly designed and fail not because of the materials but because of the design.

The supply of gutta percha for ocean cable is diminishing rapidly. A substance which will replace it will be very acceptable.

The fiber sole is now in general use. They must be cheapened and a method for rendering them slightly porous must be worked out. Leather is decreasing in supply and not only soles of rubber but tops of rubber and fabric are needed.

Continuous Processes

There is still too much intermittent hand work in the rubber factories. Machines for hose- and tire-building are in use, but the steps are far from being continuous. There are many other instances. For example, hose, tires, etc., are vulcanized in large heaters with steam. When the proper time has expired the steam is blown off and the heater cooled so it can be opened. Just consider the quantity of heat absolutely wasted. With coal at $8 or more a ton this cannot go on. Continuous processes of vulcanizing must be worked out.

Temperature Control

Temperature control, because of the extensive use of organic accelerators, is very important. Unfortunately too many companies depend on poor thermometers, which are rarely if ever checked up. Presses are particularly bad because they do not as a rule give the same temperature between all decks. The temperatures of mills and calenders are still judged by hand. Surely instruments can be developed for their direct measurement.

The rate of heat flow through fabricated articles such as a dredging sleeve, a pneumatic truck tire or a solid tire is of maximum importance in designing the stocks which are to be used. Unless this is carefully studied the surface is likely to be overvulcanized while the center will be porous or undercured. Very few accurate scientific data are available on this subject.

Conclusion

The writer has not attempted to go into detail on any one phase of the problems mentioned above. But surely there are so many big problems to be attacked that laboratories not employing physicists should engage a good one at once.

It should be unnecessary to point out that the British rubber factories are getting together and have organized a strictly British Rubber Research Laboratory under the management of the well-informed and able Dr. Twiss. The war has taught them the advantages of co-operation. But has this lesson been learned by American firms? Their men have helped in the work of the Rubber Section of the American Chemical Society, but the "powers that be" in certain of the older firms are "agin it." The English have been slow in many respects in rubber, but if they really pull together we may expect some strenuous competition and should be organized accordingly.

Surely the jealousy and antipathy which defeated the plan for an extensive co-operative rubber library in Akron a few years ago must be effectively killed. Is it not possible that a study of the physics of rubber and of rubber products, a study which is so broad that no one firm can hope to handle it alone, may not be the basis for that co-operation which we all desire but from which so many are held back for fear the other fellow will not come through with what they want to know after they have answered his question?

The Future of Chemical and Engineering Research in the Pulp and Paper Industry

Prospectus on Pulp and Paper Research—Byproduct Possibilities and Reduction of Wastes—Less Liquor Dilution by More Efficient Washing—Fuel and and Power Costs Reduced by Use of Vacuum Drying and Better Designed Beaters

BY JOHN STEVENS, 3D

IN THE past ten years chemical progress in the manufacture of paper, the processes of which are so often thought of as being of a purely mechanical nature, has been exceeded in no other industry and stands as a striking example of the value of chemical control and research when applied in an intelligent manner. In fact it was no more than six years ago that one of our largest paper corporations, operating seven mills, possessed as its chemical staff one graduate chemist assisted by a boy to conduct such routine tests as were at that time considered sufficient to maintain the highest degree of efficiency! Today this same manufacturer has a staff of fifty chemists and engineers in addition to a small army of laboratory assistants whose duties consist of testing not only everything that enters into a product but the condition of the product in its various stages of manufacture as well. There can be only one result of such a drastic change of policy—an unprecedented standardization of heretofore rule-of-thumb methods coupled with the development of new processes, revealed through chemical research, which have made great strides particularly toward an efficient recovery of valuable byproducts.

CHEMICAL CONTROL VS. RESEARCH

The work of the chemist in the paper industry has up to the present time, therefore, been concerned largely with the control of existing processes together with research in the byproduct field. It is now quite apparent, however, that there are an infinite number of problems which remain unsolved and upon which the chemist must bend his efforts in the future. The fact that they exist reflects in no way upon the ability of the paper chemist, as it should be realized that his time has been occupied largely by the control of present processes; with a few exceptions, he has not been able to carry on extensive research. Many of the larger manufacturers have maintained research laboratories in addition to those devoted primarily to process control, but such development has been comparatively recent and has not had the opportunity, due largely to the short lapse of time, to demonstrate fully the wisdom of such a step.

On the other hand, the results obtained at the Brown Company under the guidance of such men as Moore and Richter should certainly serve as conclusive evidence that research in the pulp and paper industry is of infinite value. The utilization of waste sulphite liquor and the recovery of various byproducts from the gases and liquors of the alkaline pulp processes have occupied a prominent position for some time and considerable research has been devoted to these problems.

In view of present circumstances in the paper industry, however, it appears that the chief concern of the research chemist and engineer in the future should be directed to the study of fibrous raw materials and how best to prepare them, in an economic way, to take the place of our rapidly vanishing timber resources, together with a study of possible improvements in existing processes.

BYPRODUCT POSSIBILITIES AND WASTES

The wastes incident to the conversion of wood into paper pulp are not confined wholly to the loss of non-fibrous constituents, which in the past have either gone into the sewer or been utilized for their fuel value, but a large part of these wastes are the result of careless cooking conditions and inefficient methods of handling the product. It is not at all uncommon to find a mill realizing a 38 per cent yield of pulp when a 43 per cent yield would surely result from slight variations in the cooking schedule; but what is even more distressing is to see fully ten tons of valuable pulp lost in the back waters for every one hundred tons of paper made. Such a state of affairs emphasizes the fact that the enormous demand for paper is not the only reason for the depletion of our forest reserves but that wasteful treatment of our paper-making materials within the mills themselves is partly responsible. Furthermore, a 10 per cent saving in pulp would be far more profitable to the manufacturer than the recovery of byproducts has proved to be up to the present time. Has not the time therefore arrived for those in charge of scientific development in the paper mills to regard the treatment of the fibrous raw material, both as to source and as to process of manufacture, as of equal importance with byproduct recovery?

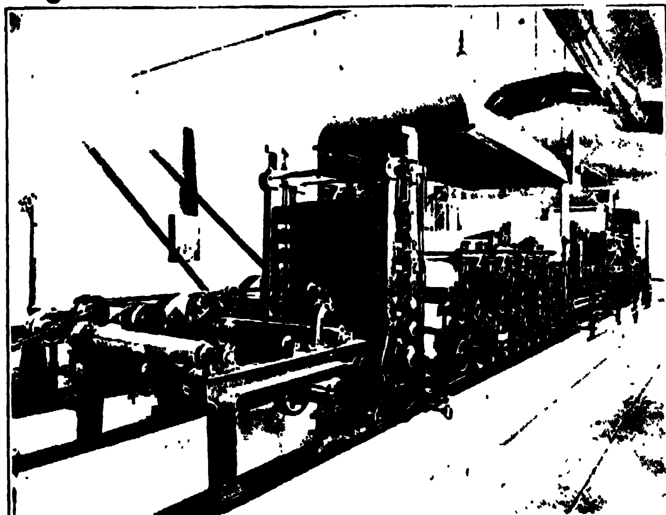
REDUCTION OF POWER CONSUMPTION

At this writing a great deal of promising research is being carried on in this and other fields and many of the most fundamental processes in paper manufacture are due for a rude jolt in the very near future. Much of this late development, such as the drying of paper continuously in a vacuum and improved methods of beating the pulp, is of largely mechanical nature, although none the less important, and will contribute as much as any chemical achievements to the advancement of the industry.

Furthermore, the processes of beating and drying are largely responsible for the enormous consumption of power in the paper mill and anything that can be done to save this valuable commodity is well worth the expenditure of considerable research. Take the matter of beating, for example; why should it be necessary to circulate pulp, say, 1,500 lb. to a beater load, for five

hours or more to effect the proper hydration for manufacture into papers requiring this quality, and in an apparatus which requires from 50 to 60 hp. throughout the operation? Surely there must be some simpler way, and an excellent opportunity is offered to the chemist, with his knowledge of the hydration of cellulose, to co-operate with the mechanical engineer in the design of more efficient equipment to effect this end.

Very similar to present beating practice is the manner in which pulp is ordinarily washed, particularly in the manufacture of high-grade papers. Here the half-stuff circulates around in washing engines of the same



EXPERIMENTAL 30-IN. COMBINATION CYLINDER AND FOURDRINIER PAPER MACHINE

general shape and design as the Hollander beater, except for the fact that the beater roll and bed-plate are supplanted by a paddlewheel to cause the motion of the stock. Fresh water is added continuously and the dirty water leaves at the same rate through the trunnions of several perforated washing drums that dip into the pulp.

More Efficient Washing

To those familiar with the methods of washing in other industries this practice must appear queer indeed. This is not at all surprising, as after all such an operation is virtually a dilution process and does not represent in any way the correct principle of displacement used in other industries. What the paper makers need in regard to washing is a method by which the dirty washings are successively removed from the pulp previous to their displacement by clean water. This method is, of course, used in pulp mills for the removal of bleach residues, but its application throughout the trade is still limited and is open for future development.

Vacuum Drying

The drying of paper is still another of the more or less mechanical processes in the paper mill which presents excellent possibilities for investigation. There are three main considerations in regard to the problem of drying—namely, the amount of steam used, the temperature of the steam, and the temperature difference between the steam and the paper. It is common knowledge that 50 per cent of the steam supplied to present drying systems is lost. This fact alone should warrant an extensive investigation of methods to improve this condition. It is also known that high temperatures are particularly injurious to the strength and quality of papers. This requires that in any improved process of drying the temperature of the steam must not be raised above that already found suitable.

We now come to the question of temperature difference, which governs largely the speed at which paper dries. The drying of paper in the atmosphere with steam at 5.3 lb. pressure within the driers will give a temperature difference of only sixteen degrees—that is, the difference between the temperature of the steam, 228 deg. F., and the temperature at which the water in the paper is boiled off, or 212 deg. F. Let us see what will happen if this same paper were dried in a vacuum of 28 in. of mercury using steam in the driers at the same pressure. The boiling point of water under a 28-in. vacuum is 100 deg. F., so the temperature difference is now 128 instead of 16. This means that the paper will be dried 128 ÷ 16, or 8 times as quickly under the vacuum as under atmospheric pressure and, furthermore, at a lower temperature. Therefore, one-eighth the number of driers in the ordinary atmospheric system would do the same amount of work and effect a considerable saving in steam at the same time, if placed under a 28-in. vacuum. Such a vacuum drying system is being developed and is an indication that the future may look to many revolutionary changes in paper drying.

Sulphate Process and New Pulp Materials

It is in regard to the utilization of fibrous materials, however, that chemical research can best be applied in the immediate future in the pulp and paper industry, and it is with this end in view that the few sugges-

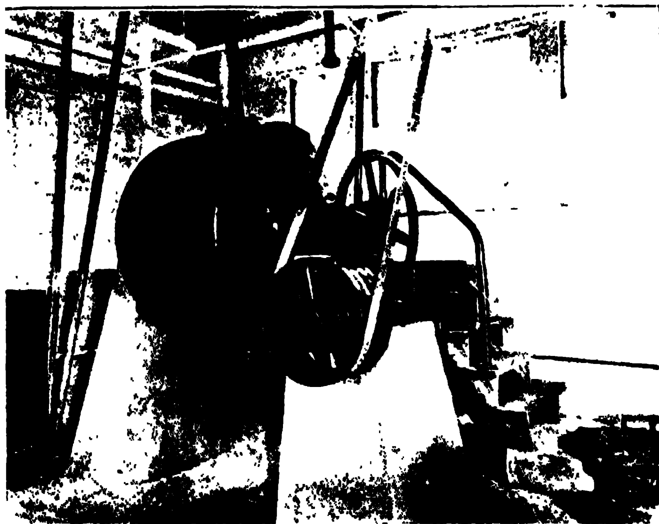


BEATER EQUIPMENT USED FOR SEMI-COMMERCIAL EXPERIMENTS ON NEW FIBROUS RAW MATERIALS

tions that appear here are written. It is when this point is reached that it becomes evident that the future of paper pulp manufacture centers largely around the so-called sulphate process. It so happens that practically all of the new materials now being introduced to the paper trade, such as waste cotton fiber, sugar cane, bamboo, etc., are best adapted to this process and open up at once a fertile field for research. Curiously enough, it has been found that bamboo, so treated, will yield a remarkably easy-bleaching pulp which is des-

tined to act as an excellent substitute for wood pulps used today.

There are, however, certain to be many problems incident to the introduction of these new materials into commercial practice and no small portion of them will be up to the pulp mill chemist to solve. Many of these fibrous materials do not contain enough ligneous matter to furnish adequate fuel for the burning of the liquors in the recovery process; others contain so much silica that the gelatinous silica compounds formed in contact with the alkaline liquors are bound to interfere with the settling and filtration of the lime sludge in the causticizing process.



EXPERIMENTAL ROTARY DIGESTER USED FOR THE SODA AND SULPHATE PULP PROCESS

These, and many other problems relative to the utilization of new raw materials, have heretofore received too little attention, which has resulted in the publication of many misleading statements. If all of the governing factors, both technical and economic, were carefully considered, it is doubtful whether more than 5 per cent of the materials proposed would be found suitable for paper manufacture. Too many investigators consider only the quality of the pulp and it never seems to occur to them that digester yield, liquor recovery and location of materials bear an equally important part. Nine times out of ten it has been found by experience that, although a material may produce a most satisfactory pulp, the yield per cu.ft. of digester space is only from one-third to one-half that of ordinary pulpwoods. This means that a four-digester soda mill would have to be turned into probably a ten-digester mill to obtain the same production from some of these new materials. It requires only simple calculation to reveal the fact that the effect on the annual investment return is quite discouraging.

In connection with the sulphate process itself, without the consideration of its application to new fibrous raw materials, there are many opportunities presented for improvement. A reliable, reasonably durable system of indirect cooking to prevent dilution of liquors is still to be found; there is room for engineering development on tumbling digester trunnion attachments and steam inlet arrangements to prevent leakage; an efficient method of washing the pulp to supplant diffuser systems and further prevent liquor dilution is desired; in the recovery end there is needed a good automatic feed for charging smelters; also chemical research looking toward a more valuable utilization of the various substances contained in the lignin dissolved in black liquors than using them for fuel and evaporating purposes; the disposal of lime sludge is an important problem which should be solved in the immediate future, as many of the mills are now contemplating this step.

Pulp From Southern Pine

The application of the sulphate process to many of our common pulpwoods such as the Southern pines should offer possibilities of improvement. It is doubtful, however, if it will ever be practicable to manufacture bleached pulps from extremely pitchy woods, such as the long leaf pine, by this process.

The content of resins in this pine is very high, when considering it as a pulpwood, but if looked at from the standpoint of the rosin and turpentine industry it is too low for economical operation. For example, the stumpwood used by the extraction plants often contains 24 per cent rosin, while the pulpwood seldom averages over 5 per cent. There have been attempts in late years to combine the extraction and pulping processes, but up to the present time this has not been successful on a commercial scale. The fact that the wood is prepared by a hog for extraction and that the extracting process removes most of the resins is ample explanation of the failure of previous attempts. Hogged wood cannot be used in the ordinary pulp digesters and black liquors in the sulphate process will not burn off if the resins which constitute a large part of the fuel value are first removed from the wood. It therefore appears that this problem has been attacked from the wrong angle and that there is room for valuable research.

In the first place, the proper sized chip must be determined which will "strike a happy medium" between the ideal hogged wood in the extraction process and the larger chips in the pulping process. It is certain, however, that either one or both of these processes will have to sacrifice something in order to obtain satisfactory operating conditions with a combination of the two. After the rosin and turpentine have been removed from the chips, the next logical step seems to be the application of a pulping process that does not require liquor recovery. We are therefore limited to the sulphite process and with certain variations in cooking conditions from the ordinary practice there is little doubt that a good quality bleachable pulp can be produced. Engineers and designers should also come forward and evolve an apparatus which will allow the extraction and pulping operations to be carried out in the same piece of equipment.

This and other problems as briefly reviewed in this paper emphasize the fact that the surface of chemical research in the paper industry has merely been scratched and that myriads of opportunities exist for future development. No doubt the foregoing review of some of the possibilities afforded may be characterized in the same way—there is so much yet to be done and so little mentioned. The conception of the idea is a very small part of the success of a project, however, so that what is now needed is the diligent solution of the many problems and not mere suggestions.

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Applied Colloid Chemistry

A Summarized Outline of the Present-Day Role of Colloid Chemistry as Applied to the Solution of Widely Diversified Theoretical and Practical Problems in Inorganic and Organic Industrial Chemistry

BY WILDER D. BANCROFT

I HAVE stated elsewhere that a knowledge of colloid chemistry is essential to anybody who really wishes to understand about: cement, bricks, pottery, porcelain, glass, enamels; oils, greases, soaps, candles; glue, starch, and adhesives; paints, varnishes, lacquers; rubber, celluloid, and other plastics; leather, paper, textiles; casts, pencils, and crayons; inks; roads, foundry cores; coke, asphalt; graphites, patines, zinc, phosphorus, sodium, and aluminum; contact sulphuric acid, hardened oils, etc.; beer, ale, and wine; cream, butter, cheese, and casein products; cooking, washing, dyeing, printing; ore flotation, water purification, sewage disposal; smoke prevention; photography; wireless telegraphy; illuminants; comets; pharmacy; physiology.

What Colloid Chemistry Is

Since the connection of some of these with colloid chemistry may not be obvious to everybody I am going to run over some of the points which involve colloids. Since a phase is defined as colloidal when it is sufficiently finely divided, colloid chemistry may be called the chemistry of bubbles, drops, grains, filaments and films, because in each of these cases at least one dimension of the phase is very small. This is not a strictly scientific statement, because a bubble cannot exist without a film around it, and both filaments and films may be considered as composed of coalesced grains or drops. Jellies also present some difficulties because they are not obviously fibrous, and if we classify them as thick films we cannot say that one dimension is extremely small. These difficulties are inherent in any rather epigrammatic classification and are not serious.

Colloids in the Ceramics Industry

When clay is heated the grains sinter together and form bricks which are less porous the higher they are heated. Sintered refractories involve the same principle but different raw materials. When selected clays are used with addition of fluxing material we get the different forms of pottery. Porcelain is a modified silica glass made translucent by crystals of sillimanite, $Al_2O_3SiO_2$, and it has been suggested that some of the furnace losses in making porcelain might be cut down by using powdered sillimanite in the mix. If the heated mass fuses more or less completely and does not become entirely crystalline on cooling we get a glaze or a glass as the case may be. In the colored glasses and glazes the coloring matter is often colloidal, ruby glass being the stock example. A white enamel is a glaze made opaque by suspended particles of stannic oxide, calcium phosphate, zirconia, or something of that sort. Haber states that 3,000,000 kg. of stannic oxide was saved per year by adding the stannic oxide to the enamel in such a way as to cause less of it to be dissolved.

Cement owes its value to the power of the fine grains to gelatinize with water and set. Other things being equal, the resulting concrete is stronger the finer the grinding of the clinker. When the Lackawanna R.R. built its famous viaduct the specifications called for more finely ground clinker than most plants could furnish. In making plaster casts the time of setting and, to some extent, the grain size are modified by the addition of colloidal substances. Some of the good qualities of alloy steels are due in part to the other elements bringing about a more finely grained structure. The use of addition agents in electroplating and electrolytic refining involves the decrease in crystal size due to adsorption of the addition agent. The gelatine in photographic films gives us colloidal silver bromide and the ripening process changes the amount of adsorbed gelatine. The concomitant coarsening of the grains is purely incidental. One of the factors determining the capacity of the lead storage cell is the porosity of the grids. Experiments by Prof. Briggs of Cornell University make it probable that the effect of lithium hydroxide in the Edison cell is to produce suitable grain size and degree of porosity. The color and opacity of pigments vary with the size and structure of the grains. The possibility of adding a white filler like ground barytes to a red pigment without making the tint paler depends on the fact that fine powders tend to coat coarser ones. When writing with a pencil or crayon the surface to be written on must abrade the writing instrument and must hold the resulting powder in place.

The formation of coke involves the obtaining of a granular structure giving strength and porosity. The modern gas mask owes its efficiency chiefly to the adsorbing properties of porous charcoal. The catalytic action of pulverulent solids is the important factor in connection with contact sulphuric acid, Deacon chlorine, Haber ammonia, Ostwald nitric acid, Chance-Claus sulphur, Sabatier hydrogenation, dehydrogenation and dehydration, surface combustion, Welsbach mantles and many other things. The use of fullers earth depends on its adsorbing properties.

Suspended Colloidal Particles

The Cottrell process for removing fumes involves the electrical transference of suspended grains and drops. With such illuminants as candles, oil, gas and acetylene the light is due to incandescent carbonaceous particles. The tails of comets contain colloidal particles and their luminosity is apparently a large-scale occurrence of the Tyndall beam.

Enzymes and bacilli are in colloidal solution and consequently all fermentation processes involve colloid chemistry. The whole subject of toxins and antitoxins will undoubtedly have to be worked out as a problem

in adsorption. Most writing inks consist of suspended particles, as in the case of the carbon inks and the old-fashioned iron-tannin inks, or of solutions which oxidize on the paper, forming grains there. We know that soap forms colloidal solutions in water, and it is probable that the fats are in colloidal solution in many oils and other organic liquids. So-called solutions of rubber and of cellulose are always colloidal, and so are the cellulose nitrates when apparently dissolved in amyl acetate, acetone, or ether and alcohol.

Colloidal fuel is said to be less dangerous than straight fuel oil because it is denser than water and accidental fires can therefore be put out by water. Water purification is due in part to the carrying down of bacteria and suspended particles by gelatinous alumina, etc. The red coloring matter of grape juice and of the wine that is made from it is colloidal and can be filtered out by means of an ultra-filter. Cocoa is obviously a colloidal solution and both appearance and flavor vary markedly with the method of preparation. In coffee and tea the suspended particles cannot be seen by the naked eye, but they are there.

The so-called tannin solutions used in making leather are colloidal. Casein is in colloidal solution in milk and its precipitation is the first step in the manufacture of cheese. The asphalt from Trinidad contains finely divided siliceous matter suspended in it. When making sodium or aluminum electrolytically the temperature of the bath must be held as low as possible or there will be undue formation of the so-called metallic fog, with enormous decrease in current efficiency.

Emulsions

Milk is an emulsion of butter fat in water. Other well-known emulsions are mayonnaise, cod-liver oil and lanolin, this last being an emulsion of water in wool-fat. By adding water to a mineral oil containing a lime soap we get an emulsion of water in oil which is so stiff that it constitutes a grease. The stabilizing action of water on ready-mixed paints is due to the formation of an emulsion of water in oil with rosin as emulsifying agent. The rubber latex is an emulsion about which we have read, though few of us have seen it. The fact that rubber is in the form of liquid drops is accounted for by assuming that the rubber is depolymerized; but this explanation could scarcely be applied to milk, though the butter fat occurs as liquid drops.

In pharmacy the making of emulsions is an empirical art and it is only recently that the scientific side of the subject has been developed. Although Cottrell has done brilliant work on the converse problem of destroying emulsions, we must admit that as yet there has been no systematic study of this subject in spite of its importance in the oil industry.

The properties of emulsions are of tremendous importance in physiology, because they enable us to account for the antagonistic action of sodium and calcium salts and for a number of the properties of protoplasm. Emulsions are used in preparing foundry cores for baking and in the kerosene spray for trees, merely to mention two instances. The solid alcohol of commerce is a jelly and not a stiff emulsion.

Selective Wetting

Selective wetting is the underlying principle of the Elmore bulk oil flotation process, and it is no longer necessary to dry white lead before grinding it with oil, because linseed oil displaces water readily and completely from the pigment. The separation of finely ground coal from ash by means of oil is a special application of the Elmore process. The shower-proofing of fabrics is done by coating the fibers with a substance which is not wetted readily by water and the treated fabric then lets air through readily but stops rain, at least up to a certain point.

The Importance of Bubbles

Bubbles play an important part in making certain soaps float, in bread, and in giving the color to white flowers, and white hair. The formation of foam on beer is due to the colloidal albumoses in the beer, which increase the viscosity of the films around the bubbles and consequently make the bubbles more permanent. In the case of champagne there is less colloidal material in suspension, the films around the bubbles are less viscous, and the foam is much less stable. For lecture experiments the law makes it necessary to substitute near-beer and ginger ale, but the principle remains the same.

The fighting of fire by the use of Foamite is an interesting application of bubbles. The method fails when applied to burning aluminum powder because the aluminum powder is carried up in the film and because aluminum will burn in carbon dioxide, reducing it to carbon monoxide. Ore flotation depends on the selective wetting of the ore by the oil and on the formation of bubbles. In the Minerals Separation process the films are very viscous and it is scarcely an exaggeration to speak of armor-plated bubbles. In the Callow process there are fewer particles in the surface films, which are consequently less viscous and the bubbles are therefore more fragile. It was recently stated that 60,000,000 tons of ore was treated by flotation process in 1918. Some experiments have been made on removing colloidal matter from sewage by a process similar to the Elmore bulk oil process; but this was not a success. It is quite possible that better results might be obtained by a modification of the bubble process.

Fibrous Colloids

Paper, textiles and leather are all fibrous colloids. The tanning of leather consists essentially in making one colloid insoluble by the addition of another, tannin or chromium oxide, in the vegetable and mineral tanning. Artificial silk is an important industry depending on the properties of filaments, and certainly no one can question the technical importance of the incandescent lamp. It is still something of a question whether soaps, jellies, celluloid, rubber, etc., have a fibrous structure and are to be considered as filaments, or whether they have a honeycomb structure and are to be considered as emulsions; but nobody will dispute their being colloids.

Colloids in Foodstuffs

Cooking of meat involves changes in a distinctly colloidal material; poaching or scrambling eggs depends on the coagulation of colloids. The amount of fat adsorbed by a doughnut is quite surprising. The staleness of bread is not necessarily due, as most people suppose, to an actual drying, but apparently involves a displacement of the water equilibrium between the starch and the gluten. Mashed potatoes are certainly colloidal, and the cooking of cereals is partly a problem in the swelling of colloids. In fondant we have grains

of sugar made plastic by surface films of a solution of partly inverted sugar. This suggests the possibility of making fondant without cooking by starting from confectioners' sugar and a glucose solution.

Adsorption Phenomena in Dyeing

The dyeing and printing of fabrics involve adsorption upon fibers. In calico printing the coloring matter is mixed with British gum or some other thickener to prevent its running. When a coloring matter will not dye cloth directly the dyeing can be done by mordanting the cloth, a mordant being a substance which adsorbs the dye and is adsorbed by the cloth. The metallic mordants are used chiefly for the acid dyes, while tannin is one of the most satisfactory mordants for the basic dyes. Owing to the ease with which tannin is peptized by water it is usual to fix the tannin on the cloth by means of tartar emetic.

Function of Soap in Washing

Washing is the removal of adsorbed material, usually by peptization. Soap is adsorbed readily by the dirt and removes the latter from the fabric or the flesh. Dry cleaning is peptization by organic liquids instead of by water. Ink may be removed from old newspapers by washing with soap, by treatment with sodium silicate, or by froth flotation. Rit is a series of dyes, made up apparently with some soap. It will dye fabrics, but does not stain the hands.

Adhesive Properties Due to Adsorbed Surface Films

The importance of glue and other adhesives is due to their forming films which are adsorbed strongly by the surfaces which are to be held together. It is because of the difference in adsorption that we have to use different adhesives with different substances. If the film remains liquid it will both hold the particles and make the mass plastic, as in the case of wet sand, of fondant, and of oiled roads. With more liquid we change from plastic flow to viscous flow. The oil requirement for pigments is apparently the amount necessary to give a certain degree of plastic flow. When water forces fine sand into the state of loose piling we have the conditions for quicksand.

Other Examples of Surface Films

A drying oil forms a surface film which may be used to hold the pigment grains firmly on the painted surface. Varnishes and lacquers are surface films intended to give increased permanency and beauty. The whole question of the manufacture of varnishes is one that should be turned over to the colloid chemist. It does not seem possible that the present purely empirical methods can be the best. Patines are films of salts adsorbed on metallic surfaces. The adsorbed oxide films on the surfaces of aluminum and nickel decrease the corrosion of these metals and make it possible for us to use them commercially. Passive iron owes its properties to the presence of an adsorbed film of a higher oxide. When condensing phosphorus or zinc vapors the important thing is to prevent the formation of films around the drops. That the structure of graphite is an important factor is shown by the greater apparent density of the natural graphite, which makes it better for use in crucibles. The electric-furnace graphite made at high temperatures is not so good for lubricating purposes as the more flaky and unctuous graphite obtained at somewhat lower temperatures.

The detectors and coherers used in wireless telegraphy appear to function, at least in part, because of adsorbed air films. Electrolytic reduction is due to monatomic hydrogen produced at the cathode and a high concentration of this substance is the cause of hydrogen overvoltage.

Cornell University.

Filtration of Colloids

Dr. W. R. Ormandy, who contributed a paper on "The Osmose Process for the Filtration of Colloids," at the July 13 meeting of the Society of Chemical Industry at Newcastle, said that the special method of treatment under consideration depended on the utilization of certain properties of finely divided particles in suspension. The new process for the application of physiochemical laws is in many respects so new that it is necessary to deal shortly with the underlying principles before the methods of their application and the limitations of the process can be properly understood.

Colloids can be divided into at least two groups, the reversible and the irreversible colloids. To the reversible group belong such substances as glue, gelatine which can be dissolved in water, dried and again dissolved in water without any great alteration in properties. To the irreversible group belong such substances as albumin, which after treatment with boiling water become absolutely insoluble. For the most part, however, the nature of the colloid is largely dependent upon the size of the particles. Sufficiently fine particles when suspended in water exhibit what is known as the Brownian movement, which is the more energetic the smaller the particle. This Brownian movement is now regarded as the visible symbol of molecular bombardment, as has been largely proved by the researches of Prof. Perrin. Generally speaking, particles of matter exceeding 0.0001 mm. in diameter will eventually settle from solution. This is about the limit of microscopic visibility. The fact that particles below the limiting size do not settle means that the molecular and electrical forces outweigh the action of gravitation. So far back as 1869 Jevons noticed that the intensity of the Brownian movement of clay particles was increased by the addition of traces of certain types of bodies and inhibited by the addition of other types of bodies. In 1895 Bliss noticed that a clay suspension exhibited increased Brownian movement with the addition of traces of alkali, but that the addition of further quantities again reduced the movement. It has long been known that the addition of certain types of chemicals tended to cause coagulation of colloids suspended in water; thus the addition of calcium hydrate and aluminum sulphate to bring about the settlement of sewage sludge is ancient history.

Dr. Ormandy took a suspension of ball china, to which had been added the necessary amount of electrolyte, and poured it into a copper cylinder having a carbon pole suspended in the center. On passing a current of about 60 volts through the liquid so that the central carbon pole was the anode, the clay was not only deposited very rapidly on the anode, but, although the clay was deposited under water, the clay on the anode was found to be remarkably dry. This result was due to the peculiar action by which water was repelled from the anode through a porous diaphragm, the action being known as electro-endosmosis. If, instead of using a stationary anode, a horizontal rotating anode was used, this process could be made continuous.—*Chemical Age* (London), July 17, 1920.

The Leather Industry

Many of the Problems Awaiting Solution in Such Phases of Leather Manufacture as Unhairing, Deliming, Bating, Tanning, Stuffing and Dyeing Involve Fundamental Scientific Principles Which Can Best Be Studied Through Co-operation Between University and Tannery Chemists

BY JOHN ARTHUR WILSON*

IN THE hands of men thoroughly trained in modern chemistry, capable of original research, and provided with the facilities of a tannery, chemistry will probably eventually revolutionize the industry. But in the hands of less able men it is a source of danger that many a tanner has learned to his sorrow, with the result that even today a number of tanners either employ no chemist at all or else limit the work of those they do employ as chemists to mere analytical routine, and this in the face of the fact that the processes used in making leather are essentially chemical. The leather chemist has made considerable progress, but it has been small compared to what might have been expected from the progress of the pure science. Yet it is not difficult to see why greater results have not been achieved in the field of leather chemistry; the great majority of men who enter the tannery as chemists have an education no greater than that ordinarily required for the degree of bachelor of science, and this alone is entirely insufficient to cope with the real problems of the industry.

INDUSTRY DEVELOPED THROUGH EMPIRICAL EVOLUTION

The manufacture of leather is a most complex chemical industry and many of the processes in use today are the results of centuries of rule-of-thumb juggling. Along with the development of processes, accompanied as they often were by very costly failures, the practical tanner acquired an appreciation of the extreme danger of deviating very far from established practice. If he thought a process could be improved, he would first make only the slightest change and then wait weeks, perhaps months, to note any effect upon the finished leather. If no difference, or possibly a slight one for the better, could be detected, he would then institute a bigger change. Often it would be found that a small improvement in one process necessitated corresponding changes in several other processes. The young chemist usually fails to appreciate the need for this extreme caution and he is often ignorant of his ignorance of the fundamental chemical principles involved in making leather. When such a man is given free rein in the tannery, the results are much more likely to be fatal than profitable.

STUDY OF FUNDAMENTAL PRINCIPLES ESSENTIAL

The first applications of chemistry should be devoted to investigations of the molecular mechanism of present processes, the fundamental principles of which are not yet definitely known. Any increase in knowledge in this direction would permit the establishment of more satisfactory systems of control over the processes. In such investigations it is likely also that new principles would be discovered and these might form the basis for new and better processes. Because much of the necessary experimental work would require very refined apparatus and great skill in accurate measurements, it would seem that the best results would come from close co-operation between the industry and the university.

With little extra work and no sacrifice of any of the objects in view, the chemist of the university could make much of his research in pure chemistry of direct value to the industry if only he were aware of the industry's needs. Often a very elaborate and painstaking research would prove of the greatest value to leather chemistry if a few additional data had been obtained, which would have been easy enough with the apparatus set up and the work in full swing, but which would present formidable difficulties to the tannery chemist without suitable equipment. It would undoubtedly prove very profitable for the industry to finance research on a large scale at the university, and all results of such work should be published freely to be of greatest good. While the work would be primarily concerned with the chemistry of leather manufacture, it will be seen from the problems now to be outlined that the field is so broad that the gain to pure science would probably be fully as great as that to the industry.

SOAKING THE HIDES

Hides are received at the tannery in any of four different conditions: fresh, salted and wet, salted and dried, and dried without salting. The first of the chief operations is "soaking," which consists in putting the hides into vats of water and changing the water frequently until the hides are clean and have reached equilibrium with the water; usually several days are required. Dried hides absorb water very slowly, but they must remain in the soak vats until they have acquired their normal amount of water or the leather later on will not have the proper suppleness. The process of imbibition is sometimes hastened by adding alkalis to the soak water.

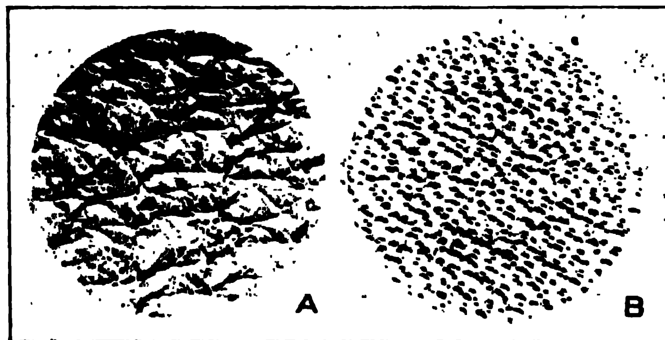
UNHAIRING

The next step is to free the hides from hair and epidermis and this is commonly done by putting the hides into saturated lime water containing an excess of lime and some sodium sulphide. Since these liquors are used over and over again after restrengthening, they generally contain decomposition products of the protein constituents of the hide, such as polypeptides, salts of aminoacids, amines, and ammonia, and all of these seem to play a part in this process, which is known as "liming."

After the hides have been in the liquor for several days, the malpighian layer of the epidermis is destroyed and the corneous layer and the hair may simply be

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rubbed off, and this is done on a suitable machine. Sometimes arsenic sulphide is used instead of sodium sulphide to "sharpen" the limes, and similar use has also been made of lye and of ammonia. In earlier times lime was used alone, but the action of pure lime liquors is extremely slow and satisfactory results were obtained only with old liquors that had become heavily charged with decomposition products of the hides and probably also with bacteria. Another method, once widely used, was to put the hides into a warm chamber where the epidermis was destroyed by putrefaction. Where the cost of labor has been large compared to the value of the hair, some tanners have employed strong solutions of sodium sulphide alone to destroy the hair, the hides being practically free from hair and epidermis when hauled from the vats. An unhairing action can also be produced by dilute solutions of ammonia and by pancreatic enzymes. All of the processes mentioned leave something to be desired and the whole subject of unhairing is in need of a much more thorough investigation than has yet been made.



GRAIN SURFACES OF GOAT SKIN (*A*) AND CALF SKIN (*B*) (X 8)

Deliming

Two more general processes complete the preparation of the hides for tanning: the removal of lime or other alkalis from the hides and a curious process known as "bating." The bulk of the lime is removed simply by washing, and the remainder, which has either carbonated or is combined chemically with the hide protein, is removed by treatment with dilute acids or is sometimes allowed to remain in the hides until removed by the acids present in the tanning liquors.

Bating or Puering

Bating, or puering, originally consisted in putting the hides into vats containing a warm infusion of the dung of birds or dogs and leaving them there until the "plumping" action of the lime liquors had been counteracted and the hides had become soft and raggy. Just how the early tanners hit upon this process is a matter for speculation, but the fact remains that the method appeared to be necessary to get certain desirable results in the leather. Investigations, notably that of J. T. Wood of Nottingham, seemed to indicate that pancreatin is the active constituent of the dung, and now mixtures of pancreatic enzymes and ammonium chloride largely replace the obnoxious dungs. But the question as to why we bate at all is still a moot one. Many tanners, especially those making heavy leathers, do not bate; others claim that good leather cannot be made without bating. If the object of bating were simply to counteract the alkaline swelling of the hides coming from the limes, this could easily be accomplished by reducing the hides to a nearly neutral condition, and some tanners claim that this does produce the desirable effects of bating. Recently, however, evidence has been brought forth to show that, in bating, the elastin fibers of the papillary layer are digested by the enzymes present.

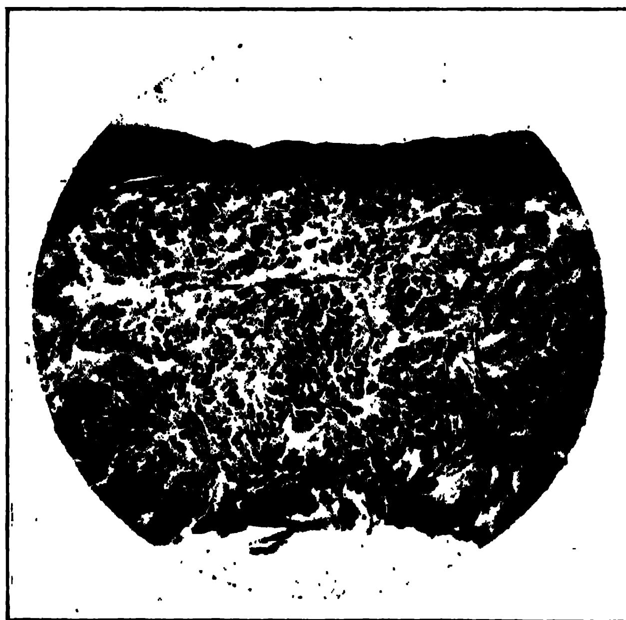
The foregoing represent what are known as the "beam house" operations and their prime object is to free the hides from everything excepting the collagen fibers and hyaline layer of the true skin, which is then ready to be tanned.

Tanning

There are numerous methods of tanning, of which only the two most important will be mentioned: these are vegetable tanning and chrome tanning. While the origin of vegetable tanning is lost in antiquity, chrome tanning is a product of the last few decades and is often referred to as the one big contribution of chemistry to the leather industry. These two processes and the materials involved in them have been the subject of the great majority of investigations made in the industry, and yet it cannot be said that we have made more than a start in the direction of solving the chemistry of tanning.

Chemistry of Vegetable Tanning Process Still Obscure

Vegetable tanning, as its name implies, consists in the conversion of hide into leather by means of material procured from plant life. The barks of trees, such as the hemlock and oak, the wood of quebracho, chestnut, etc., and the leaves and fruits of many plants contain matter which is soluble in water and capable of tanning hides. The hides upon coming from the beamhouse are first suspended in vats containing very dilute solutions of these tanning materials, each day or two they are moved into stronger liquors, and are finally hauled out when the color of the tan liquor has completely penetrated the hides as shown by examining a cutting in the thickest part of a hide.



CHROME TANNED COWHIDE (X 15)

Simple though this process may seem, its chemistry is exceedingly complex. Many theories of the mechanism of the process have been propounded and there is still no general agreement on any theory. The process is one in which the tanner finds he dare not deviate much from his daily practice. If the liquors become too strong or too acid, there is danger of the grain surface becoming rough or wrinkled to such an extent that it cannot later be made smooth and the value of the leather is lessened considerably. If the liquors are not sufficiently acid, the tanning action is retarded and the liquors and leather become darker in color through oxidation.

Different kinds of tanning materials often produce very different kinds of leather, but it is still a matter of some doubt as to whether such differences are due to differences in the active tanning principles which they contain or to differences in the content of foreign matter, such as acids and sugars or other fermentable substances. Some evidence has been brought forth recently to show that astringent tanning materials differ from milder ones chiefly in possessing less of non-tanning matters of acid character. Many difficulties that sometimes confront the tanner in the later processes are traceable to slight changes in the condition of the tanyards.

Vegetable Tanning Problems Suited for University Research

Much of the research required on the subject of vegetable tanning is especially suited for university laboratories. Among the more important problems in this connection might be mentioned the chemistry of the tannins, the swelling of the collagen fibers by dilute acid solutions and the opposing action of the tannins, the diffusion of the constituents of a tan liquor into the substance of the hide fibers, the effect of change of acidity upon the tanning action, and the nature of the tanning action itself. It will be found convenient in university studies of these problems to use a standard hide powder which has been placed on the market by the Standard Manufacturing Co. of Ridgway, Pa., especially for use in tannin analysis. This powder is made up chiefly of purified collagen fibers containing about 12 per cent water, 0.3 per cent ash and about 0.8 per cent of fat.

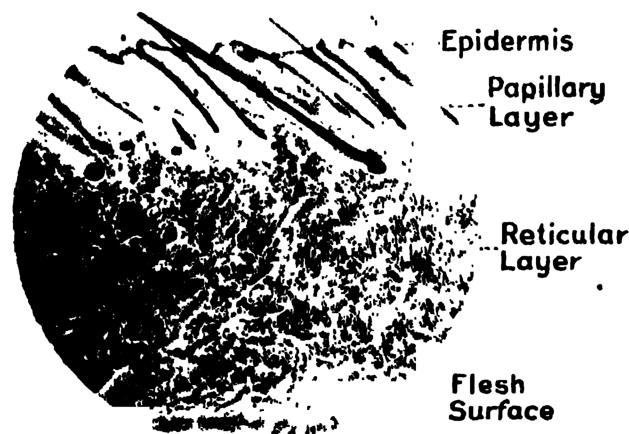
Chrome Tanning

Chrome tanning consists in treating the hides first with a solution of sulphuric acid and common salt, a process known as pickling, and then with a solution of basic chromic sulphate corresponding roughly to the formula $Cr(OH)SO_4$. Since chrome liquors are usually made by reducing sodium dichromate, they also contain a considerable amount of sodium sulphate. Sometimes the hides are taken from the pickle bath and put into a separate tanning bath and sometimes the chrome preparation is added directly to the pickle liquor containing the hides. After the hides have been drummed or churned in the chrome liquor for a day or more, the green color of the chrome will have penetrated them completely and they are then tested to determine whether or not the tannage is complete. This is done by keeping strips of the leather in boiling water for five minutes or longer; if they are fully tanned, the boiling water will apparently be without effect upon them, but any unchanged collagen present will be converted into glue, causing a considerable distortion of the strips. When the hides are not fully tanned at this stage, it is generally necessary to reduce the acidity by a cautious addition of alkali.

Complexity of Chrome Tanning Process

It would seem that tanning with inorganic salts and acids should be less complex than vegetable tanning, but the process is nevertheless almost bewildering in its complexity. Work now in progress at Columbia University has already shown that chrome liquors are much more complicated systems than we previously had reason to believe, although anyone who has done much experimenting with chrome tanning must have experienced the annoyance of not being able to duplicate certain results because of the variation of some unknown and therefore uncontrollable factors.

A. W. Thomas and his collaborators at Columbia have shown by hydrogen electrode measurements that the acidity of a chrome liquor changes with the time, especially just after some change has been made in the liquor, such as dilution or the addition of acids or alkalis. The acidity is markedly increased by adding neutral chlorides, such as common salt, and is decreased by neutral sulphates. They showed also that neutral salts have a similar action upon solutions of



COWHIDE FROM SOAK VATS (X 17)

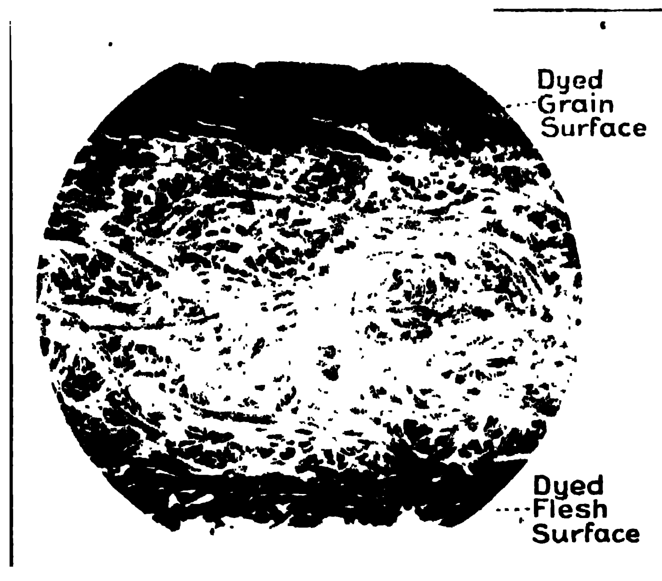
hydrochloric acid or sulphuric acid. It is quite evident, then, that before we can hope to control every factor in chrome tanning we must learn more about pure solutions of acids and salts. It is in further studies of this kind that the pure chemist can be of very great service to the industry and it is desired that he should appreciate the possibilities for applying his discoveries. An increase in the acidity of a chrome liquor retards the tanning. The addition of sodium chloride increases the acidity and, as would be expected, retards the tanning. On the other hand, the addition of sodium sulphate decreases the acidity, but it also retards the tanning. The explanation of these facts surely lies within the province of the pure chemist.

The writer has done much work on theories of tanning and believes that vegetable tanning consists of the combination of collagen and tannin, yielding collagen tannate or vegetable leather, and that similarly, in chrome tanning, we have the formation of a chromium collagenate, collagen being amphoteric. On

this basis the combining weight of collagen appears to be 750, or some multiple or submultiple of 750. This view has been contested, but its truth or fallacy should interest the pure chemist.

Fatliquoring and Stuffing

After tanning, by either the chrome or vegetable process, the hides are fatliquored or stuffed. Fatliquoring, which is applied to light leathers, consists in drumming the leather with a hot emulsion of suitable oils. If the condition of the leather is right and the proper quantities of materials have been used, the leather will remove practically all of the oil and leave nearly pure water behind. Stuffing consists in treating the hides with greases, such as a mixture of cod oil and tallow, which are often added hot to the dry leather. The object in applying oils to leather is to prevent brittleness, to increase strength, and to impart other properties desirable for certain types of leather, such as waterproofness, etc. There is much room for experiment in the making of suitable emulsions.



VEGETABLE TANNED CALFSKIN (× 40)

Dyeing

Another important process is the dyeing of leather. A pack of skins which has been kept together through every process may emerge from the color drum with some skins light in color and others dark. Any one skin will be uniform in color, but one skin may be much darker than another. The writer has found that slight differences in the amounts of acid carried by chrome-tanned skins cause them to take different amounts of dye from the same bath, but difference in acidity of different skins scarcely furnishes the full explanation.

University Chemists Should Develop Theories

The research work which the industry needs is of two very distinct kinds, the one pertaining to the discovery of facts and of reasons for certain processes and the other the correlation of those facts and application of them to actual leather manufacture. The former requires an extraordinarily broad knowledge of general chemistry and great skill in dealing with specific problems in many different fields of chemistry. For example, in studying the mechanism of bating, the investigator should have a knowledge of both bacteriological and enzyme actions, he should be familiar with the action of electrolytes upon proteins and with the work of H. R. Procter of Leeds and others upon the swelling of proteins in certain solutions by absorption of water, and he should be skilled in preparing and staining cross-sections of the hide for microscopic examination.

At the end of his investigation he might be able to say with certainty that bating has two and only two important functions, the counteraction of the swelling caused by the limes and the removal of elastin fibers from the papillary layer. Such a statement properly substantiated would do much to elevate a now uncertain process to a scientific basis. In the study of chrome tanning the investigator must have some very refined apparatus, particularly a good hydrogen electrode, and he must have a very thorough knowledge of physical chemistry. He might be able to settle definitely the molecular mechanism of tanning and show exactly what essential rôles are played by the salts and acids present. For the purpose of solving problems of this kind the university is vastly better prepared than the tannery.

Chemists Familiar With Tannery Practice Should Apply Theories

But when it comes to correlating such facts as the university chemist might discover and applying them to actual leather manufacture, a tannery is necessary as well as a chemist thoroughly familiar with its practical workings, and this of course the university could scarcely be expected to furnish. This would of necessity be the work of the tannery chemist, and such tanneries as do not employ chemists might fail to profit by the work done at the university. For example, suppose the university chemist proved the value of bating and recommended the use of a certain type of bating liquor that was slightly alkaline. A tanner who now delimes his stock with dilute acids, but does not bate, reads of the great discovery and attempts to profit by it. He follows the instructions carefully, but the resulting leather is much inferior to what he has been making. He concludes that bating is detrimental and remains satisfied with his deliming process. He has gained nothing from the research simply because he did not have in his plant a chemist with sufficient training and knowledge of the tannery to see that good results could not be expected until the vegetable tanyard was altered to conform to the changed condition of the stock coming from the beamhouse. Before instituting the bating process, the stock arrived in the yard in a slightly acid condition. After bating, the stock was slightly alkaline. To meet this changed condition, either the tan liquors should have been more strongly acid or the stock should have been put through the usual deliming process after the bating. Thus a given discovery might be hailed as a success by certain tanners whose processes chanced to be specially suited to receive it, while other tanners would consider it a failure.

The industry needs the help of the university chemists and it also needs highly trained chemists holding positions of responsibility in its tanneries; its development will be greatest when these two groups of chemists learn to do teamwork.



MACHINE PROCESS OF MAKING WINDOW GLASS

Putting the Glass Industry on a Scientific Basis

The Role of Modern Science in the Ancient Art of Glassmaking—Developments Due to Engineering — Refractories and Raw Materials — Accomplishments of the Chemist

By E. Ward Tillotson*

GLASS and glassmaking ever have had a peculiar appeal to the imagination of all peoples. Glass, possessing many of the attributes of precious jewels and in addition possessing the susceptibility of constructive formation, is particularly adapted not only for articles of use but also for pieces of art in which the form, decoration and coloring reflect the artistic sense of the glassworker. Glassmaking as an art practiced in secret for centuries has been surrounded with the glamour of mystery and the masters of the art have enjoyed the patronage of royalty and the perquisites of the nobility.

Developments Due to Engineering

During the last two centuries, however, conditions incident to the advancement of civilization have swept away many of the mysterious formulas. The establishment of the glass industry in this country marked the beginning of scientific advancement in the technology of glassmaking: the economic situation prevailing in a civilization such as ours makes impossible the maintenance of a great industry in a state of technical secrecy. It is not to be inferred that the industry is free from ignorance and prejudice or that glass manufacturers do not jealously guard certain secret processes, but it is only just to say that in no other country are glass factories more open to inspection for casual visitors and for business competitors. The glass manufacturer in general realizes that an exchange of ideas is of greater value to both parties than any doubtfully guarded secret could be to either one.

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The first advances in glassmaking in the United States and the most widely known American contributions to the industry consist in the applications of mechanical appliances and the making automatic of many glassmaking processes. For example, the pressing of glass, an American invention of one hundred years ago, has passed successively through hand-fed hand-operated presses, hand-fed power-operated presses, and now certain pressed glass articles are manufactured by automatic machinery which carries out the operations of "gathering" the molten glass, pressing the article, transferring it to and conveying it through the "leer."

Improvement in Bottle Making

A similar development has taken place in the manufacture of bottles, bulbs for incandescent lights and other articles involving pressing or blowing or even a combination of the two operations. In the window-glass industry the process, though of more recent date, has been equally brilliant and of far-reaching importance. Machines not entirely automatic, to be sure, draw huge cylinders from a pool of molten glass, and not only is the product of a far better quality than that

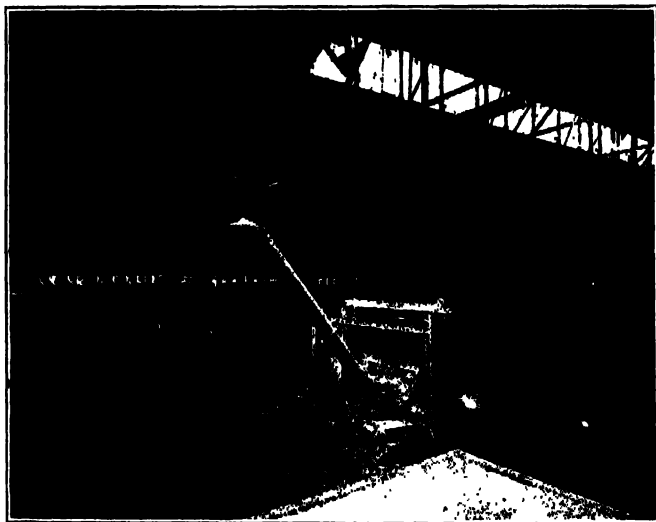
produced by the old "hand-blowing" process, but the great economic saving marks the introduction of machine-drawn window glass as a revolutionary achievement. Of the very recent developments in machine-made window glass mention should be made of a process in which "endless" flat sheets of glass are drawn and passed continuously through the leer. It is considered that this machine is an assured success. Obviously it possesses certain advantages over the cylinder machines, not only by reason of its continuous operation but also because the expensive operation of "flattening" is eliminated.

Little Progress in Plate-Glass Industry

The plate-glass industry has not experienced any spectacular developments of the nature of the inventions just mentioned; the operations as carried out at present are fundamentally the same as those of Thevart in 1688, with, of course, modern furnaces and leers and mechanical appliances for handling the glass in the several operations. This particular industry has been slow to develop in this country, but in recent years the requirements for windshields and other plate-glass fittings for automobiles have greatly stimulated the production of plate glass.

Mention should be made of "wire glass," which is manufactured by processes analagous to those employed in plate-glass manufacture. It is an American invention and represents perhaps the greatest advance in the application of plate glass for special purposes.

In the other glass industries American manufacturers have had the advantage of large resources of raw materials of a high degree of purity and of cheap clean fuel (natural gas); and while these factors have contributed to maintain the quality of American glassware on a par with that of other countries, revolutionary developments in certain lines have not been made.



FILLING END OF A LIBBEY OWENS FURNACE

Role of the Chemist and Physicist

It is, therefore, evident that American contributions to the advance of the glass industries have been largely from the engineering standpoint. It is not to be supposed, however, that the chemist and the physicist have entirely neglected these great industries. In fact, the part of these scientists has been of greater importance than is commonly supposed or acknowledged. Little has been written of the chemist's accomplishments, except, perhaps, in connection with the development of optical glass during the past few years.[1] Chemical contributions have been isolated, sporadic and, unfortunately, dimmed in the shadow of a general policy of secrecy which has resulted partly from tradition and partly from fear of legal complications. Such conditions do not make for real scientific progress in this or any other industry, but it is believed that the present is a period of transition and it is certain that great opportunities exist for the chemist and that his work in the future in conjunction with that of the physicist and engineer will transform the whole aspect of glass technology. The problems which are to be solved include the basic principles of all the operations involved and of the materials employed. The problems in connection with refractories, furnaces, fuel and raw materials are shared in common with all branches of the glass industry.

The Role of the Refractories

The pots in which glass is melted and the walls of the tank melting furnace are made from certain refractory fireclays. The curious situation is therefore presented of melting one type of silicate in a container composed of another type of silicate which is slowly but surely dissolved by the molten material. Unfortunately, none of the common metals possesses properties satisfying the requirements for these containers, and such substances as are known to be insoluble in molten glass have not yet been bonded successfully with an equally refractory and insoluble cement. The proposal has been made that the tank be constructed as a water-jacketed iron box. Walls of chilled glass would thereby be formed of the same composition as that of the glass to be melted. This would appear to be an almost ideal solution of the refractory problem, but in trial certain faults have been disclosed. Between the walls of cool and comparatively rigid glass and the channel of flowing molten "metal" there exists a zone in which the conditions are favorable for devitrification. Crystallization of some of the components of the glass occurs and these crystals are gradually carried to the working end of the tank and appear as defects in the finished product. When the chemist has succeeded in preventing devitrification in glasses of the type melted in tanks, this water-cooled tank will perhaps have a large field of usefulness.

The Pot an Important Factor

The use of green or partly burned pots and blocks is not to be considered as entirely satisfactory. Even if the pot is burned carefully in the pot arch, it is subjected to a higher temperature in the furnace. As a result, the back wall and crown are more thoroughly vitrified and subjected to considerable shrinkage, while the bottom and front walls are protected from the heat and remain more porous and do not shrink. This condition results in the introduction of large strains in

[1] For a concise review of the contributions of the chemist to the optical glass industry see A. A. Houghton, *J. Ind. Eng. Chem.*, vol. 7, p. 290 (1915). In speaking of developments in this country Mr. Houghton says: "America's contributions to the development of the glass industry, chiefly in methods of working and handling the molten glass, are epoch-making in character; along more strictly chemical lines creditable work has been done, as instanced by the Tiffany or Aurene glass, the selenium red, and others. Aside from optical glass, on which a beginning is being made, the glasses produced in this country probably are fully equal in quality and variety to those produced abroad; and in some respects America is forging ahead." For a recent report on the status of the optical glass industry, see R. J. Montgomery's "Twenty-three Types of Optical Glass," *J. Am. Ceram. Soc.*, vol. 3, pp. 404-10 (1920).

the pot walls and contributes to a lessened life by reason of breakage and for other causes.

Certainly the several operations involved in the manufacture of the pot or the block are of an equal importance with the kind of clay employed and a thorough understanding of these operations would be of inestimable value to the glass industry.

The historic glass furnace is illustrated by the open pot and covered pot furnaces in common use. These furnaces are admittedly inefficient and cannot be considered as satisfactory from any standpoint. With covered pots, especially, the heat necessary for melting the glass is generated within the furnace and must traverse the walls of the pot before it can perform its work. Even with efficient regeneration—and few of the installations can be so classified—the waste of heat is sufficient to justify the most serious consideration. Because of this the use of pots except for melting certain kinds of glass[2] may be expected to decline.

The introduction of the tank furnace has made possible the quantity production of glass which has justified and prompted the development of automatic machines. This type of furnace represents something of an advance over the pot furnace from the standpoint of heat efficiency, but still leaves much to be desired. The tank was used first for window and bottle glass, but has been adapted to melting "lime flint" or "crystal" glass, and the indications are promising that even "lead" glass may be produced in it commercially; it will undoubtedly be employed for any glass whenever the volume of production justifies.

The melting of glass by electrical energy has been the subject of much experimentation, and it is understood that elaborate trials of this principle now are being conducted. Molten glass is a fair conductor of electricity; and if the electric current can be passed through the molten glass and the heat be thereby developed within the charge, it appears that the optimum conditions of efficiency will be realized.

Raw Materials

The great developments of the glass industry during the past forty years have been associated with the supplies of natural gas. This fuel, which was ideal for the use of the glass manufacturer, is failing rapidly and even now is to be considered as a pleasant memory. The question of fuels is largely an economic one. Glass factories always have been located near the supplies of cheap fuel, but with the improvements in the manufacture of producer gas this consideration will perhaps be of less importance in the future. The necessity in melting and annealing glass of an ashless fuel and one as free as possible from sulphur and other impurities probably excludes all solid fuels except as they are gasified in the producer; and while in a measure successful, the use of fuel oil does not appear to become general by reason of its growing cost and of its lessened availability. Improvements in the design of furnaces and of regenerating systems which will admit of a more efficient application of the fuel and of a better control of combustion will be of material aid in conserving our fuel resources and in making for economy in the industry.

[2]For example, most of the colored glasses and other special glasses are used in too small a quantity to justify the use of a tank in their production. The more intensely colored glasses, in addition, are so impermeable to radiant heat that they may be melted only in pots; and pots are thought necessary for chemical reasons in the making of ruby glasses.

The American glass manufacturer is favored with large supplies of raw materials possessing a high degree of purity. The sand, lime and soda which are available are not surpassed in any country. Good as the sand is, however, it contains small amounts of extraneous minerals, containing iron, titanium and other color-producing oxides, the economic and complete removal of which would materially lessen the "color" problem in the manufacture of the finer grades of glass.

The importance of the chemical control laboratory should be pointed out in this connection. Automatic machines demand "metal" of constant viscosity, heat conductivity, "hardness"[3] and other physical properties. It is therefore important that the composition of the glass be maintained as constant as possible from day to day. When it is considered that not only does the composition of the raw materials vary in different shipments but that some of the materials—for example, the "lime" (CaO with more or less MgO)—change in composition during storage by reason of absorbing moisture or carbon dioxide, it is evident that the scientific production of even the more ordinary kinds of glass necessitates constant and adequate chemical control.

The substitution of limestone for burned lime, the addition of feldspar or other aluminiferous minerals to the batch and the use of other glassmaking materials are problems not only of economic importance but are also essential in scientifically adapting the properties of the glass to its intended use. A new source of potash would be of benefit to certain branches of the glass industry.

Problems in Special Branches of the Industry

Each branch of the glass industry has its own individual problems. In the present state of the window-glass industry, for example, there are many problems in connection with eliminating the relatively minor difficulties consequent on the creation of a new and great manufacturing procedure.



TAKING OFF GLASS AT END OF LIBBEY OWENS SHEET DRAWING MACHINE

Similarly in the machine-production of bottles and "packers" the majority of the problems of immediate

[3]Since no glass has a definite melting point, the word "hardness" has been used to denote the temperature at which it possesses a prescribed viscosity.

importance are related to the perfecting of the several processes which are competing for supremacy. The situation is one of mobility and of rapid progress, and it appears that the man of scientific training may have an important part in the developments of the future which will determine whether each of the automatic and semi-automatic machines will have a particular use of its own or whether one of them will prove to be so superior as to be of universal application.

The plate-glass industry is waiting for fundamental developments. At present the glass is melted in open pots and from these is poured on to the casting table, on which it is rolled. A means for conveying glass melted in a tank furnace to the casting table without the introduction of bubbles or other defects would almost revolutionize the industry. The mechanical appliances for handling the huge plates of glass have been highly developed and important innovations in the annealing process have been made, but the procedure employed in grinding and polishing, in spite of recent improvements, is impressive in its awkwardness complexity and lack of economy. A fundamental solution of this technologic problem may perhaps be the deciding factor in the future of the polished plate-glass industry.

In all these industries, as well as those represented by a smaller volume of production, there is need for a wealth of scientific data of a chemical and physico-chemical nature. The chemical reactions taking place during melting require scientific investigation; the principles of annealing glass have not been wholly worked out, and the building of leers to apply these principles is necessary for scientific annealing. A better understanding of the physical properties of glass at all temperatures and of the relation of the chemical composition to the physical properties is of real importance, not only in its fabrication in automatic machines but also in the development of new glasses or of glass for specific applications.

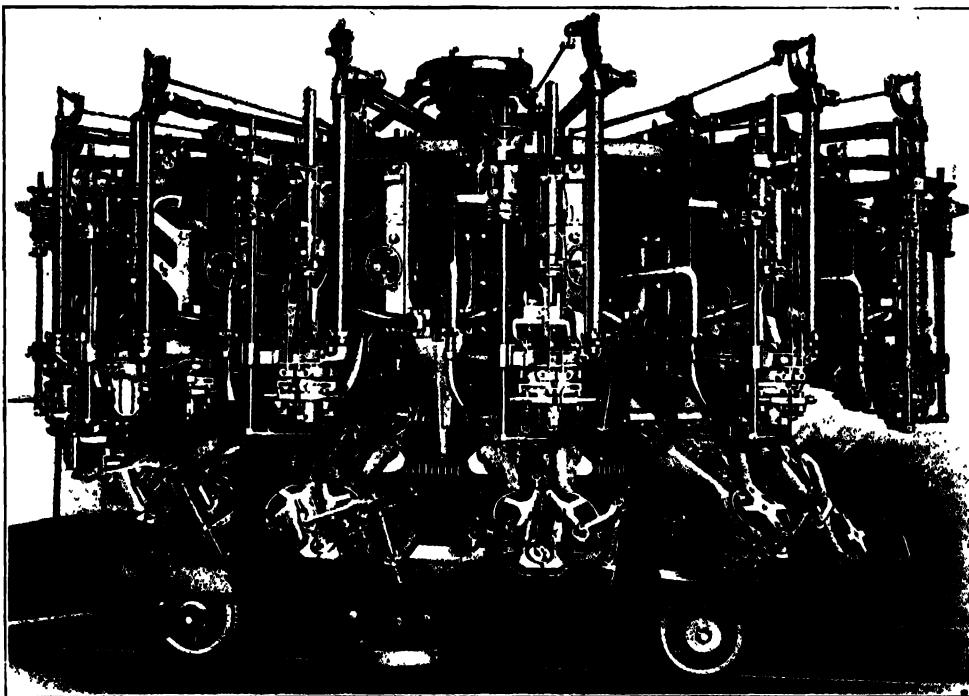
The adsorption of gases on glass surfaces and the behavior of glass to the solvent action of water and solutions is also of importance. A cheap glass of lesser solubility would find many uses and a glass of great mechanical strength would be desirable for containers which are to be used repeatedly.

To mention all the problems of the glass industry would be to discuss every detail in the manufacture and uses of glass. It should be mentioned, however, that a pink, red or ruby glass has not yet been produced in which color is constant throughout the operations and heat treatments which are involved. A highly colored red glass of permanent tint used in conjunction with the well-known blue glass, "powder blue," would form an ideal "decolorizer" and would be appreciated by the glassmaker. The use of colored glasses for signaling, for color screens in photochemical work and for goggles and spectacles to protect the eyes indicates the importance in the manufacture of these glasses of a scientific understanding of their properties, production and uses. The successful application of artificial illumination is associated closely with the glass used, and the scientific production of translucent and other glasses of the required properties offers a fruitful field of investigation for the scientist.

Accomplishments of the Chemist

Examples of what the chemist already has accomplished in the glass industries will occur to any one who is familiar with this field of manufacture. The German scientist has received his share of glory in the development of the optical glass industry, but the American inventors have been given little publicity. The American contributions of "lime flint"[4] glass, and recently of new laboratory glassware, of glass of extremely low coefficient of expansion, of glasses of peculiar properties for particular uses, and, during the war, the rapid establishment of a whole optical glass industry, under the direct supervision of scientists from the Geophysical Laboratory and the U. S. Bureau of Standards, are noteworthy accomplishments and are indicative of greater achievements when the glass industry has been put on a scientific basis.

The responsibility for fulfillment of this condition rests equally upon the scientist and upon the industrialist. It is fair to conclude that the glass manufacturer is not yet convinced that the scientist has an understanding of his problems or the ability to solve them equal with that of his practical glassmaker. It is probably true that the chemist often has failed to



OWEN 15-ARM AUTOMATIC MACHINES
This machine is capable of producing 350 gross of pint bottles per 24 hours, equivalent to the work of fifty hand operators.

[4]Invented in 1865 by William Leighton, Sr., of Wheeling, W. Va. Leighton used sodium bicarbonate in place of soda ash, which at that time contained quantities of impurities.

SOME NOTABLE DEVELOPMENTS IN THE GLASS INDUSTRY

Innovation	Date	By Whom Introduced	Place	Comments
First glass factory in America	1608	....	Jamestown, Va.	For the manufacture of beads and bottles.
Pressed glass	1827	A carpenter, name unknown	Sandwich, Mass.	The Boston & Sandwich Glass Co., Deming Jarves, mgr.
First plate-glass factory in America	1857	....	Williamsburg, N. Y.	Failed by reason of competition from France and Belgium.
Lime-flint glass	1864	William Leighton, Sr.	Wheeling, W. Va.	This invention nearly extinguished the old flint industry.
First regenerative pot furnace	1865	James B. Lyon	Pittsburgh, Pa.	Built at the O'Hara Glass Works, for use with producer gas
First continuous tank in America	1879	Poughkeepsie Glass Works	Poughkeepsie, N. Y.	For the manufacture of bottles.
First use of natural gas in melting glass	1882	Bradford Window Glass Co.	Bradford, Pa.	In 1884, gas was used for melting flint glass in the Riverside Glass Works, Wellsburg, W. Va.
Prepressed blank	1882	Philip Arbogast	Pittsburgh, Pa.	An important step in the development of the automatic bottle machines.
Continuous leer for window glass	1882	Cleon Tondeur	Dunhamville, N. Y.	Fox & Sons Window Glass Co. (the "rod" leer).
Continuous tank for window glass	1884	United Glass Works	Streator, Ill.	
Wire glass	1892	Frank Schuman	Tacony, Pa.	
Favrille glass	1892	The Tiffany Furnaces	Corona, L. I.	
Selenium ruby glass	1894	Nicholas Kopp	Pittsburgh, Pa.	
Flint glass melted in tank	1898	Charles H. Runyon	Rochester, Pa.	Keystone Glass Co.
Continuous leer for plate glass	1898	Marsh Plate Glass Works	Walton, Pa.	
Fire polishing cut glass blanks	1899	Michael J. Owens	Toledo, Ohio	
Automatic bottle machine	1899	Michael J. Owens	Toledo, Ohio	
Machine drawn window glass	1900	John J. Lubbers	Pittsburgh, Pa.	The American Window Glass Machine
Machine drawn sheet glass	1903	Irving W. Colburn	Franklin, Pa.	The Libbey Owens Sheet Glass Machine.
Flowing device	1903	Homer Brooke	Jersey City, N. J.	Used in connection with automatic machines.
Continuous leer for flint glass	1908	Maryland Glass Corporation	Baltimore, Md.	The intermittent pan leer had been in use for fifty years.
Low expansion glasses	1915	E. C. Sullivan & W. C. Taylor	Corning, N. Y.	Pyrex glass
Hartford-Fairmont feeder	1915	Karl E. Peiler	Fairmont, W. Va.	For use with automatic machines.
Automatic tube machine	1916	Edward Danner	Toledo, Ohio	
Automatic bulb machine	1917	August Kadow	Toledo, Ohio	The Westlake machine producing bulbs for incandescent lights

produce results in the glass factory; it is also probably true that the glass manufacturer has not understood what he might expect of the chemist and has not had a sufficient comprehension of science to utilize the services of the chemist to the best advantage. It is evident, therefore, that a fundamental consideration in putting this industry on a scientific basis is a more adequate training of chemists and chemical engineers in glass technology. The number of our universities which offer courses in the chemistry of glass is distressingly small and there remains to be established in any school an adequate course in glass technology in which the knowledge of the practical glassmaker is correlated with the known principles of chemistry and physics. The opportunities offered in this field and the knowledge that men of scientific training will be required in the glass industries constitute the primary arguments for the establishment of such courses of training, and the assurance of co-operation on the part of the industrialist will be of material aid and is indeed necessary in the consummation of this desirable purpose.

Such a course in glass technology should not only develop men for research and control work but should also offer to the practical man an opportunity to gain such a knowledge of scientific principles as will be of benefit to him in working in sympathetic accord with the scientific men in his factory. A mutual understanding on the part of men associated together is an essential of success.

In this principle is undoubtedly to be found the reason for instances of failure of the chemist in the glass industries. The chemist has not been trained to understand the point of view of the men making glass and the practical man has not understood the point of view of the chemist. In many industries in which the professionally trained man forms an essential part it has been found advantageous to give him in the factory an additional special training in the particular business of that factory. The recognition by the glass manufacturer of the fundamentals of this situation will quickly react to his advantage. The work of the chemist, particularly if he is engaged in research, lies within a field which properly comes under the direct jurisdiction of the chief executive of the organization. It is notable that in those concerns which have made the best use of the chemist he has come into a position of high executive responsibility. One instance, of many, may be cited in which the chief of the chemical laboratories is one of the five principal officers who report directly to the president of the company. This method of organization does not presuppose that the president is a man of scientific training, but it does assume that he has a sympathetic understanding of the relation of his business to the scientific principles involved.

It is not to be expected that even a large number of chemists working independently and in isolation in the laboratories of a large number of glass factories will, in the highest sense, put the glass industry on a scientific basis. Science supposes organization and experience has demonstrated that united efforts are more productive than equally intense but dispersed expenditure of energy. The success which has accompanied the research laboratories established by associations of manufacturers in a united purpose for the common good may well be considered by the several glass industries. The establishment in England of the Glass Research Association under the auspices of the Department of Scientific and Industrial Research is to be taken as indicating the beginning of concerted effort to apply scientific principles to the manufacture of glass, an attitude of co-operation which is commended to the attention of the glass industries in this country. Other industries have learned that properly conducted scientific laboratories yield substantial returns.

The glass manufacturer may again read the words of an old-time but progressive glassmaker. "In an age of progress, whoever clings to the methods of the past will soon be neglected and forgotten."

Safety Glass Factory at Mount Vernon, N. Y.

The Triplex Safety Corporation of New York is operating a factory at Mount Vernon, N. Y., for the manufacture of its products. In this plant ordinary window glass is carefully graded as to size and thickness and thoroughly cleaned and dried. Two plates are then put together with sheets of celluloid between and cemented with a cement having the same optical properties as the glass.

Glass treated in this manner can be shattered by hard blows, but will not splinter. A sample made up of three such thicknesses of glass was not penetrated by a bullet discharged from a 0.45 caliber automatic.



Recent Developments in the Hardwood Distillation Industry and Suggestions for the Future

Work on the Increase and Variation of Yields of the Pyroligneous Products: Acetate of Lime, Methanol and Charcoal—Cord Sticks Cut Into 5-In. Blocks—Control of Retorting Temperatures—Central Research Organization

BY L. F. HAWLEY*

IN A brief article[1] published in 1913 the writer called attention to many technical operations in the process of wood distillation in which efficiency studies would be of great value. Since that time there has been considerable progress both in research work and in the commercial application of the fundamental facts discovered.

Work on the variation in yields of products from different species of wood has continued,[2] and new plants have been built in sections of the country where the industry had not previously existed. More attention is also being paid to the use of mill wastes such as slabwood by distillation plants near which such wastes are available.

On the effect of moisture content of the wood on the yields obtained during distillation some experimental figures have been published by Palmer and Cloukey.[3] So far as we know these results have not been applied to any great extent in practice, but another development in connection with the moisture content of wood has been made by commercial plants. Formerly the drying of distillation wood was entirely by natural methods consisting of one year to eighteen months air drying. At two large plants artificial drying of the wood in three days has taken the place of this long period of air drying with resulting reduction in cost of piling wood in the yard and in interest charges on wood in storage.

CORD STICKS CUT INTO 5-IN. BLOCKS

Artificial drying has also led to another change in methods, on account of the fact that rapid drying is better obtained with small blocks of wood than with the ordinary 4-ft. stick. For the drying process, therefore, the wood has been cut into blocks about 5 in. long, and from this point onward the wood does not need to be handled, but is carried through the process entirely on the cars in which it is distilled. Although there is some extra cost in preparing these blocks and a small proportion of the wood is lost in the form of sawdust, these are more than counteracted by the lower cost of handling and the other economies mentioned above.

CONTROL OF RETORTING TEMPERATURES

A few years ago R. C. Palmer, then connected with the Forest Products Laboratory, called attention to the possibility of influencing the yields of valuable products by more careful control of the temperature of distillation. It had previously been known that by a very slow distillation the yields of a cord of wood could be increased, but Palmer showed a method by which the

EDITOR'S NOTE.—In endeavoring to eliminate the use of the terms wood alcohol and methyl alcohol, the Committee on Occupational Diseases of the American Chemical Society has suggested that these be replaced by methanol or methyl hydroxide. Since methanol has been adopted by some of the leading producers, it will be used in these pages in place of wood or methyl alcohol.

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[1] *J. Ind. Eng. Chem.*, vol. 5 (1913).

[2] U. S. Dept. of Agr. Bull. 508.

[3] *J. Ind. Eng. Chem.*, vol. 10, p. 262 (1918).

yields could be increased without increasing the total length of time required for distilling a charge of wood. This was accomplished by very rapid heating at the beginning of the run with constant watching of the temperature and distillate so that the heat might be cut down just in time to prevent the distillation from "running away." This method of temperature control has been commonly adopted by the larger wood distillation plants and has been of great benefit to the industry.

Products From Wood Tar

There has recently been some development[4] in the preparation of marketable products from hardwood tar, but only a few plants are now making a complete utilization of this product by the preparation from it of marketable products. The developments along this line have been so favorable, however, that it is very likely that the utilization of hardwood tar will increase rapidly in the near future. The usual method of recovery of acetic acid and light oils from tar by distilling with steam in the wooden tar still has been studied[5] with the result that the most efficient conditions for the operation have been determined.

The products carried off in the non-condensable gas are still being lost at the same rate that they were several years ago. A few crude attempts have been made to recover a part of these products, but the subject has not been properly studied and the installations have not been very efficient or profitable.

The Acetate, Methanol and Charcoal Trio

It is seen that the hardwood distillation industry has made considerable technical progress in the last seven years, but there are still many technical details which require further study and many other points that require careful attention if the industry is to continue its present importance. The hardwood distillation industry is peculiar in that it produces three marketable products which have been of about equal importance to the industry. At one time acetate of lime may seem to be the most valuable and important product, and then methanol takes first place. The third product, charcoal, varies somewhat in demand, but in any case it makes a good third in the line. Persons frequently ask what is the cost of production of methanol or of acetate of lime, without thinking that it is an impossibility to figure the cost of production of one of these products in a practical commercial way without including the other products. It would be unreasonable to charge the entire cost of production to either product alone, and at the same time it is difficult to apportion the proper costs of the three materials. If for any reason there is a drop in the price of one of the three products and if this drop in price brings the total cost of production above the price of the products, it is necessary that some other of the three products increase in price sufficiently to make up the difference. This is probably the explanation of the rapid increase in price of methanol shortly after the Government restrictions were removed from this product and acetate of lime. The demand for acetate of lime had fallen off, and there were large stocks on hand. When the price of this product decreased for these reasons, the price of methanol had to advance in order to keep the value of the three products above the cost of production.

During the war there was such a demand for acetate and acetone that the hardwood distillation industry could not supply the required production, although previous to the war practically all acetic acid made for industrial purposes was obtained from wood as the original raw material. Several new processes for the manufacture of acetone and acetic acid were developed, and some of them were put into commercial operation. Two of these new processes are even now in operation, apparently in successful competition with similar products made from wood. This means that the monopoly of the hardwood distillation industry in acetone and acetic acid is broken and that its strength will now lie in its monopoly in methanol.

Up to the present time no promising method for the synthetic manufacture of methanol has been developed, but five years ago we could have said that no promising method for the synthetic manufacture of acetic acid had been developed. If the demand is great enough and if the price is high enough, there will be a great incentive for development work on a synthetic methanol or formaldehyde. If some process is developed which can compete with methanol from wood the hardwood distillation industry will be in a very precarious condition. It seems desirable, therefore, that the industry make efforts to remove this incentive by greater production and lower price for methanol and that it build itself up to the very highest efficiency in order to meet competition of this kind when it does arrive.

Central Research Organization

There are several points in which the industry can build up its general efficiency in order to meet this situation. One general method which has been used with very good results in other industries is the development



HARDWOOD DISTILLATION PLANT

of a central technical control or a central research organization. Any new method developed by one of the units of the industry should be made known to the others, and the details of costs and profits should be made available so that the other plants can determine whether the new development is desirable under their conditions of operation.

In connection with such a system a few technical men should be in the employment of the industry as a whole, in order to study these new developments and report on the results obtained. This is the simplest method of obtaining and applying new developments, but it is of course very slow in comparison with the operation of a central research organization, in which new ideas would

[4] *Trans.*, A.I.M.E., 1916, p. 1,387. Chem. & Met. Eng., vol. 20, No. 11, June 1, 1919, p. 586.
[5] *J. Ind. Eng. Chem.*, vol. 12, p. 684 (1920).

be actively sought for and investigated. In the end the more extensive research organization is really the most efficient, because it prevents the units of the organization from duplicating new work and it assures more careful and complete research work on new problems.

There is also a very good field along the line of general efficiency in the operation of the plant. Such simple things as pipe fitting, control of the temperature of the condenser water, and proper methods of firing the retorts and boilers may make a very large difference in the cost of production.

Higher Yields to Be Sought

It is also possible that the time has come when the attention of the industry should be directed toward increasing the production from a unit quantity of wood rather than increasing the capacity of a plant of unit cost. The cost of wood and the cost of labor are both very high at the present time and will probably continue much higher relatively than they have been previously. On this account any labor-saving device or any method by which more products can be obtained from a cord of wood should be very seriously considered. It is possible that a complete change in the design of the retorts and in the general method of handling the wood would give greatly increased efficiency under the new conditions of increased cost of wood and labor, although this change might have been entirely impractical under the old conditions. The practicability of preparing artifically dried blocks about 5 in. in length may encourage the introduction of an idea which has been several times suggested but never put into practice. This is the idea of a vertical continuous retort in which the temperature increases as the wood descends. Such retorts should be very economical of fuel, since the flue gases from the lower chamber of the retort could be used for heating the higher and cooler portions. As the operation would be continuous, the control of the temperature could be made very simple and each part of the retort could be kept at a nearly constant temperature.

Methods for the destructive distillation of sawdust would also be of value, though they would not be likely to have a very great influence on the industry, since the localities where large amounts of hardwood sawdust would be available are not very numerous. Unless larger sized pieces of wood, such as slabs and edgings and possibly some tops and limbs, were ground up for use in the process, it would be difficult to obtain enough small-sized material to run a commercial plant.

Control of Product Yields

Some experimental work started at the Forest Products Laboratory a few years ago and now in progress again after a few years interval has indicated the possibility of changing the yields of various products by the addition of certain chemicals to the wood previous to distillation. It has been shown[a] that the presence of a small amount of phosphoric acid prevents the formation of any tar; and it would, therefore, be possible to start the refining of the pyroligneous acid without a preliminary distillation in order to remove the tar. This would result in considerable economy of fuel.

Some recent experiments along this line have indicated that a small proportion of certain chemicals tends to increase the yield of methanol very considerably but with a small decrease in the yield of acid. At the present time, when there is a great demand for methanol and only a slight demand for acetic acid, a process of this kind might be very desirable. It is not impossible that further work along these lines might develop methods by which the relative yields of the different products would be controlled according to the markets, so that when methanol, for instance, was in great demand the yields of this product could be increased, possibly at the expense of some other product. At the present time there are no indications of a chemical or catalyzer which could be used to increase the yield of acid possibly at the expense of the methanol.

There is a great deal of work to do in research and in plant control and organization, in order to keep the wood-distillation industry generally efficient and progressive and make it able to meet the competition which has already arisen in regard to one of its products. Although this industry has made great technical advances in the last few years, it cannot rely on past records but must continue to advance at even increasing speed.

[a] *J. Ind. Eng. Chem.*, vol. 10, p. 264 (1918).

Tannins and Dyewood Extracts

H. O. Chute in a paper read at the Montreal meeting of the American Institute of Chemical Engineers on the Progress in Dendrochemistry stated that:

The discovery of the use of wood extracts for tanning and dyeing is prehistoric. Many of the most savage and primitive tribes have knowledge of their use.

In late years the United States has produced about 200,000,000 lb. tanning extract annually and has imported—mainly from South America as quebracho extract—about as much. Much bark, as hemlock and oak, is also used for the production of leather.

Someone has said that anyone who can make a pot of tea can make a wood extract. In an earlier day this was perhaps so, but modern methods have been introduced into this industry.

The most approved practice in the United States is to grind the woods or barks, etc., and extract in a diffusion battery under pressure. This necessitates the use of copper to give the strength and resistance to the acids which are present. Probably the most popular extractor or diffusion cell is about 5 ft. diameter and 12 ft. long, slightly enlarged toward the bottom so as to allow of quick discharge of the exhausted chips. The bottom is hinged and is the diameter of the cell and, on opening, the charge drops out to a conveyor which takes the chips to the boilers for fuel. These usually furnish all the steam necessary to the works. Each wood requires a different temperature and pressure and treatment to get the best extract. Some woods, such as quebracho, are best extracted by adding some SO_2 to the liquor to dissolve the more refractory tans Some extracts, like logwood, are oxidized, the oxidized logwood extract being called "hematine," and this is used for leather dyeing and where oxidation after applying cannot be used. On the other hand, the unoxidized logwood is preferred where bichromate mordants are allowable.

All the different woods and tannins differ in containing various other constituents. Some contain glucose, which, by fermenting, produces an acid liquor which is desirable at certain stages of the process and for certain leathers. Others contain much coloring matter and give colored leathers which are desirable or not according to their purpose. Those extracts which will not ferment, such as chestnut and quebracho, are used in connection with such fermentable extracts as hemlock, etc., or are used in the later stages of tanning.

The woods most commonly used in America for tannin extracts are hemlock and chestnut.

What seems to be a purely American invention is the production of a tannin from the chipped wood and a soda pulp from the extracted residue, thus utilizing both the fiber and tannin in the wood.

Putting the Paint and Varnish Industry on a Scientific Basis

During the Last Twenty-five Years Empiricism Has Been Rapidly Replaced by Scientific Control in the Paint Industry, Due Mainly to the Initiative of American Chemists — Research in Varnish Industry Has Dealt Chiefly With Raw Materials

By MAXIMILIAN TOCH*

THE manufacture of paints is purely scientific, and although pigments have been made for many centuries no scientific control was observed until about twenty-five years ago.

The manufacture of varnish is partly empirical and partly scientific, but within the last fifteen years the manufacture of varnish has emerged from the rule-of-thumb to the semi-scientific state.

No scientific work of any consequence was done in Europe on paints and varnishes until American investigators had already established that industry on a sound basis, and as recently as 1906 it was evident that there were only four or five concerns in the United States which manufactured paints and varnishes that had chemists in their employ.

I do not include in these half a dozen concerns that employed analytical chemists to test the purity of the materials which they bought, but it was well known at that time that there were only a few of us who knew how to analyze mixed paint or had even a working knowledge of the composition of an oil so well known as linseed oil.

Prior to 1906 the most impossible and worthless mixtures paraded under the name of paint and it must be said to the credit of the State of North Dakota that Prof. Ladd was authorized to make an analysis of the various paints and pigments which were for sale, in order to protect firms from buying adulterated and useless materials in that state. There were many innocent errors made in the promulgation of the law in question, but the results worked out admirably, and today almost every paint and varnish manufacturer of the United States either employs a chemist directly or seeks scientific assistance indirectly.

Scientific Status of Industry in 1906

There was at that time no literature on the subject, and I had been collecting the results of my own work since 1900, with a view to publishing a book which I intended to call "The Chemistry and Technology of Mixed Paint"; so when the State of North Dakota passed a law which broadly amounted to labeling all paints excepting those of certain composition, all paint manufacturers of the United States attempted to defend it; and the peculiar condition became apparent that men like A. H. Hooker, of Heath & Milligan; G. W. Thompson, of the National Lead Co.; Prof. Sabin, of Edward Smith & Co.; Dr. C. B. Dudley, of the Pennsylvania R. R., and I were the only chemists in the United States who had at that time any knowledge of the chemistry of paints. There were, perhaps, three or four more, like Parker McIlhenny, C. W. McKenna and others who did private work, but when it came to testifying on the witness stand as to an exact knowledge of the composition of paints, the value of such materials and an expert knowledge of the manufacture of the finished product, I was the only man, at that time, in the United States who qualified as a chemist and a manufacturer.

This was less than fifteen years ago, but since that time hundreds of able men have been engaged in work on this subject; and today lectures are delivered at our various institutions of learning, both here and abroad, so that what was empirical and regarded as exceedingly valuable, from the standpoint of secret process, is today common knowledge published for the information of all.

Change in Attitude Toward Certain Products

During that famous trial, lithopone, regarded as a useless and cheap pigment, was brought to the attention of the paint industry, and its manufacture rose until today it is third in the list of white pigments, corroded lead and zinc oxide still taking the lead.

Chinawood oil, which only a very few knew how to manipulate, was given its proper place as a paint and varnish material, and today it is for certain purposes far more valuable than linseed oil.

Chemical and physical tests have been devised for the identification of pure turpentine, and that solvent was shown to be only a solvent and no better in the manufacture of paint than several of the petroleum solvents which evaporate completely.

I remember a very interesting experience I had more than twenty-five years ago on my first trip South to the turpentine stills, when I saw that it was the custom to add a barrel of kerosene or benzine to nine or ten barrels of the sap of the pine tree to "start the distillation properly," as some of these turpentine distillers put it, with the result that when I arrived back home and tested turpentine for specific gravity and polymerization by means of sulphuric acid, I came very nearly establishing wrong data because of this custom among the turpentine distillers.

It is very difficult for me to write a short history of the scientific development of the paint and varnish industry without repeating myself, because I have so often told of my experiences, both orally and in writing, but it does no harm to repeat one or two of my experiences for the benefit of those who wish to profit thereby.

Rule-of-Thumb Methods Unprofitable

Once a well-known color manufacturer who, although a competitor, was a very warm friend confided to me that in the manufacture of chrome yellow he could never make any money; and he asked me to investigate and find out whether there were any leaks in his factory that his color-maker could not discover. I found, on going through his plant, that he had no chemist and that his color-maker was an ignorant man, practical to

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the last degree, but unscientific in every respect, and that he had a little note-book of formulas, one of which read as follows:

"To one pail of nitric acid add 50 lb. of litharge; then pour this in a barrel and fill it with water. Then take 100 lb. of bichromate of potash, and mix them, and you get pure medium chrome yellow."

On investigating further I found other formulas in which my friend used sugar of lead; that the color-maker dissolved a certain number of buckets of this material and added it to a certain number of buckets of bichromate of potash, with the result that the wash water showed a very large excess lead acetate which went into the sewer, and it was very easy to indicate where the loss took place; and after correcting these glaring errors I had the satisfaction of installing a chemist in the plant, and from that time on the color works in question became profitable.

Little Change in Varnish Technology

The manufacture of varnish was described four hundred years or more ago by an Italian named Cennini, and to this day the manipulation, the kettles and the tools used have scarcely changed, with the one possible exception that we know more concerning the raw materials which we use; we have been able to utilize products which were formerly regarded as adulterants; and every oil and resin used in the paint or varnish industry whose constants are indicators of its eventual physical characteristics we are familiar with.

The advent of chinawood oil has brought about a change, and I am unafraid to admit that, while I despised and discouraged the use of it in my own factory, I am now a firm believer in it until something better can be discovered.

Let us remember that fifteen years ago chinawood oil was condemned because its physical characteristics were compared with linseed oil, which shows us that it is a mistake to take a new material and judge it by an older one. Raw linseed oil, as everyone knows, dries with the aid of a drier, and when suitably mixed with the proper pigments forms a film which lasts anywhere from three to eight years, even under extreme exposure.

Raw chinawood oil, on the other hand, no matter what it is mixed with, dries with an opaque, brittle, crystalline film, which is neither flesh nor fowl. It polymerizes or solidifies when heated for twenty minutes to 420 deg. F. (216 deg. C.). It is difficult to manipulate and in unskilled hands it is a failure. But when 4 lb. of chinawood oil is heated with 1 lb. of rosin that has been partly or wholly converted into a resinate of lead or similar compound, the heat can be carried up to 600 deg. F. (315 deg. C.) without danger of the polymerization of the oil, and a varnish is obtained which, while fairly high in acid number, possesses more remarkable qualities than the best kauri linseed oil varnish ever made. This sounds strange, but it is true.

Of course, to those skilled in the art it is known that this resultant fusion of 5 lb. just mentioned must be diluted with equal quantities of turpentine or turpentine substitute, and the film so produced will not turn white after it has been permitted to dry thoroughly, even though the test sample is placed in water for weeks. When I made my first experiments along these lines I did not use the material as a varnish, but I used it as a paint oil. Of course, lead and zinc could not be used as bases, because chemical union would take place, and the compound, which I called a tungo resinate of lead or zinc, was formed, which was a viscous, ropy, gelatinous material, physically unfit for making paint ready for use. But, if the proper pigments were selected, such as graphite, lithopone, red oxide and blanc fixe, a paint could be made which remained in suspension for a long time.

As many know, I do not rely upon laboratory experiments for the finding of my conclusions; but in 1915 and 1916 I made several hundred gallons of various colored paints, omitting linseed oil entirely as a vehicle, and substituting for it a varnish made from rosin and chinawood oil, and these paints I applied to wooden structures on the Atlantic coast which were from 100 to 500 yd. distant from low tide and subject, therefore, to the heavy sea fogs of that locality. In comparison with these tests there were a number of smaller buildings painted with various mixtures of lead and zinc and linseed oil, and the conclusions arrived at were that the gloss and hardness of the resulting film, after three years, was as good for the rosin : chinawood oil mixture as for the linseed oil paint, with this exception—that the rosin : chinawood oil paint left a better surface for repainting.

Preservation of Engineering Materials

Much work has been done on the preservation of engineering materials by means of paint; and whereas we formerly thought that all paints protected, we now know that some pigments produce corrosion and others retard it to a remarkable extent.

Paints have many uses, both decorative and protective, which frequently give them a value that is inestimable, such as, for instance, the modern flat wall paints for the interior of buildings, which can be washed and which are far more economical than the dust-collecting wall papers and hangings formerly used.

Paints for Concrete Surfaces

It has been said that this is the concrete age, where portland cement is taking the place of flammable and other perishable building materials; and it is only within the last seventeen or eighteen years that methods have been devised for the coating of concrete for exterior and interior with paint materials, and these methods have been worked out purely on a scientific basis. Paints are usually made of a saponifiable base, and concrete is basic in its nature; therefore, the average oil paint is readily destroyed, and that accounted for the well-known dictum that concrete cannot be painted. But this has been completely overcome through scientific investigation, so that concrete structures of all kinds may be preserved against the acid fumes with which they may come in contact and the aqueous and other disintegrating influences which may tend to abrade them.

It is not my intention to indicate that all paint manufacture has been placed upon a scientific basis, but the enormous strides many have made in the last fifteen years and the many scientific investigations that have been made indicate that this industry will eventually be one in which empiricism will be entirely eliminated, and the credit for most of the investigation that has taken place must go entirely to America, for Germany, with all her much-heralded chemical knowledge, did very little if anything toward the scientific investigation or improvement in the manufacture of paint and varnish.

Alloys of the Past and Present

A Review of the Recent Developments in the Production of Pure Metals, Ferro-Alloys, Bronzes and Brasses and of the Increasing Uses for the Less Common Metals and Their Alloys—Research Suggestions for the Production of Special Alloys

BY COLIN G. FINK*

CENTURIES ago pure metals as derived from their minerals were practically unknown. There are a few noteworthy exceptions, such as the pillar of pure iron at Delhi, now over 1,600 years old. But in general the metallurgical processes of the past were so crude that it was not possible to produce, say, pure copper or pure nickel or pure zinc, nor to cast alloys of constant composition. The copper of the Greeks and of the Romans never even approached the "International Annealed Copper Standards" of today.

Within our present era—in particular within the latter part of the nineteenth century—metallurgical investigations were carried out here and abroad with a view of producing metals of "absolute" purity. It was found that the elimination of the last traces of impurities in copper brought about a very decided increase in the electrical conductivity of the metal. Traces of certain foreign metals in gold when removed resulted in a very malleable and ductile metal.

It was a natural inference that in general metals of 100 per cent purity were the most desirable. Metallurgical processes were being rapidly developed and improved upon. Electrometallurgy became of ever-increasing importance. Metals could be produced of a purity never before attainable.

However, it wasn't very long before we found that "100 per cent purity" was not always desirable. For example, in the case of silver a product was obtained by electrolytic refining methods which was extremely pure, purer than "Sterling" and exceptionally soft and malleable; but for actual service this "100 per cent pure" silver showed very poor wearing qualities and accordingly had to be "doped" with copper and other impurities to bring it back to "Sterling" grade.

Pure nickel could not be rolled into sheets and drawn into wire without excessive breakage. It was necessary to add a small percentage of manganese to render nickel workable. Iron containing small percentages of copper[1] or larger percentages of silicon or chromium corroded less than pure iron. Aluminum containing a little manganese was in general preferable to pure aluminum. Tungsten with ½ to 1 per cent thorium makes a better filament than 100 per cent pure tungsten. Specifications today not only point out the impurities the metal or alloy must *not* contain but include various foreign elements with limiting percentages that must be present in the product to be acceptable.

Ferro-Alloys

The advent of the electric furnace and the introduction of commercial electrolytic cells with fused salt baths, more than any other factors, brought about a sudden spurt in the development of our modern alloy and rare metal industries. The most remarkable advances have been made within the last twenty to twenty-five years. The electric furnace and electrolytic aluminum have made possible the production of ferro-alloys of a tenure and purity never before attained by the ordinary blast or hearth furnaces. It is very clearly demonstrated at the Chemical Exposition that a number of our capital industries, such as the machine industry, the electrical industry and the automobile industry, are largely if not wholly dependent upon electrolytic and electrothermic products and processes. Chief among these products are the ferro-alloys—ferromanganese with 78 to 82 per cent Mn, a valuable deoxidizing and recarburizing agent; ferrosilicon, up to 90 per cent Si, more effective than ferromanganese for eliminating gases in steel and other alloys and for the manufacture of silicon iron used in electrical apparatus; ferrovanadium with 30 to 40 per cent V, an indispensable addition to steels for the automotive industries where high tensile strength and resistance to constant vibrations are demanded; ferrochrome with 30 to 60 per cent Cr, for chrome-nickel and chrome-vanadium steels, armor plate, stainless steel, tool steels, etc. (according to C. B. Gibson, over 50 per cent of the chrome-vanadium steels are absorbed by the manufacturers of automobiles); ferrotungsten with 70 to 80 per cent W, for high-speed steels and magnet steels; ferrotitanium with 15 to 25 per cent Ti, a most valuable scavenger in the making of steel for rails and high-grade castings; ferro-uranium, for tool steels; and ferromolybdenum, one of the latest alloys to come into popularity, for crankshafts, gears, springs, etc.

Alloys for Tools

Rapid strides within recent years have been made in the development of alloys for tools. Modern high-speed tools, with 400 to 700 per cent efficiency as compared with the old carbon steel tools, were of inestimable value during the war when the element of time was a very important factor; and today, with labor and material prices soaring skyward, there are few that can afford to use an ordinary carbon-steel tool. The introduction of vanadium into the original tungsten steels greatly improved their quality and endurance.

Systematic investigations into the composition and nature of tool steels have lately been published by J. A. Mathews of Syracuse, K. Honda of Japan, R. C. McKenna of Pittsburgh, Dean J. O. Arnold and Fred Ibbotson of the University of Sheffield and others. A detailed discourse on tool steels by A. J. Langhammer of New York recently appeared in this journal.[2] He cites, as average composition of modern high-speed tool

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[1]L. T. and E. A. Richardson, MET. & CHEM. ENG., vol 15, p. 450, Oct. 15, 1916.

[2]CHEM. & MET. ENG., vol. 22, pp. 829, 889, 939, 969.

steel, tungsten 16 to 18 per cent, carbon 0.60 to 0.70 per cent, vanadium 0.75 to 1.05 per cent, chromium 3 to 4 per cent.

The introduction of the chrome-molybdenum-cobalt steel Stellite by Haynes, of automobile fame, has given rise to exhaustive tests, in particular in Canada and England. Arnold, in referring to this and similar steels, terms cobalt a stabilizer of molybdenum. Stellite alloys have gained a wide use as lathe tools, but many of these contain tungsten in place of molybdenum. The high-speed steel industry is still in a development stage, and as regards the proper intelligent operation of these special tool alloys comparatively few machine shops are fully conversant with the grinding, the best operating speed, the correct methods in heat treating, etc. Unfortunately there is a different heat treatment prescribed for each brand of tool steel. Aside from this it is usually difficult to get a machinist to realize that tool steels of today require different heat treatment from ordinary carbon steels.

Acid-proof Alloys

Most important among the acid-proof alloys are the ferrosilicon alloys containing from 10 to 15 per cent Si. As every visitor to the Exposition will concede, these alloys have passed beyond the experimental stage. Large vats, mixers and boilers for corrosive liquids have been installed in industrial plants all over the



FIG. 1. ORDINARY COBALT

world. Furthermore the 13 per cent ferrosilicon alloy has been found superior to lead and to magnetite as an insoluble anode in electrolytes containing not only sulphuric acid but nitric as well. Next to ferrosilicons in industrial importance as non-corrosive alloys are the ferrochromes. They are chemical corrosion-proof but not very electrolytic corrosion-proof. Exhaustive tests have been carried out at laboratories in Niagara Falls and in New York. A. W. Clement in his patent (U. S. 1,333,706) recommends an alloy of 60 per cent chromium, 40 per cent iron for acid-resisting pipes and valves. Nickel-chrome alloys are giving very satisfactory service not only as acid-resisting material—for example, for dipping baskets in plating and pickling operations—but also as a material resisting oxidation and destruction at high temperatures. Accordingly, annealing boxes made of nickel-chrome are far outlasting the older ordinary iron boxes.

The Brasses and Bronzes

The brasses and bronzes are among the very oldest alloys in metallurgy, but it is only within the last generation that their composition and properties have been thoroughly investigated and stringent specifications drawn up for more than two dozen different grades and qualities, depending entirely upon the use to which the brass or bronze is to be put. The last two or three years have seen a complete conversion in the brass melting art from gas- or oil-fired furnaces to electric furnaces. The reduction of spelter losses is only one of the many advantages gained. A section of this year's Exposition will be devoted entirely to brass-melting electric furnaces. Types of the direct-resistance, the indirect-resistance and the arc type will be on display. Electric melting of brass costs about half that with the older combustion furnaces.

The introduction of aluminum among the cheaper metals has given rise to innumerable investigations on aluminum alloys. Many of these alloys, on account of their light weight, have been found indispensable in airplane construction. One of these airplane alloys contains 3 per cent copper and 13 per cent zinc, the remainder being aluminum. As the copper content is increased the hardness of the alloy is increased. Duralumin contains approximately 94 per cent Al, 3.7 per cent Cu, 0.6 per cent Mn, 0.25 per cent Zn, 0.43 per cent Mg, 0.6 per cent Si, 0.5 per cent Fe. It has a tensile strength of 38 kg. per sq.mm. and a Brinell hardness of 90.[3] An alloy which is an improvement on the well-known "Coney Island gold" alloy (90 to 91 Cu + 9 to 10 Al) has recently been patented by S. Shigeta (U. S. Pat. 1,319,537). It contains about 80 per cent copper, 10 per cent aluminum, 5 per cent molybdenum and 5 per cent tungsten. In color it resembles gold very closely and can be worked into thin sheets. The alloy corresponding to the formula Al_3Mg_2 (about 46 per cent Al) was carefully investigated by Waltenberg and Coblentz of the Bureau of Standards,[4] and they found that the polished surface possessed a very high reflectivity and was suitable as a mirror providing the surface can be protected from tarnish.

Bearing Alloys

According to W. K. Frank[5] a typical bronze bearing contains 9.5 per cent Pb, 10 per cent Sn, 79.7 per cent Cu and 0.8 per cent P. This bronze has a Brinell hardness of 60 and a compression of 0.25 on a 1-in. cube with a load of 100,000 lb. per sq.in. High lead alloys are plastic but wear rapidly and are difficult to produce uniformly. The best bearings have the greatest hardness compatible with the required plasticity. Of special interest are the Frary bearing alloys. One of these, for example, contains about 97 per cent lead and 3 per cent barium plus calcium. These alloys have given remarkably good service, are uniform in

[3] L. Guillet, J. Durand and J. Galibourg, *Compt. rend.* vol. 169, p. 508.

[4] Bu. Stand. Sci. paper 363, 1920.

[5] *Iron Age*, vol. 105, p. 948 (1920).

quality and readily reproduced. As compared with ordinary lead, the alloys are hard and when struck with a hammer emit a clear metallic ring. The alloys are now manufactured on large scale at Keokuk, Iowa.

Low-Temperature Coefficient Alloys

Constantan, a copper-nickel alloy with a very low-temperature coefficient, has received renewed attention within the last few years and exhaustive treatises have been published by Hunter and Bacon, F. E. Bash, D. W. Gray and others. Gray found that the addition



FIG. 2. CARBON-FREE COBALT

of manganese increased the specific resistance and decreased the temperature coefficient. One of his best alloys has a specific resistance of 70 microhms per c.c. and a temperature coefficient of practically zero. It is composed of approximately 55 parts of copper, 45 parts of nickel and 10 parts of manganese. For thermocouples Bash[6] recommends the following proportions of the elements in constantan: Copper 53.18 per cent, Ni 45.71 per cent, Fe 0.26 per cent, Mn 0.61 per cent, C 0.17 per cent, Si 0.09 per cent, and S 0.02 per cent.

Increasing Uses for the Less Common Metals

Of the less common metals zirconium has been one of the most popular lately and there have been at least half a dozen laboratories, both here and abroad, investigating the properties of the metal, its alloys and other compounds. The laboratory of the Bureau of Mines at Golden has been turning out some very pure metal. At Pittsburgh zirconium steels were tried out, but details have not as yet been published.

Thallium, manufactured in limited quantities at Denver, has found application as the "getter" thallous chloride in tungsten lamps. It is one of the very few metal chlorides whose lower or "ous" state is more stable than the higher or "ic" state. A very interesting recent application of thallium is in the "Thalofide Cell," whose active principle is an oxysulphide of thallium. The cell is a new light reactive resistance of great sensitivity.[7] The electrical resistance drops 50 per cent on exposure to ¼-ft. candle. The cell is more sensitive than the selenium cell, especially on exposure to very low light intensities.

Calcium is now manufactured on a commercial basis and has found a definite and valuable application in small rectifiers and similar electrical apparatus. The Frary lead-calcium alloy has been referred to above.

The Department of Mines of Canada has carried out exhaustive researches on the alloys of cobalt. Cobalt steels have been made equal in many respects to the best tungsten steels. An interesting alloy which shows a very high degree of ductility is composed of about 20 parts of cobalt and 80 parts of nickel. Rods ½ in. in diameter can be rolled and drawn down to $\frac{3}{100}$ in. in diameter without intermediate annealing.[8]

Suggestions for Research

There are a number of metals whose alloys have been only partly investigated. Among these might be mentioned tantalum, columbium, uranium and molybdenum, all of which are obtainable in fairly large quantities and are not, strictly speaking, rare metals such as gallium and scandium.

The tantalum filament appeared on the market in 1905, but within a few years it was superseded by the more efficient tungsten filament. However, a world search for tantalum mineral deposits had been instituted by the Siemens & Halske Co. and a bountiful supply of the metal was assured. There are large deposits in Australia and the United States.

Tantalum is a metal whose properties have been carefully investigated, its manufacture at one time being carried out on a commercial basis, but today the metal is almost unknown and forgotten. Considering a few of the remarkable properties of tantalum, such as the high melting point (2,900 deg. C.) high ductility and tensile strength, insolubility in acids except hydrofluoric, the metal certainly deserves further study and research. Tantalum alloys readily with nickel, cobalt, iron and other metals.

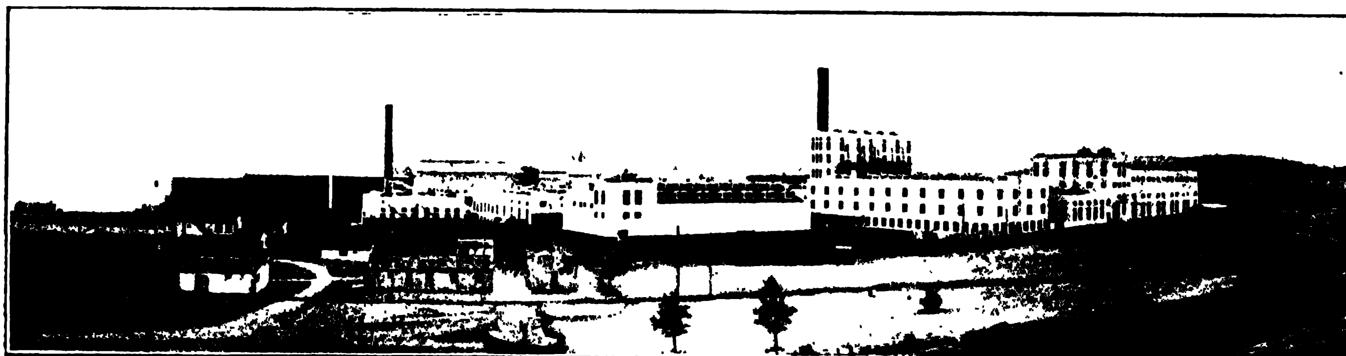
Uranium, molybdenum and zirconium have been investigated so far mainly as addition metals to steel. There is every possibility that one or all of these metals will form a valuable constituent of iron-free alloys. An alloy of molybdenum and cobalt has the same coefficient of expansion as glass, can be drawn into wire and makes a perfect seal in glass.

Another field of alloy research is the production of alloys absolutely free from carbon, sulphur and phosphorus. The author's investigations on ferronickel and on cobalt metal and its alloys have demonstrated rather strikingly that the properties of the metals and alloys undergo a decided change upon the complete elimination of the above three impurities. In the accompanying microphotographs Fig. 1 is a sample of commercial cobalt melted in the presence of carbon, and Fig. 2 is the same sample after heat treatment in hydrogen. After hydrogen treatment, cobalt, its alloys with nickel and similarly ferronickel are almost as soft as copper. The disappearance of the carbon is readily recognized in the microphotographs.

[6] Bull. Am. Inst. Min. Eng., 1918, p. 2409.

[7] Case Research Laboratory.

[8] Fink. U. S. Pat. 1,342,993, June 8, 1920.



BALTIMORE WORKS, U. S. INDUSTRIAL ALCOHOL CO.

Science and Industrial Alcohol

Development of the Alcohol Industry Caused by Chemistry and Allied Sciences—Production Involving Raw Materials, Synthesis and Fermentation—Recovery, Involving Distillation, Rectification and Purification—Byproducts Obtained and Unsolved Problems

BY BURNELL R. TUNISON

THE industry of producing alcohol for manufacturing purposes is one of the older fields of activity with which science and particularly chemistry have been concerned. It has been considered by many that the process of alcohol production and recovery has reached a high degree of perfection. That being the case, it may be of assistance to some to note the development that has been made, the obstacles overcome and the problems which still remain unsolved.

Alcohol as such has been known and used for a great many years and even centuries prior to the study of alcohol as such and its properties. Even as early as 500 to 1000 B.C. the natives of India and China knew that by distilling certain mixtures a beverage could be obtained which exhibited marked properties as a stimulant. The Greek alchemists from the first to the fourth century A.D. learned the use of stills for simple distillation and the elements of condensation. About the twelfth or fifteenth century alcohol became recognized as a stimulant and curative agent in disease. Not until the nineteenth century, however, was the industrial use of alcohol developed. Up to that time very little progress in the art of distillation had been made, the apparatus was crude and the alcohol produced was very dilute, in addition to containing other alcohols and fermentation impurities which made it unsuitable for most industrial purposes.

The progress made in the alcohol industry may be noted from two points of view—namely: (1) The production, involving the raw materials and the fermentation or synthesis, and (2) the recovery, involving the distillation, rectification and purification.

RAW MATERIALS

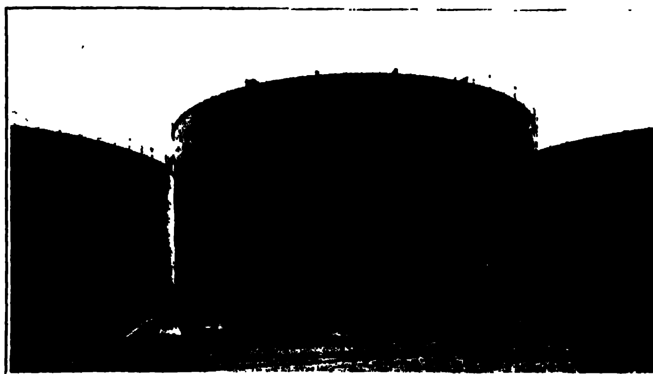
Probably the first materials used for the production of alcohol were the fruits and fruit juices which were universally used as beverages. As more was learned about the constitution of alcohol and the type of compound from which it was being made, the grains came into use. During the eighteenth century the question "What is alcohol?" led to considerable work being done to determine its actual composition and a study by the foremost scientists of the times to determine its process of formation and the nature of the compounds from which it was formed. Since the eighteenth century this constant application of scientific truths to this industry has made it safe to say that at the present day it is possible to utilize any material containing starch or sugar and many products of cellulose as a raw material for the production of alcohol. Thus the factors at the present time which determine the raw material which shall be utilized for alcohol manufacture are largely economic, the technical difficulties having been practically solved. It is true that in the use of many materials there are possibilities of much improvement in the matter of yields and efficiency of handling the process materials, and these are some of the many problems which are at present receiving the attention of experts.

At the present time the most important raw material for the production of alcohol is cane or black strap molasses. It is one of the easiest of all the raw materials to handle, requiring only dilution and acidification before fermentation. Next to molasses in importance as a raw material are the grains, corn probably being used most extensively. The choice of a raw material for alcohol production is dependent largely upon economic conditions, consequently they differ in different countries, nearly every country using a different product as a raw material. For example, Germany is noted as a country where potatoes are grown for this purpose, France uses grain and sugar beets as well as beet molasses, the United States molasses and grain chiefly. The Philippine Islands use nipa palm, China uses large quantities of rice, England is beginning to use mawra flowers, mahua and similar plants. Yucatan uses sisal waste and India uses dates and date palms.

Where we have so many possible sources of raw materials, those who are charged with the technical control of the alcohol plants of the world are very likely not to take into consideration enough of the factors or products which should be given attention. In most countries there are at least several raw materials which

should be considered. This is especially true of those plants which thrive in tropical climates. As a general rule these plants grow very rapidly and thickly over large areas and the cost is merely that of cutting and transportation to the point of utilization. For example, the nipa palm (*Nypa fructicans*) is used in the Philippines. *Commerce Reports* (July 12, 1920, page 212) states that alcohol can be made from this material for approximately 20c. per gal. There is a sufficient quantity available to produce approximately 50,000,000 gal. of alcohol per year. The present production of alcohol from this source amounts to only 2,500,000 gal. per year.

In most tropical countries the cassava and arrowroot grow very luxuriously and are excellent raw materials. They compare very favorably with potatoes as to starch content, containing approximately 25 per cent starch and



MOLASSES STORAGE—SEVEN TANKS—2,000,000 TO 3,000,000 GAL. EACH

from 4 to 6 per cent of fermentable sugars. Cassava tubers are about 8 to 10 lb. in weight. An acre of ground producing average cassava, it is stated (Press Bulletin 63, Bureau of Science, Manila, 1917), will yield approximately ten tons of tubers giving about 5,000 lb. of extractable starch, which is more than double the yield of the same area growing an average crop of potatoes.

An endless number of examples of raw materials might be given, but the above are typical. More thought should be given to the matter of raw materials for fermentation by all those engaged in the manufacture of industrial alcohol.

Two other sources of raw material for the production of industrial alcohol should be mentioned, as they will very probably be developed to some extent in this country. These are waste sulphite liquor and wood waste. The former material is available in only relatively small quantities, but in that it does contain fermentable matter and is a waste product it will probably be utilized to greater extent than at present. Wood and wood waste have been experimented with for many years, but normal conditions have not become such as to make possible the production of alcohol from this source on an extensive scale at a price which can compete with alcohol produced from the other sources.

Synthesis of Alcohol

The first chemical synthesis of alcohol is usually attributed to Berthelot. In 1854 he obtained it by absorbing olefiant gas in sulphuric acid, diluting the product and distilling it. It is also claimed that Hennell (Simmond's "Alcohol," p. 10, 1919) in 1827 succeeded in identifying ethyl sulphuric acid in a quantity of sulphuric acid into which Faraday had passed olefiant gas. Hennell in 1828 is supposed to have distilled this ethyl sulphuric acid with water and a little sulphuric acid and obtained sulphuric acid and alcohol.

Because of the relative cheapness of the raw materials for fermentation and the ease of making them very little attention has been paid to the various methods of producing alcohol synthetically. In recent years, however, where unusual conditions exist alcohol has been produced synthetically on a commercial scale. In localities where raw materials for fermentation are not abundant or where cheap power is available, such as are the conditions in Norway or Switzerland, alcohol is produced synthetically from acetylene. Calcium carbide is produced in the electric furnaces and acetylene from the carbide by the action of water. Two methods are used in the production of alcohol from acetylene:

1. Acetylene is hydrogenated by catalytic means and ethylene is produced. The ethylene is dissolved in sulphuric acid, and alcohol and sulphuric acid are formed upon saponification.

2. Acetaldehyde is produced catalytically from the acetylene. The acetaldehyde is oxidized to acetic acid or reduced to alcohol by means of catalyzers. Consul W. O. Kent of Berne, Switzerland, has described (1917 *Commerce Reports* 102, p. 426) an equipment for the production of 7,500 to 10,000 tons of alcohol per annum by the above means.

One of the newer developments for the production of industrial alcohol is its production from the waste gases from coal carbonization plants. The gases given off during the coking of coal contain appreciable quantities of ethylene. This ethylene may be separated, purified and dissolved in sulphuric acid and ethyl sulphuric acid formed. This may be readily converted by saponification to alcohol and sulphuric acid. Extensive experiments have been carried on in England with the result that it is claimed by H. F. Grady (1919 *Commerce Reports* 219, p. 1,460, also 1920, 21, p. 506), who describes the operation of a plant at the Skinningrove Iron & Steel Works, that 1.6 gal. of 95 per cent alcohol can be obtained from the gases produced by each ton of coal carbonized. The report of the British Inter-Departmental Committee on the production and utilization of "power alcohol" states that sufficient ethylene can be obtained from the gas works and coke-oven gases of Great Britain to yield annually up to 150,000,000 gal. 90 per cent alcohol. Experimental work along this line is being done in the United States and our own production may soon be supplemented in this manner.

Fermentation

Although the production of alcohol from fruits and grains has been known since the beginning of the Christian era, it was not until the seventeenth century that any attempt was made to study the mechanism of its formation. In 1659 Willis stated that a ferment was a body in a state of decomposition, its particles being in constant motion. This motion could be imparted to other bodies capable of fermentation. In 1689 the German physician and chemist Becker thought that fermentation was a process similar to combustion because of the similarity of the waste gases evolved. He also stated that only the different varieties of sugars were capable of alcoholic fermentation.

Liebig held that sugar was mechanially decomposed as a result of molecular motion, and that the yeasts

themselves were a product of the reaction and not its cause. Another theory explaining alcohol formation was that sugar was taken in as a food by the yeast, and alcohol and carbon dioxide were given off.

Berzelius regarded fermentation as a catalytic process.

Although, little by little, knowledge was acquired concerning alcoholic fermentation, very little progress was made until the beginning of the eighteenth century. On account of the microscopic size of the yeast cells, definite knowledge concerning them was not obtained until the development of the modern microscope. Although



60,000-GAL. ALCOHOL STILLS

some of the earlier investigators had seen yeast cells, it was not until the microscope reached a high state of perfection that the fungi were carefully studied. During the early part of the eighteenth century much was learned concerning the specific properties of these micro-organisms, their nourishment, growth, multiplication, etc.

In 1836 Cagniard-Latour (*Ann. Chim. Phys.*, 1838, vol. 68, p. 206) believed that from the results of his researches the yeast must be a living organism and was very probably a plant. Several other investigators about this time confirmed the conclusions that the yeasts were vegetable organisms and that they reproduced by budding or by spore formation.

Traube in 1858 explained that fermentation was due, not to the yeast cell itself, but to certain substances which were produced or secreted by these cells. However, this theory was discredited for many years.

The nineteenth century brought forth the famous controversy between Liebig and Pasteur as to the cause and mechanism of fermentation and the settlement of the question thus brought about. Liebig believed that the ferments were unstable nitrogen-containing substances, formed by the action of air upon plant juices containing sugar. These easily decomposable ferments he thought were in a constant state of degradation or decay. This decomposition imparted a corresponding chemical motion to the atoms of the sugar; and thus the sugar itself was decomposed with the production of alcohol. Pasteur eventually proved that the theory advanced by Traube was essentially correct. At the present time it is believed that the organisms capable of causing fermentation belong to one of the three groups of lower fungi—bacteria, yeasts or molds.

The bacteria attack not only carbohydrates but proteids and to some extent fats and other organic bodies. Frequently acids are produced by their action, but they are not producers of alcohol.

The yeasts which are the most important as producers of alcohol are monocellular organisms. The yeasts are the source of production of enzymes. These enzymes are the active fermenting agents. The yeasts are more or less imperfectly classified as to species, varieties and races. The various yeasts were carefully studied and classified by Pasteur, and since his time investigation has greatly extended our knowledge in this field.

The work of Pasteur also showed that because of the fact that yeast is a plant it requires nutritive substances of organic, nitrogenous and non-nitrogenous as well as mineral form. The chief non-nitrogenous organic nutritive substance for the yeast is found in sugar. It is usual practice to add yeast foods for the proper cultivation of the yeast.

E. C. Hansen, stimulated by the work of Pasteur, investigated the life history of individual alcohol-producing yeasts and developed the method now in use in all modern plants of procuring a pure yeast by cultivation from a single cell.

E. Buchner (1896) was the first to demonstrate that an extract could be obtained, by crushing yeast cells and subjecting them to high pressure, which would ferment sugar to alcohol and carbon dioxide as a result of the monocellular enzymes which were thus liberated.

Modern Conception of Fermentation

As now understood, the enzymes are nitrogenous compounds, either albuminoids or very closely related to albuminoids in composition, which occur in vegetable and animal organisms. Their function in the life



CONTROL FLOOR OF STILL HOUSE, SHOWING ALL CONTROL VALVES AND TAIL BOXES FLOWING ALCOHOL AT RATE OF 60,000 GAL. A DAY

processes of the organism in which they exist seems to be to transform the more insoluble food materials to a soluble form in order that they may be more readily assimilated by the organism. These enzymes may be classified into groups according to a kind of action which they exert. The proteolytic enzymes which convert protein materials into simpler bodies, such as peptones and amino acids, are of secondary importance in the production of alcohol.

There are three principal types of enzymes which convert the complex carbohydrates to simple ones: 1. The diastatic enzymes which decompose starch. The resulting products are dextrine, maltodextrine and maltose. The principal enzyme of this type is diastase (amylase), which is usually obtained from malt—that is, germinated barley. Other diastatic enzymes are obtained from the molds. 2. Maltase is an enzyme which decomposes maltose into fermentable dextrose. Maltase also occurs in malt as well as in many yeasts. 3. Invertase is the enzyme which inverts cane sugar, producing a mixture of dextrose and levulose. Invertase is found in malt as well as the yeasts.

Zymase is the enzyme produced by yeast cells which directly produce alcohol from the monosaccharoses such as dextrose and levulose. Zymase, while it produces alcohol directly from dextrose and levulose, cannot produce alcohol from sucrose or the disaccharoses nor from



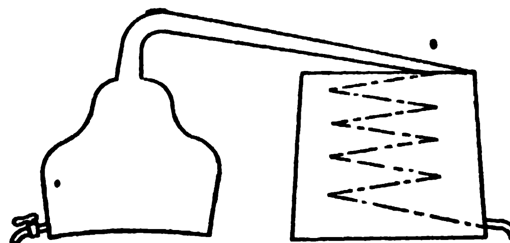
DENATURING BUILDING

starch, and the other enzymes do not produce alcohol directly, but prepare the material for the action of the zymase. Thus diastase transforms starch to maltose, maltase converts this into dextrose, invertase changes cane sugar into dextrose and levulose, which are acted upon by zymase.

There are other enzymes which are not of particular interest from the alcohol production point of view.

Theoretically when sugar is converted into alcohol we should expect to obtain only alcohol and carbon dioxide. Practically, however, the fermentation is always accomplished by the formation of byproducts which decrease the amount of alcohol recovered. Yeast is an organism which consumes sugar for its nourishment and propagation, and also converts sugar into other substances besides alcohol and carbon dioxide during its metabolic changes, thus reducing the percentage conversion. The products other than alcohol formed in the fermentation are usually glycerol, succinic acid, acetic acid, butyric acid, lactic acid, propionic acid, formic acid, higher alcohols and ketones, aldehydes, with sometimes small quantities of various esters (ethyl acetate, butyrate, caproate, etc.).

Chemistry and biology have brought the process of fermentation from the point where it "just happened" and the results were sometimes one thing and sometimes another to a point where it is possible to always obtain the products desired and to eliminate to a great extent those not wanted. However, there are still great opportunities for improvement in the yields obtained and the elimination of undesirable reactions. Progress has been made in the utilization of special ferments for the production of other alcohols and ketones and in this field of fermentation great possibilities are before us. Even in this day of much knowledge concerning fermentation we do not know exactly what the enzymes are nor just how they produce the change from starch to sugar,



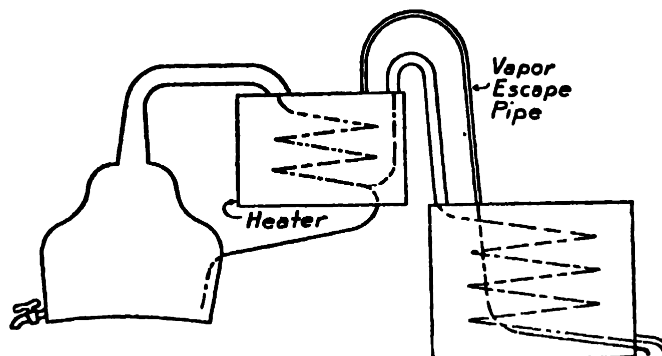
POT STILL

sugar to fermentable sugar, fermentable sugar to alcohol. We do not know just why one enzyme will produce ethyl alcohol and why another will produce butyl alcohol, glycerol or acetone. If we knew some of these things, who knows how much more we could accomplish by the process of fermentation? Wonders have been accomplished, but there still remain many fields to conquer.

A tremendous amount of work has been done and great progress has been made in working out the commercial application of the fundamentals learned concerning the process of fermentation, such as yeast growth and development of yeast, the media in which these yeasts thrive, saccharification, etc. The preparation of the raw materials has been a specialized problem and separate processes have been perfected for the handling of the different raw materials and the preliminary treatment of them which is necessary before fermentation. The process of saccharification, or the transformation of starch material into fermentable sugars, has reached a high state of perfection and all types of starchy products may be efficiently utilized.

Distillation and Rectification

While the first crude stills for the production of alcohol from beverages were constructed before the beginning of the Christian era, it was not until about the



POT STILL WITH HEATER

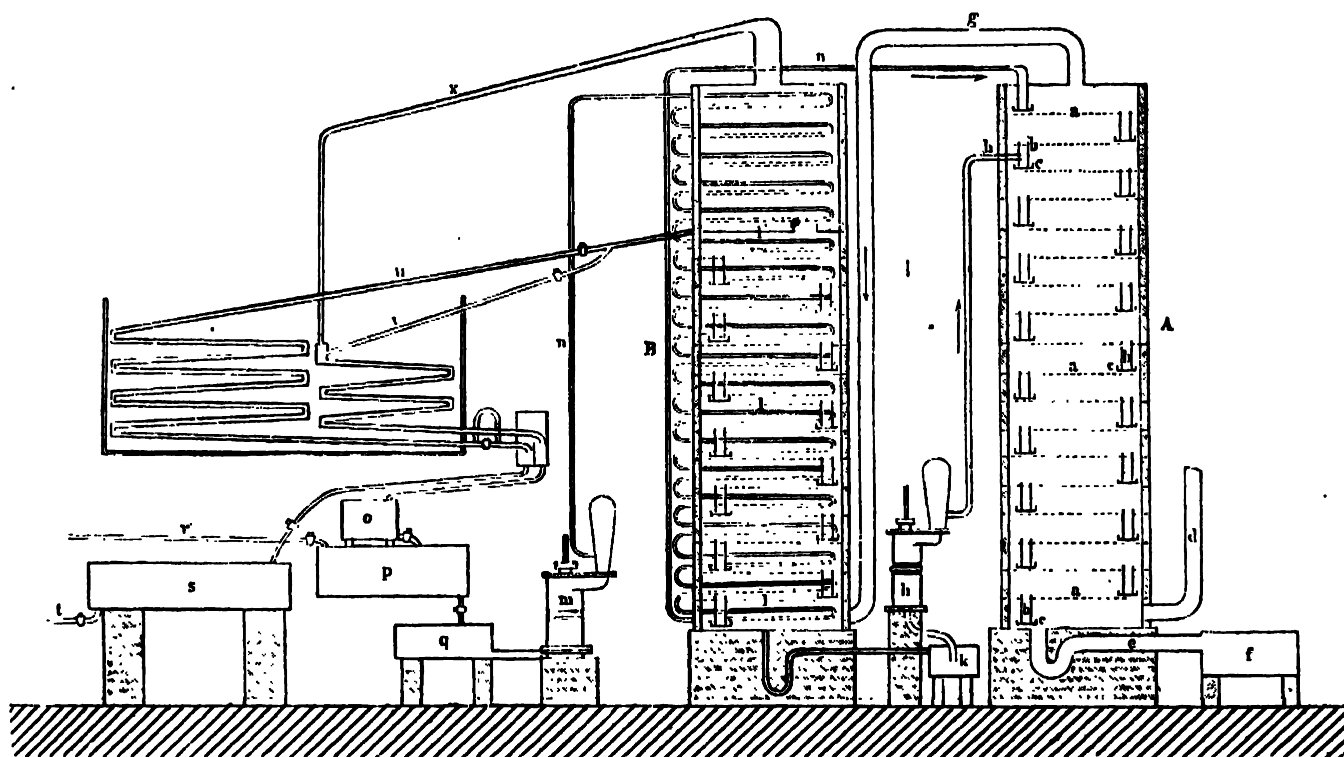
fifteenth century that any particular progress in the construction of the apparatus was made. As the fundamentals of chemistry and physics were learned they were gradually applied to the distillation of alcohol. In the eighteenth century it had been learned that by a simple distillation concentrated alcohol could not be obtained. They knew that if they were to start with a solution containing 5 per cent alcohol the vapor would

Water Overflow
Condenser
Tail Box
Cold Water
Chambers Omitted
Column
Still
Cistern

SIMPLE KETTLE AND COLUMN

Hot Crude to Still
Crude Heater
Condenser
Water Overflow
Tail Box
Cold Crude to Heater
Cold Water
Chambers Omitted
Steam
Still
Slop Outlet
Tank

SIMPLE CRUDE ALCOHOL STILL

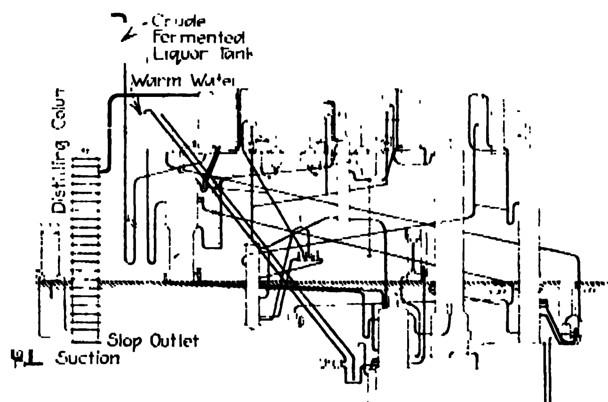


A, analyser; B, rectifier; a, perforated copper diaphragms; m, pump, forcing wash through zig-zag tubes to top of A; g, pipe leading spirit-vapour to bottom of rectifier.

DIAGRAM OF COFFEY'S PATENT STILL

contain over 40 per cent alcohol, but by condensing this and continuing the distillation, the concentration of the alcohol in the original solution having become less, the vapor from it also decreased greatly in alcoholic content. By redistilling the condensate they found that the alcohol content could be greatly increased. That is, if the condensate had an alcoholic content of 30 per cent the first vapors from such a solution would contain nearly 80 per cent alcohol.

The first distilling apparatus for the production of strong alcohol on an industrial scale was invented by



GUILLAUME SYSTEM DIRECT DISTILLATION AND RECTIFICATION

Edward Adam in 1801. This was a simple pot still which was heated over an open fire and which contained a heater. This heater condensed a part of the vapor from the still and the uncondensed portion of the vapors was made to bubble through the condensate before passing up to the condenser. The excess condensate was returned to the still. Progress was made gradually until 1832, when Coffey invented the still the principles of which are embodied in present-day apparatus. At the present time two general methods are utilized in the distillation of alcohol.

Many producers of industrial alcohol subject the fermented material to a preliminary distillation. This separates the alcoholic liquors from most of the yeast, water and other impurities of the fermentation. This alcohol still contains too high a percentage of aldehydes, water and higher boiling components (fusel oil) to be used commercially, so it then undergoes a secondary separation or rectification.

Some of the later types of apparatus combine the primary distillation and rectification into a continuous operation, the fermented crude entering at one point and the finished alcohol passing out at another.

The diagrams show the development of the apparatus for the production of alcohol, including the present complicated types.

Alcohol forms mixtures with water which distill at a constant temperature when the pressure is kept constant, without change of composition. At 760 mm. pressure the mixture of constant boiling point distills at 78.15 deg. C. and contains 4.43 per cent water (by weight) (Young, *Trans.*, Chem. Soc., 1902, vol. 81, p. 710). Since this temperature is lower than that of either pure component, it is impossible at ordinary pressure to obtain pure alcohol from a dilute aqueous solution by distillation and rectification only.

The grades produced as commercial products at present contain between 94 and 96 per cent alcohol and are usually sold as they are taken from the rectifying columns. For some particular uses, however, alcohol is often purified by passing it through a filter containing carbon black or charcoal. Sometimes it is necessary to give the alcohol a chemical purification in addition to or in place of the treatment with carbon.

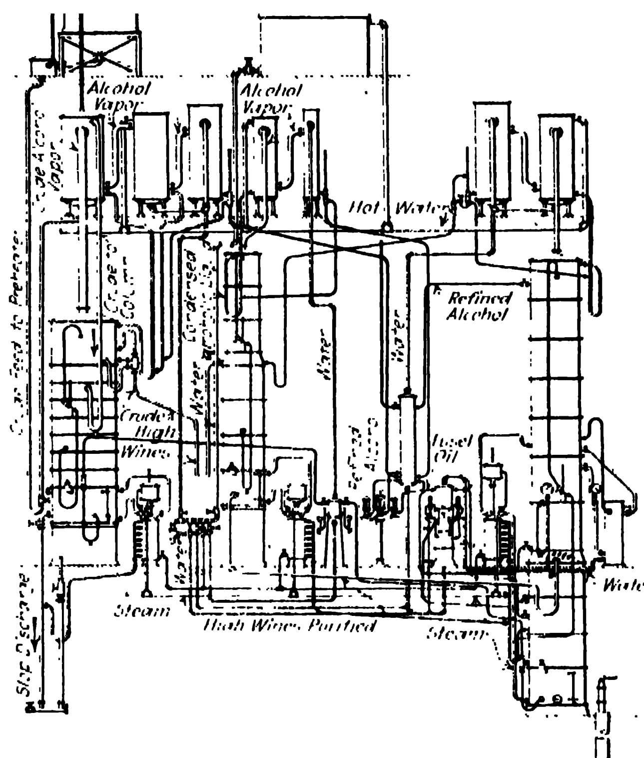
Ethyl alcohol also forms an azeotropic mixture with benzene with a boiling point of 68.25 deg. C. at normal pressure, and with water these two liquids give a ternary constant boiling mixture at a temperature of 64.85 deg. C. By a very careful study and application of the complex laws of physical chemistry concerning phase reactions, Young (*Trans.*, Chem. Soc., 1902, vol. 81, pp. 7-10) proposed a very ingenious method for dehydrating or producing absolute alcohol.

BYPRODUCTS

Scientific men have not neglected those waste materials which are incident to the production of industrial alcohol.

In alcohol fermentation carbon dioxide is formed in large quantities. Many of the modern plants have covered their fermentation tanks and are recovering this gas which finds a ready market.

Not many years ago fusel oil was considered a thing to be avoided as much as possible and that which was necessarily obtained was thrown away. Uses have been developed for this mixture of higher alcohols until today because of the demand there is considerable work being



BADGER-BARBET CONTINUOUS DISTILLATION AND RECTIFICATION SYSTEM

done toward the production of a synthetic fusel oil or the development of a ferment which will make a much greater proportion of these now very valuable products.

The fusel oil has been separated into its components by careful methods and efficient apparatus so that such products as the amyl, butyl and propyl alcohols are

obtained in a relatively pure state and are in substantial demand in the chemical and pharmaceutical industries. These alcohols as such are important solvents and are necessary raw materials for the synthesis of countless compounds.

During the primary distillation of the fermented material the crude alcohol is separated from the other components. Even today this mass of waste or "slop" in some localities is discarded. In others, however, the yeast cells are separated from the mass and are utilized in the production of plastics used in the manufacture of buttons, combs, brushes, phonograph records, etc. The slop is evaporated and the organic matter burned in some plants and the potash content recovered in the ash as a material suitable for use in fertilizer manufacture. In other cases after evaporation the organic matter is charred and the potash materials are removed by washing with dilute acid. The result is a very efficient decolorizing carbon and the removed potash salts may be purified as desired.

During the ordinary fermentation process an appreciable amount of glycerine is produced. This may be recovered.

Accomplishments and Problems

Chemistry has made the production of large quantities of practically pure alcohol an industrial reality. The application of chemistry and allied sciences to other industries has developed uses for industrial alcohol until at the present time the consumption of this necessity in the United States alone amounts to approximately 100,000,000 proof gallons per annum. Because of these sciences we have learned the composition of alcohol and its application in the production and synthesis of countless essential commodities. Chemistry has taught us the raw materials which could be used and the possible amount of alcohol which could be obtained. Biology has taken the process of fermentation and has learned its secrets and has developed fungi, determined conditions and applied these to particular raw materials so that at the present time results are obtained which were thought impossible relatively a few years ago. Engineering has rendered great assistance in the working out of the mechanical apparatus for the preparation and handling of the materials to be fermented. Chemistry has developed processes for the synthetic production of alcohol so that it may be obtained in a number of ways only a few of which at present are commercially applicable because of the relatively cheap sources of fermentable materials. The waste products in the manufacture of alcohol have been taken and made available and necessary for the production of essential commodities as previously indicated.

Chemistry, physics and physical chemistry with the assistance of engineering have improved the process of recovery and purification so that now it is possible to obtain at pleasure any grade of alcohol from 5 or 10 per cent alcoholic content, which was the best obtainable until the above sciences were applied, to absolute alcohol of the highest purity.

Of the possibilities for future development much could be said if time and space were available. There are undoubtedly a great number of raw materials available in quantity for the production of the various alcohols which have never been utilized nor their possibilities carefully studied. As economic conditions change and as the supply of petroleum products, particularly motor fuels, diminishes the demand for alcohol will greatly increase and the available raw materials will be utilized to a far greater extent than at present.

The process of alcoholic fermentation has been developed to a high state of perfection. There are desirable results, however, which have not been obtained. In the production of ethyl alcohol, as has been indicated, the formation of other products than ethyl alcohol takes place. It would be desirable to control the fermentation a little more completely in order that only ethyl alcohol would be produced, and then if desired the other products of the usual alcoholic fermentation, such as the higher alcohols, could be produced separately.

Then there is the problem of the utilization of cellulose materials. These materials have been utilized to some extent, but it is usually necessary to prepare them for fermentation by digestion with acids under pressure.

May we not look forward to the day when a ferment will be found and developed which will make possible the direct fermentation of cellulose to alcohol on a commercial scale? That will eliminate the present necessity of hydrolyzing this material by means of acids, heat and pressure. Being thus able to produce alcohol from any material containing sugar, starch or cellulose, our alcohol may be obtained at a very low figure and our chemical industries will be assured of rapid growth and development.

There are many latent possibilities in the utilization of the slop. By proper fermentation it may be possible to obtain paying quantities of the higher organic acids. These compounds have been produced to a limited extent, but there is no general commercial utilization of these materials. This phase of the industry well warrants the time and consideration of our fermentologists.

The distillation and rectification of alcohol have been perfected until no great development is expected. The fundamental laws involved have been discovered, studied and apparatus worked out which correctly applies them. Probably the greatest development in the future will be in the matter of control. It should be possible to maintain the complicated apparatus for the distillation and rectification of alcohol under the conditions for which they were designed more continuously than is now the case.

From the alcohol made available and the byproducts of its manufacture it has been possible to place before the markets of the world a list of commodities which have done much to raise the standards of living of all countries. The application of the sciences to the alcohol and allied industries in our country has assisted in the growth of a large chemical industry in addition to making possible the manufacture of many of the primary necessities of our people. Let us hope that our chemical and allied industries may continue to expand by the application of correct scientific knowledge in order that our independence may become a greater reality.

New York City.

Fuel for Motor Transport

The Fuel Research Board of Great Britain has just issued an interim memorandum entitled "Fuel for Motor Transport." In reference to alcohol it states the production of considerable quantities of power alcohol from vegetable materials grown in the United Kingdom is not economically possible owing to insufficient acreage, high cost of production and raw materials being important foodstuffs.

The Future of the Animal Products Industry

Future Research in This Industry Will Be Centered Primarily in the Byproducts, From Which Are Manufactured: Leather; Fertilizers; Oils and Fats; Lard, Oleo Stock and Margarine; Soap; Glue and Gelatine; Organotherapeutic Products and Enzymes

By WILLIAM D. RICHARDSON

THE old era of the animal products industry passed away without notice and the new era began without ceremony. That era witnessed the passing of the small abattoir with its wasteful and insanitary methods and the establishment of the packinghouse on a scale adequate to handle the great livestock output of the Mississippi Valley and to vend the multifarious products and byproducts of the industry in the markets of the world. The efficiency, sanitation and commercial economy of the large establishments became proverbial. Mechanical refrigeration was generally substituted for natural. The refrigerator car came into common use and mechanical methods were highly developed and gradually extended into all departments. During this period the aim was to utilize in some way all parts of the animal body, not necessarily in the best way—the byproduct industry developed too fast for that—but at any rate in a manner which would yield profitable products.

This point marks off one period of development—everything but the bleat, squeal and moo (as the common saying is) were utilized somehow, some way, but not necessarily for the highest use or in the most economical way. The new period imposes this task on the chemist—to put all products and byproducts to the highest possible use. Nothing less is demanded and will be enforced by present economic exigencies.

The chemical laboratories under the old order were organizations with mixed functions, partly analytical, partly research and partly operative, and one chemist might be called upon to perform all sorts of work, from sampling fertilizer or tallow to operating a part of the plant. For many years routine analytical work predominated—in fact, still does predominate—and it has only been in recent years that definitely and separately organized research laboratories have been thought of.

The Meat Business

To the casual observer it might seem that, considered individually, carcasses of animals are handled and meats consumed by the human race today in very much the same manner as they were by neolithic man. The principal difference exhibited today is in the direction of an ever-increasing number of byproducts; then (one is reminded of the story of the apple and its core) there were no byproducts. Speaking seriously, man today eats meat when he is hungry for it and when he can get it, the best cuts taking first place, as has always been the case. Meat being a natural and desirable food, it is not likely that customs will change.

There are, however, three directions of work for the chemical investigator in connection with the general meat food industry: First, the more complete utilization of the edible portions of the animal body; second, the prevention of waste or, rather, the more complete utilization of waste parts and trimmings in the retail market and in the home; third, more complete investigation of the dietetics of meats. So far as the further utilization of the animal carcass is concerned, it may be said that in some respects the dietitian is in advance of the public taste and in other respects public practice has gone ahead of the work of the dietitian. However, both scientific and practical dietetics and the public taste are coming closer and closer together on the subject of greater conservation of animal food products and apparently the progress is as rapid as can reasonably be expected.

The wastes and trimmings of the retailer, particularly the fats, are generally fairly well utilized, although improvements, particularly in preventing spoilage, are desirable. Wastes in the home continue and much food of value is regularly thrown out to be utilized at best in rendering works and at worst as filling material. The cure for waste of food materials in the home lies in general public education on these matters, enforced by the economic pressure of food scarcity and high prices.

In spite of the great advance made in the chemistry of foods and dietetics in recent years, our ignorance is still profound and this field will tax the efforts of our investigators to the utmost for many years to come. The chemistry of proteins and fats, their assimilation and metabolism, are realms whose borders only have been explored. Of the composition and functions of the vitamines we are still in almost complete ignorance nor, although it would be rash to predict, does it seem likely that definite information will be forthcoming in the immediate future.

The Preservation of Meat Food Products

Of the four general methods for the preservation of foods, low temperatures, sterilization, salting processes and desiccation, all but the last are in general and extensive use in the meat-packing industry. Cold storage divides itself into two procedures: The preservation of foods above the freezing point, and their preservation in the solid frozen condition. The main principles of handling for both these methods have been carefully worked out, but there are still a number of details which will bear further investigation. The circulation of purified air in cold storage chambers, the complete regulation of humidity therein, the prevention of desiccation of frozen products and further knowledge of the chemical changes which occur in foods stored above the freezing point are among the problems requiring further attention. It is now well established that meat food products can be held in the solid frozen condition without essential deterioration for practically unlimited periods of time. When the product is not in solid frozen condition, however, certain very slow changes ensue.

Preservation by means of heat sterilization may be

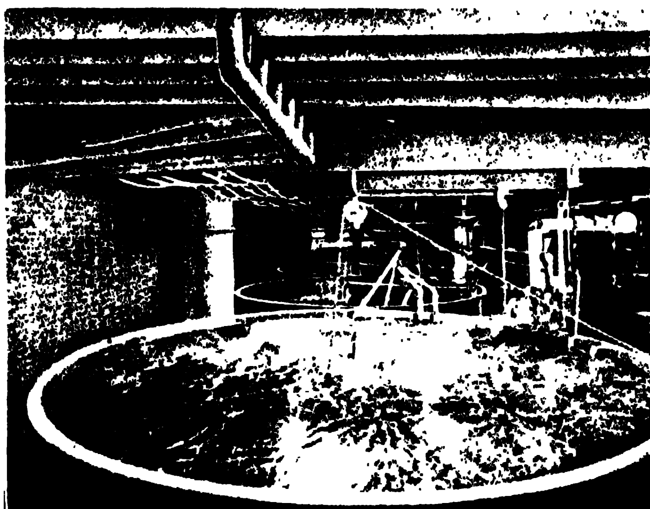
said to have reached its full development some years ago and no essential changes have been introduced recently. To be sure, the machinery and the details of handling have undergone continuous evolution. The lining of tinned cans has received much attention and a greater variety of products is placed on the market each succeeding year, but the principle developed by Francois Appert in 1804 is still applied.

The great need in salting and curing processes is for more speed in the operations. Some advances have been made in the case of salted tinned meats, but for the standard kinds of cured pork hams, beef hams and bacon the old slow methods prevail limited by the speed of osmosis. While it is eminently desirable to hasten these processes, this must be done at no sacrifice of flavor or texture. In principle, the processes of today are what they have always been and improvements relate chiefly to quantity handling of product, sterilization methods to prevent spoilage and a general extension of cleanliness and sanitary methods.

Desiccation, one of the oldest methods of food preservation, is applied only to a limited extent in the meat packing industry. There is little or no public demand for dried meat products, public taste in nearly every instance preferring fresh or undried, juicy, succulent products. Before desiccation can be largely used for the preservation of meat products there must be a change in the public preference. At present drying is definitely applied only to the types of sausage of the "summer" variety, to "dried" beef, and incidentally to hams and bacon in connection with smoking. There are a number of patents in existence for drying processes, but when a manufacturing development depends on the public taste there is no certainty when or how the development will take place. There ought to be a large market for desiccated meats, but at present this market does not exist.

Chemistry of the Animal Body

Our slowly developing knowledge of the substances and the transformations concerned in living phenomena is dependent on the general development of organic chemistry for its extension. It is dependent now upon biological tests, feeding experiments and bacteriological tests *in vitro* for information of the mere existence of many substances whose chemical nature and composition cannot even be foreshadowed at present. The immensity of this field may be emphasized by the statement that no single organ, no individual tissue, no fluid of the animal body has been investigated with any degree of completeness of results. Blood and milk have perhaps received more attention than any others, but nevertheless our information is far from complete in these cases. A more complete knowledge of the chemical nature and constitution of the substances making up the different tissues and fluids of the animal body cannot fail to make its impress on the future development of the byproducts of the animal industry. Since the bearing of this new and increased information of the general chemistry of the animal tissues cannot be determined in advance, a technologic discussion of the results at this time would be hypothetical and futile.



STEAM COIL LINED KETTLE FOR BOILING SOAP. CAPACITY 10 TO 12 CARLOADS OF FINISHED PRODUCT



MILLING TOILET SOAP

Organotherapeutic Products and the Enzymes

What is true with respect to our general knowledge of the chemical substances composing the tissues and fluids of the body applies with special emphasis to the active principles of the secretions of the ductless glands and some other organs. The hopes for organotherapy have risen and fallen during recent years with the discovery of a new physiological action, the isolation and identification of an active principle and, on the other hand, the failure to discover, or the failure of extracts to produce, uniform results in all cases. Nevertheless, there should be no discouragement as to the future usefulness of these preparations or the importance of this branch of industry.

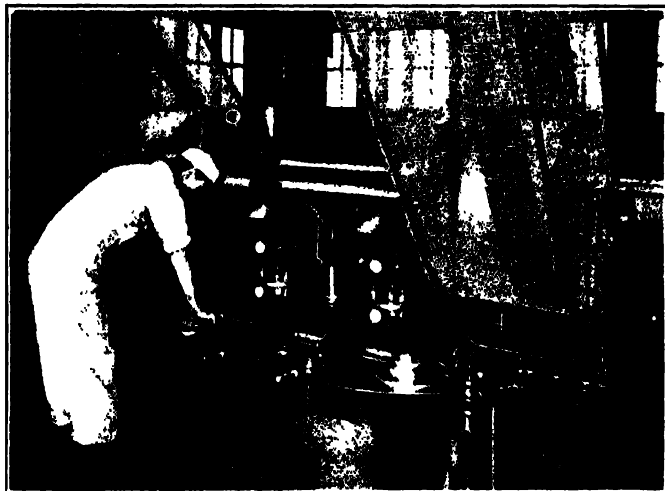
Passing over the great need for further knowledge of the physiological action of the active principles and extracts, one of the primary manufacturing needs is methods of standardization. Standardized products are the primary requisites. Products of good keeping qualities are also required, since standardization would be well nigh useless if the product did not maintain its original standard for a considerable period of time. Perfect standardization can be attained only with the separation and identification of the active substances. The only active principle certainly identified up to the present is that of the suprarenal gland, generally known as adrenaline, dioxy-phenyl-oxyethyl-methylamine. The problem of the precise nature of the active principle of the thyroid remains unsolved. Much work has been done on the pituitary body. Ovarian and testicular extracts

are at present somewhat out of favor with the medical profession and much physiological work remains to be done with them and the extract of the corpora lutea. The same remarks apply to the parathyroid, the thymus and the pineal gland. The nature of the digestive ferments, ptyalin, pepsin, the enzymes of the duodenum and of the pancreas remain to us as very incompletely solved chemical problems. The chemical nature of the hormones, gastrin and secretin is still unknown. In all directions a vast field lies open for the chemical investigator of these and other active principles of glands, organs and fluids. While the manufacture of organo products can never be a large part of the meat products industry, from the standpoints of chemistry, medicine and humanity this branch is of the utmost importance. A great future lies before it.

Tanning and Leather

While the entire industry of animal products has suffered because it was an old industry filled with ancient customs and prejudices, leather manufacture has been stigmatized by tradition perhaps more than any other branch of it. Ancient industries which were among the arts practiced by primitive man can be put upon a modern and scientific basis only by herculean effort. New industries start from a scientific mark without the handicaps of age, tradition and rules of thumb.

Scientific progress in the art of vegetable tanning has been lamentably slow, in mineral tanning much



OLEOMARGARINE CHURNING ROOM

more rapid. The extreme slowness of the one may be accounted for by the adherence to old formulas and methods and because the tanners have not made sufficient effort to gather around them scientists of intelligence and imagination to apply their knowledge to the old processes. Modern tanning practice is still full of salting, plumping liquors, bates, drenches, puers, pickles and tanning liquors of unknown or partly known composition and mode of action.

Fortunately—and this also is a bar to progress—in the hands of experienced masters of the art, leather of the highest quality is regularly turned out by the old methods. The things most needed in the industry may be stated briefly as increased speed and certainty of quality in the product. The speed of tanning is limited chiefly by the slowness of diffusion, but quality of product is limited by the uncertain composition of preparatory fluids and tan liquors, both of which are subject to control. At every step problems present themselves. The salting of skins and hides, including the time factor, the chemical and physical changes which occur during soaking, the changes taking place during the liming of hides, methods of deliming and the chemical and physical nature of vegetable tannage, all require much further study.

The development and use of synthetic tannins is a great problem in itself which will occupy the time of many research chemists. All along the line the substitution of definite chemicals or mixtures of chemicals and definite bacterial cultures for uncertain mixed cultures will gradually take place. It should be said that much has already been accomplished in this direction, but much more remains for future accomplishment. There are perhaps more possibilities for improvement by the chemist in the tanning industry than in any other branch of the animal byproduct industry.

Fertilizers

Of the fundamentals of inorganic plant nutrition we know little more than Liebig taught us. Of the specific functions of the mineral substances found in the ash of plants we know next to nothing. The fertilizer business today consists in supplying phosphates, potash salts and nitrogen compounds in suitable chemical and physical condition for application to the soil, and the farmer himself generally supplies humus in the form of barnyard manure and lime as carbonate of lime or gypsum if these are required.

The association of the animal products industry with the fertilizer trade began with the supplying of blood, tankage and bone to the latter, at first in the undried condition, later dried and ground. Gradually blood and tankage were absorbed more and more in animal foods, bones were taken over by the glue and gelatine manufacturer, so that at the present time the supply of these raw materials is steadily lessening to the vanishing point, and in the near future, if the chemist continues to keep the industry in the line of progress, none will be available for the fertilizer trade.

The fertilizer material of the immediate future will consist of phosphates from phosphate rock and basic slag, potash salts from the Stassfurt and Alsatian deposits and various salines, nitrogen compounds from natural and artificial nitrates, and ammonia compounds from the coking industry and from cyanamide. The entire fertilizer business is tending more and more toward concentrated product and herein lies the fertilizer chemist's greatest opportunities in the immediate future, since the idea of concentration carries with it the production of synthetic products and highly concentrated salts.

Concentrated phosphates are still made chiefly by the old superphosphate process depending on the separation and concentration of phosphoric acid from calcium phosphate and the acidulation of rock with the acid thus produced. Considerable work has been done on the reduction of phosphates in the electric furnace with the subsequent oxidation of phosphorus to phosphoric anhydride. Various difficulties have been encountered in the development of this process which the chemist of the future will have to overcome. At present by far the greatest bulk of phosphate entering the fertilizer trade is still in the form of ordinary acid phosphate containing approximately 16 per cent available P_2O_5.

Although the war forced the United States to take the first steps in the manufacture of ammonia from the

nitrogen of the air by the direct process as well as the indirect, this manufacture is not yet established. Ammonium salts still have their source in the coke industry and nitrates in the salt mixtures of Chile. The price of fertilizer nitrogen is higher at present than it has ever been and there appears to be a considerable shortage of nitrogenous materials. Nevertheless, there is still a question about the commercial practicability and success of some of the fixation processes unless practiced on a very large scale with cheap power. Considerable experimental work has been accomplished in connection with fixation by means of nitrides, but the development of these processes also lies in the future. Cyanamide, however, is firmly established in the fertilizer industry, as are also ammonium salts derived therefrom.

The American potash industry starting up at various points chiefly in the Western United States and working on different sources of raw materials suffered a setback when the armistice was signed, but later, when potash imports did not reach the expected tonnage, took a new lease of life. Some of the plants, particularly those manufacturing from the Nebraska lakes, have been in the main successful throughout. Others, such as those working on the mother liquor from salt crystallization at Great Salt Lake and Saldura, Utah, achieved partial success. The kelp potash plants were successful during the war and the Searles Lake industry, having encountered many difficulties, according to reports can now turn out potash salts containing less than 0.5 per cent borax. There is a grave question about the success of any of these enterprises in competition with foreign potash salts when these are received at our ports in the quantities demanded by our industries, but it is hoped that since the industry has been established here it will continue.

There is one thought which should be taken to heart by American chemists generally in connection with this situation and that is whether any other great country of the world would fail to utilize to the best advantage as a source of potash and organic chemicals the great kelp beds of the Pacific Coast. The Department of Agriculture has given encouragement to the development of the kelp potash industry and still maintains the experimental plant at Summerland, Cal. That the industry will be well established some day seems certain, but it is unfortunate that it went out of existence, practically speaking, with the signing of the armistice.

Oils and Fats

Twenty years ago the oil and fat chemist labored under the impression that his knowledge of oils and fats was in the main sufficiently complete and satisfactory. Today he realizes that he is only beginning to obtain information of these most important substances —important alike to manufacture and technology, dietetics and physiology. After Chevreul showed that animal and vegetable fats could be hydrolyzed into glycerol and fatty acids, the principal effort of chemists and technologists, resting on this information, was to utilize these two products in the best way for the manufacture of soap, candles and refined glycerine. In dietetics fats were considered as so much fuel, in physiology as substances which were stored up in the body to be consumed as fuel in time of need. The great functional importance of fats physiologically has come to be appreciated only within the past few years.

The proximate composition of the fatty acid complex of several of the fats has been worked out, but even this work is very far from complete. When the composition of any of the well-known fats themselves in terms of their glycerides is considered we realize at once our almost total ignorance. We do not know the composition completely even of the fatty acids of the common fats, and we have only the slightest information in regard to their mixed glycerides, and most of this is hypothetical. The isomers of oleic, linolic, linolenic and clupanodonic acids, the chemical changes taking place in rancidity and other little understood oxidation processes, and in the drying of oils, all require much more work for their elucidation. The mechanism and reactions of digestion and assimilation of fats and of their synthesis in the body remain unsolved. Of the real basis of the shortening power of fats and oils our knowledge is negligible. Opinions vary as widely as the results of tests thus far conducted and theory on the subject is chaotic. On the technological side there is still a waste of fats and loss of quality at various points which can and will be overcome. Rendering and extraction processes are both susceptible of improvement. Refining processes also are incompletely developed and considerable betterments may be looked for in the future.



OLEOMARGARINE ROTARY WORKERS FOR WORKING IN THE SALT AND SQUEEZING OUT THE EXCESS MOISTURE

Since color, bad flavor and high free acid are generally associated with one another, improvements which improve one generally improve the others. Prompt handling, low temperatures and the avoidance of the use of strong chemicals, so far as this is possible, should be the rules in the handling of fats. It is becoming more apparent that excessively high temperatures which have been used in refining processes may not be desirable from several standpoints. We may hope to see in the not far distant future a better correlation of our knowledge of fat constitution and physiological function with production and refining processes.

Lard, Oleo Stock and Margarine

The chemical and mechanical features of lard manufacture have been very well worked out and do not require the immediate attention of the chemical technologist as much as other departments of the fat and oil industry. On the other hand, while the rendering of

oleo fats is handled in a satisfactory manner, the methods in vogue for seeding and pressing the stock are primitive. Mechanical seeding apparatus has been introduced at a few points and attempts have been made to improve and simplify the presses. It is likely that within a few years mechanical seeders will be universally used and that a suitable press will be developed capable of displacing the present clumsy and laborious pressing methods. Like all the old processes, however, those at present used for the manufacture of oleo oil and stearine produce excellent products, and this fact is as usual a bar to progress.

Legislation, tradition, custom and the public taste have all been factors in retarding the development of the oleomargarine industry. Legislation has always favored the butter industry and favors it at the present time. Following tradition and custom, oleomargarine manufacture adopted many of the methods used for handling butter, whereas it is altogether likely that simpler manufacturing processes could be devised which would make a perfectly satisfactory product. On account of adverse legislation which permits butter to be colored and denies or penalizes the privilege in the case of margarine, manufacturers are inclined to sacrifice flavor to color and unfortunately public taste commends this policy. Legislation should not be partisan in this respect. If color is used in the one case it should be used in the other or the privilege of coloring should be denied both industries.

In recent years there has been a great increase in the variety of oils used in margarines. Formerly oleo oil, cottonseed oil and neutral lard were the three chiefly used. At the present time the list has been extended to include coconut oil, peanut oil, soya bean oil, hydrogenized product and others. Many so-called nut butters composed largely or exclusively of coconut oil have been placed on the market, and while these have not proved the equal of standard oleomargarines in point of flavor, keeping quality or melting point range, they have met with much public favor.

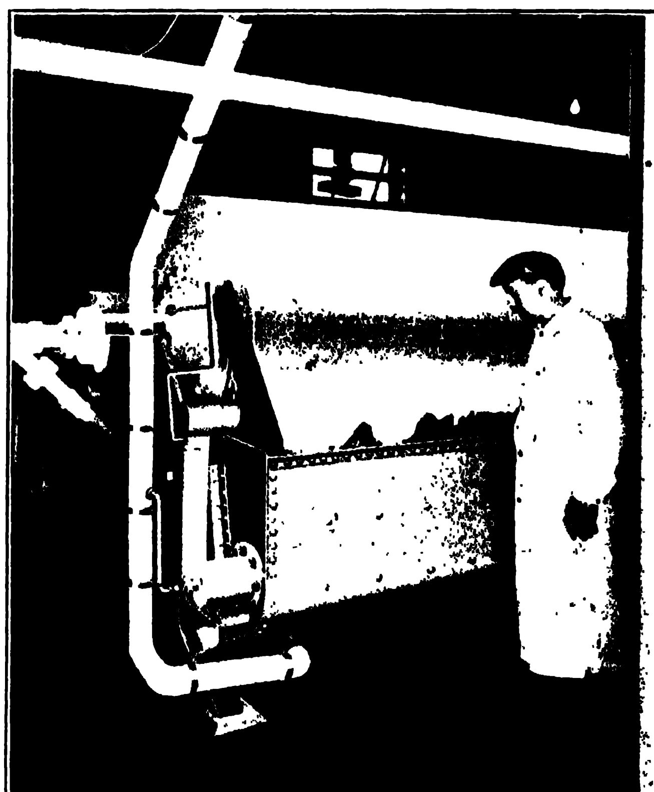
The oleomargarine industry is steadily increasing, although the consumption in the United States is still behind that of most European countries. Indeed, our consumption of butter and butter substitutes taken together is below that of many foreign countries. The future development of the oleomargarine business will probably lie in the direction of an increasing list of raw materials, improved emulsification, and simplification of the mechanical processes used, with a general tendency away from the methods used in the manufacture of butter, thus allowing the industry better opportunity to work out methods specifically adapted to its own needs.

Hydrogenation

While hydrogenation, or the conversion of unsaturated into saturated fats by addition of hydrogen, has been well accomplished, the reverse process, dehydrogenation, remains unmastered, nor is there available at present any chemical information capable of foretelling how or when this development may be achieved. Hydrogenation has been brought to a meritorious first development, and the industry, satisfied for the present, does not appear to be undergoing any marked technological developments. Aside from more active and cheaper catalysts, which are always in demand, some of the desiderata are methods for purifying low-grade oils so as to fit them for hydrogenation and render them incapable of killing the catalyzer before the reaction is completed, a method for the manufacture of cheap, pure hydrogen other than the electrolytic way, and methods for purifying hydrogen as produced by the steam-iron process. However, for one so recently developed the industry is in a very healthy, thriving condition.

Soap

The soap industry also has come into the modern era following a long train of ancient methods and customs. On the manufacturing side two broad improvements are needed: first, greater speed in the saponification and boiling processes, and secondly, quick mechanical methods of molding the liquid product into bars. Even though the first reform may be long delayed on account of the necessity for separating glycerine lyes, there can be no valid excuse for greater delay in instituting the second procedure. The tedious processes of framing,



CONGEALING REFINED LARD ON REVOLVING TANDEM ROLLERS

chilling, slabbing, cutting and pressing ought all to be condensed into one continuous operation. This is the next important practical step in the industry.

This is not the place to dwell on ethical reforms in industry, but it would seem from every standpoint that the soap industry would do well to rid itself of the gross adulterations practiced therein and return to the manufacture of purer soaps. All fillers and adulterants added to soaps, without exception, lessen the detergent power, having none in themselves or much less than the soap to which they are added. Sodium resinate and sodium silicate may be excused on the grounds of easier solubility when used in small proportion. They can hardly be excused when used in extreme quantities. Other fillers, such as mineral fillers, petroleum oils and the recently advocated clay, can scarcely be justified on any grounds except that one manufacturer begins it and the others follow suit to meet competition. There is no substitute

which is the equivalent of pure soap in detergent value. The manufacture of soap based on detergent value has not been undertaken. Some attention has been given to solubility (particularly in the case of textile soaps) and also to lathering qualities in the case of ordinary toilet and laundry soaps, but for the most part soap manufactures and soap products rest upon an empirical foundation or worse. Special forms of soap to catch the public eye and preference have been introduced without number and unwarranted claims are frequently made for them in extravagantly worded advertisements so that on the whole the public is uninformed or misinformed as to what constitutes good soap and buys largely on the basis of whim and prejudice—not a good foundation for the marketing of any standard commodity. Usually and perhaps always it is the advertising or the premium rather than the quality and the price which sells the soap. The public needs reforming as much as or more than the manufacturer.

Glue and Gelatine

On both the chemical and physical sides collagen and gelatine offer an unlimited field for the investigator in pure science. The problems connected with these substances are innumerable. Their chemical composition so far as it has been unraveled differs as greatly as their physical properties from the other animal and vegetable proteins and even from elastin. A more complete understanding of these substances must await the time when our chemical knowledge of the entire protein group is more fully developed.

The industry has developed empirically and the rules of thumb have been handed down from workman to workman, generation to generation. Many attempts have been made to quicken the liming process by the use of caustic soda and with considerable success. Open cooking with circulating water has come into partial use only. Clarification by means of centrifugals has displaced filtration methods to some extent. The greatest improvement has come in the mechanical handling of jellies by means of the belt-chilling system, which has displaced the old jelly pans all but universally. Much attention has been given to improvements in drying methods, but trouble is still experienced in most tunnel systems during warm, humid weather.

The slow evolution of byproducts manufacture in the animal industry is well illustrated in the handling of bones. At first these, together with other raw materials of the fertilizer industry, were sold at a low price to neighbor firms which worked up the byproducts of the packinghouses, at that time concerned primarily with dressed live stock and cured meats. Next the bones, after first being boiled in open vats for tallow or oil, were dried and ground into raw bone meal and sold for fertilizer.

It was considered a great step in advance when the same bones were steamed for glue and the dried residues sold for fertilizer as "steam bone meal." This product, following the conservation movement of the day, was later worked into animal and chicken feeds. Today some of the large establishments are just beginning to realize that bones are capable of yielding still higher values as gelatine stock. The foregoing refers to ordinary bones. The stronger and heavier bones have always been worked into knife handles, buttons and other objects.

There is much room for improvement in the matter of standards for glue and the methods of arriving at these standards. Although some attempts have been made to put glue testing on a scientific basis, little headway has been made and reference is still had to arbitrary standards. The viscosity determination has been improved and may be said to be on a reasonably satisfactory basis at the present time. On the other hand, the determination of jelly strength is not on a satisfactory basis and there is no agreement among manufacturers and users as to the method to be used. Several types of mechanical devices are installed in different glue laboratories and in others the antiquated, uncertain finger test is still supreme. Its advocates claim that it is more certain and reliable in the hands of an expert than any mechanical device, which is far from the truth. Reform in these matters must come in the future by general agreement among manufacturers and users.

Research

The greatest need of the animal products industry today is the establishment of large, thoroughly organized and well-equipped modern research laboratories. They should be entirely separated from the usual routine analytical laboratories and should have on their staffs the best available experts in the various branches. Without these, progress in the new sense cannot be made and the industry will move ahead by inches where it should go forward by miles. Fortunately, the progressive heads of the large establishments are seeing this need and it may be confidently hoped that in the very near future research in the best sense will be in the hands of an adequate personnel and backed by ample funds. It is hardly necessary to state that research will be applied in the main to the byproducts of the industry. The principal branches of the business are already on an eminently satisfactory and efficient basis.

Changes in the American Diet

Whether it is because of the increased cost of meat or because people's tastes have changed, the fact remains that Americans are eating 8 per cent less meat than they were twenty years ago. This is disclosed in a recent dietary survey made by the United States Department of Agriculture. In this survey 2,000 dietary records, each covering a period of seven days, were collected from 1,425 families and 575 institutions in forty-six states. Sixteen nationalities and many occupations and incomes were represented, as were also both urban and rural localities.

From a summary of 500 of these family records it appears that last year the average cost of food per man per day was 46c., with an average return in food value of 3,225 calories, 96 grams protein, 118 grams fat and 405 grams carbohydrate. These figures are in fairly close accord with the dietary standards ordinarily used in discussing such problems of general nutrition.

A comparison of the foodstuffs purchased by the 500 families with the amounts of the same food purchased by 400 families about twenty years ago shows that the amount of meat in the American diet has decreased about 8 per cent and the amount of grain products about 11 per cent. People are eating more milk, butter and cheese than they were two decades ago, for the amount of dairy products consumed has increased about 6 per cent. Four per cent more vegetables and 8 per cent more fruit are being eaten now.

Some individual food habits undoubtedly need to be corrected, but, judging by these studies, it seems fair to conclude that the average diet seems to be adequate. (*Pure Products*, vol. 16, No. 6, 1920, p. 308.)

Artificial Leather and Coated Fabrics

A Succinct Review of the Development of the Artificial Leather and Coated Fabrics Industries and of the More Important Steps Involved in the Manufacturing Processes Employed, With Special Reference to the Use of Pyroxylin Solution Coatings

ARTIFICIAL leather is a loose term more generally applied to any composite material made up of a base such as cloth, felt or paper, upon which is spread a coating embossed in imitation of grain leather. A very satisfactory product was obtained by coating split leather with pyroxylin. This led to the substitution of fabric for the leather, and thus began a large and growing industry. Stevens first suggested the use of amyl acetate as a solvent for pyroxylin, creating the pyroxylin lacquer industry; in 1884 Wilson and Story first coated cloth with a pyroxylin-amyl acetate solution with which was combined castor oil, the forerunner of the formulas in use today in the manufacture of artificial leather. Subsequent improvement in the latter product has been dependent upon the development of more satisfactory and cheaper solvent formulas, mostly discovered by rule-of-thumb experiment, and also through the use of a better quality of nitrocellulose.

As the result of improved methods for the purification and the nitration of cellulose, a product is obtained which, when combined with a suitable solvent, produces a "dope" which can be readily applied to the base and upon evaporation of the solvent becomes a tough, elastic and durable film.

The Base Material

Little if any change has been made in the base material; the ordinary weaves of cotton cloth have not been improved upon. Cotton cloths, such as sheetings, ducks, sateens and the heavier mole-skins, do not possess an equal stretch in all directions. The strength of the coated fabric on the bias of the weave is somewhat dependent upon the toughness of the film, and in the present state of the art toughness of the film is, unfortunately, gained at the expense of pliability. Even should an improved film be developed, the unequal stretch of the base fabric would remain; a more suitable base fabric would, therefore, considerably improve the quality of the product. For many uses the unequal stretch of the fabric is immaterial; for certain uses the base may be composed of paper, felt or other substance.

For automobile tops the coating is more often composed of rubber, or rubber substitute, or of boiled linseed or other oil combined with pigments. These are not usually termed by the trade as an artificial leather; they constitute, however, a very large class of coated fabrics.

The factors that control the physical and the chemical characteristics of nitrated cellulose are sufficiently well understood, and it is possible to obtain a product which is fairly satisfactory. Nevertheless certain qualities of the pyroxylin are still largely dependent upon the source from which the cellulose is obtained; the fibers from the seeds and the hulls of cotton are considered the most satisfactory. It is possible to purify and to nitrate wood pulp or other cellulose substance, but it is difficult to obtain uniformity of product. At the present price of wood pulp, cotton linters and hull shavings it is a question whether any real economy would result from the substitution of wood pulp. Uniformity of product is essential. A fairly complete dehydration of the nitrocellulose is also essential, and it is therefore necessary that the nitrocellulose be insoluble in ethyl alcohol, as in the most satisfactory method of dehydration the water is displaced by alcohol.

Manufacture of Pyroxylin-Coated Fabrics

The manufacture of pyroxylin-coated fabrics is not a complicated process. The more important steps are: Solution of the nitrocellulose in a solvent; incorporating oil and pigment with this solution; spreading the mixture on the fabric or other base material; evaporation of the solvent; recovery of the solvent (this step is not essential); embossing the coated fabric.

Cotton cloth is generally used as a base. This must be free from imperfections of weave and must be made from uniform yarn, as loose or heavy threads will show in the finished product. Light-weight fabrics, such as sheetings, are usually sized; heavy-weight fabrics are teased to raise the nap. The cloth is usually dyed in order to prevent any discoloration of the back becoming apparent should the coating come through the cloth. In the light-weight fabrics this is largely prevented by the sizing, the primary object of which is to stiffen and weight the goods. Raising the nap on the heavier weaves assists in producing a firm anchorage of the coating to the cloth. For certain uses, such as wall coverings, paper may be used as a base; felt, or fabric made from other material than cotton, may be coated successfully.

Solvent Formulas Secret

Many solvents and combinations of solvents have been used; it is to the development of improved or less expensive solvent formulas that the expansion of the industry has been largely due. For this reason the manufacturers of artificial leather keep their formulas secret. Patent literature is replete with solvent and "dope" formulas, but it is quite certain from commercial considerations that but few solvents are being used. The manufacture of artificial leather is a highly competitive business; for this reason the solvents selected are restricted to those that can be obtained cheaply. Ethyl alcohol is relied upon in the dehydration of the nitrocellulose and is an incidental constituent of most solvent formulas, but other aliphatic alcohols could be used. On the other hand, alcohol is not an essential constituent. Amyl acetate is now largely replaced by the cheaper ethyl acetate; this is diluted with benzol or other hydrocarbon of the benzol series. Benzene or gasolene is a constituent of some formulas. The pyroxylin solution must be clear, free from dirt and undissolved nitrocellulose, and as near as possible of a standard viscosity. The solution will contain from 75 to 90 per

cent solvent. If such a solution were used to produce a heavy film, the finished product would be stiff. In order to obtain pliability an oil is mixed with the pyroxylin solution, and to this mixture may be added pigments ground in oil to produce a colored coating.

Oils Used to Give Pliability

Various oils may be used to give pliability to the film. Castor oil was first used, and no satisfactory substitute has been found where a light-colored coating is required. This oil has, however, an objectionable odor which is noticeable in the finished product. Other oil may be substituted for castor, such as blown linseed, rapeseed or cottonseed, or a mixture of these; and other non-drying or semi-drying oils have been used. Blown oils are dark in color and therefore cannot be used with the lighter colored pigments. Another source of trouble is the likelihood of the commonly used oils becoming rancid if the finished product is stored for any considerable time. A cheap, non-drying oil that is light in color and one that would not develop rancidity would fill a long-felt want in the industry. Standard pigments ground in oil are used to give color to the coating. The less expensive pigments are chosen. Except for light-weight coatings over a non-dyed base material it is not necessary that the pigment possess great covering power.

The Coating

The coating on a piece of artificial leather is built up of a number of thin coats, all of which do not have the same composition. Upon light-weight fabrics as few as three coats may be applied, while to produce an imitation of heavy Spanish leather, such as is used for upholstery, twenty-five to thirty or even more coats may be necessary. The first two coats are depended upon to give anchorage; these are of special composition and usually contain less oil and pigment than the succeeding coats. The top coats give the finish to the product, and take all the wear. These are applied thinly, except on very light-weight goods; usually the top contains neither oil nor pigment. Exceptions would be the imitation Spanish and Morocco leathers, to which are applied an elaborate hand finish; or, in cheaper grades, machine finish.

Individual coats are applied, drawing the base material under a knife-edge, the "dope" being run onto the material in front of the knife-edge as fast as it is used. This operation is performed by machines. By paying attention to such details as the design of the knife-edge, the tension applied to the base material and the viscosity of the pyroxylin solution, it is possible to control the weight of each coat. In the present state of the art the quality of the product is improved by increasing the number of coats for a given weight of coating. This adds to the cost of production. Here is a very promising field for development. Considerable ingenuity and a large amount of capital have been expended in attempting to solve the problem, so far without marked success.

Between individual coats the solvent is evaporated from the film more or less completely. Often some solvent is retained in the finished piece to give additional pliability, and a high boiling point solvent may be added for this purpose. This is not, however, a satisfactory method of obtaining pliability; in the first place, it is more expensive than other methods that may be used; in the second place, such solvent ultimately evaporates from the coating and thus defeats the purpose for which it was added. If an attempt be made to recover the solvent, that added for this purpose is an unnecessary loss.

Recovery of Solvent a Subject for Development

It is still a moot question as to whether the solvent which must be evaporated from the coating should be recovered or not, the claim being made that a better quality product can be produced without solvent recovery. For theoretical reasons the reverse should be true. With a properly designed recovery apparatus it is possible to control drying conditions and in this way produce a more uniform film. If from 80 to 90 per cent of the solvent can be recovered, there is no question that recovery is economical. With the probability of increasing prices for solvents, the manufacturer with efficient solvent recovery apparatus has a decided advantage, both as to costs and quality. The problem of putting the recovered solvent into suitable condition for re-use is not difficult. There is an opportunity for considerable development along these lines.

Embossing to Imitate Grain Leather

The coated material from which all or at least a large proportion of the solvent has been removed is embossed in plate or rotary presses to get an imitation of grain leather. The heavier grades are preferably embossed on plate presses, as these are likely to roll-cut, and deep embossing is to be avoided. Imitation Spanish and Morocco leathers are hand-finished to give the impression of age to the product. To obtain this appearance a light deposit of a pigment darker in color than the coating is spread over the embossed piece of goods. This pigment is rubbed off of the high spots into the valleys of the embossing by means of a pad soaked in a solvent that softens the film slightly, anchoring the pigment onto the coating.

Two Problems Awaiting Solution

Two problems of utmost importance in the artificial leather industry are awaiting satisfactory solution. The first is the production of a durable film with fewer number of coats and the second has to do with the recovery of solvents. These apply to pyroxylin-coated fabrics. As has been pointed out, the base fabrics in use are not as satisfactory as could be desired. It is quite probable that the market for coated materials can be further developed, with improvement in durability and reduction in costs.

Recent Patents on Artificial Leather

Among the quite recent patents on the manufacture of artificial leather may be mentioned the United States patent No. 1,337,802 and the German patent No. 302,445.

The American patent, by Albert E. Somerville, consists in winding into a roll a vulcanizable rubber layer and sheet of paper in intimate surface contact with each other, subjecting this roll to the action of the vulcanizing medium, and removing the paper sheet, thereby providing a material having the characteristics of dull finished leather.

The German patent, by E. Reidel, consists of treating dried animal intestines, sinews and the like with acetic acid or sodium sulphide. The product is washed, compressed between rollers, dried and saturated with a solution of albumin and a marine animal oil. The product, after compression to sheets, is dried and tanned by the combined mineral and vegetable process.



(Photo by J. W. Hess, Pueblo)

A VIEW IN THE DEBEQUE, COL., OIL SHALE REGION

The Necessity for Research in the Oil-Shale Industry

An Account of the Shale-Oil Industry as Developed in Scotland—Steam-Regulated Pyrolytic Distillation-Quality and Quantity of Oil Yields—New and Improved Practice Should Be Developed From Old Operation

BY MARTIN J. GAVIN*

ONE rarely reads a technical or oil-trade journal without coming across some article or statement regarding oil shale. We are told of the enormous supplies of this material within the borders of the United States, of the plants to treat shale that are operating or under construction or about to be constructed, of the companies organized to produce and refine oil and other products from oil shale, and commonly of the huge profits to be made on small investments in oil-shale operations. Supplementing these articles, the country has been well covered with oil-shale company promotion literature, commonly of a still more optimistic and often misleading nature. The public apparently has been led to believe that the American oil-shale industry is a going one—that is, plants are making and refining shale oil on a successful commercial scale—and that money is actually being made in oil-shale operations by marketing shale oil and its products.

SHALE-OIL INDUSTRY ACTIVITY

The writer does not desire to discourage the proper kind of activity in connection with oil shale, because the time is growing near when shale-oil products will undoubtedly be necessary to supplant in part our present petroleum supplies, and he believes that in the course of a comparatively short time oil-shale operations, if properly conducted and financed, can be made commercially successful. It is desired in this paper to indicate particularly the great necessity of properly conducted scientific research and control work on oil shale and shale oils, without which it would be indeed difficult to carry on oil-shale operations successfully.

At the present time there are, strictly speaking, no commercial oil-shale operations under way in the United States. There have been perhaps eighteen or twenty shale retorts erected in the country and most are in intermittent operation from time to time for experimental or demonstration purposes, but with one or two possible exceptions these are too small to give much of an idea of their commercial feasibility. Nearly if not quite 150 companies have been organized in connection with oil shale, many of which, unfortunately, are purely stock promotion concerns. Some are actually engaged in experimental work of a sort, and a very few are actually conducting well-planned and organized investigational and research work.

GREATER CO-OPERATION AMONG INVESTIGATORS NEEDED

There is very seldom a laboratory at the experimental plants, and only infrequently a well-trained technical employee. Except in a very few cases, shale oils produced in the small plants have never been given more than very superficial inspection and the real quality of the oil made is generally unknown even to the operators themselves. There is little spirit of co-operation among the oil-shale operators, each apparently believing his idea of a shale retort to be far superior to all others. In passing, the writer expresses as his opinion that mutual helpfulness and co-operation will go a long way in the building of a successful oil-shale industry in this country, as there is so much work to be done and so many problems to be solved that no one individual or company can hope to do it all.

NOT ENOUGH CONTINUOUS EXPERIMENTAL WORK

Experimental work in connection with oil shale, again, with one or two notable exceptions, has so far consisted in the construction of a retort, usually designed along lines as different as possible from the well-known Scotch type of retort, and its operation at maximum capacity until a certain lot is run through; then it is shut down until another lot is ready for testing.

Rarely is attention paid to the quality of oil produced. As far as the writer knows, none of the plants has been operated long enough or under such conditions as would

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give an idea of its life in commercial practice. A run is usually considered successful if oil is produced and the residual shale yields practically no more oil. There are practically no recognized retorting methods and usually, in any particular type of retort, all shales are treated under the same more or less accidental conditions.

As a rule the retorts are designed with the idea of removing oil vapors from the retort as soon as they are formed, but this idea is not always carried out. Most retorts builders try to get as far away from Scotch practice as possible and though many use steam in retorting, the quantity used is so small or it is applied under such conditions that it gives negligible results.

The Scotch Practice

For a proper understanding of problems in shale-oil production and refining, it is desirable that Scotch practice in this regard be outlined, as it is generally not well known, or its principles are misinterpreted.

In the following discussion the writer wishes it to be understood that he does not believe Scotch oil-shale retorts and operations to be the last word in the oil-shale industry. It is reasonable to believe that types of retorts and practices different from those employed in Scotland may be developed in this country more particularly adapted to American shales and conditions. It is emphasized, however, that the Scotch oil-shale industry is really the only commercially successful oil-shale industry in the world at the present time and that it has been successful for more than sixty years. This being the case, the logical first step in the development of an oil-shale industry in the United States, a new art here, would be an attempt to apply the apparatus and practices now used in the country where oil-shale operators have reached their highest development. If Scotch methods are not found satisfactory in this country, it may be possible to modify them, and even if modifications are unsuccessful, the knowledge of Scotch shale operators, based on over sixty years of practical experience, cannot reasonably be disregarded but logically should serve as points of reference.

In Scotland the shale brought from the mine is crushed by toothed rolls into pieces of average size of an ordinary brick; as a rule everything going through the rolls goes to the retort.

Scotch Retorts

From the breakers the shale is carried in cars up an incline to the top of the retorts, where it is dumped into the retort hoppers by hand. The most commonly used Scotch retorts are vertical and tapered, consisting of the following parts: At the top there is a hopper, which holds several hours supply of shale. Below the hopper is a cast-iron upper part which is about 12 ft. in length and which has a vapor outlet near the top. Under the cast-iron part, and joined to it with a fireclay joint, is the lower masonry part, which is about 18 ft. high and made of a single tier of very special-shaped firebrick. At the bottom of this part is the discharge mechanism and below that the spent-shale hopper, which serves one or two retorts and in which the spent shale accumulates. The cast-iron part is made circular or elliptical in cross-section, and the masonry part square or circular. Those of circular cross-section have an internal diameter of about 2 ft. at the top and 3 ft. at the bottom. The taper is constant.

Each retort, with its supply hopper, holds about nine tons of shale and the feed is by gravity. Four retorts, as described, are set in a common furnace and are heated by the combustion of the fixed gases resulting from the distillation of the shale, supplemented by coal producer gas when necessary. Four retorts are a unit, and sixteen such units constitute a bench, two retorts wide and thirty-two retorts long. The present retort working on shale now being mined in Scotland has a capacity of about four and one-half short tons per day. Tests indicate that the retort capacity is a function of oil production rather than shale throughput. Apparently a Scotch retort will produce approximately 100 gal. of oil a day, whether it is working on a 10-gal. shale or 100-gal. shale. In the former case approximately ten tons can be put through; in the latter but one.

In the upper or cast-iron part of the retort most of the oil distills and the maximum temperature in this part does not exceed 900 deg. F. The lower or masonry part serves mainly as an ammonia and gas producer. About 105 gal. of water, as exhaust steam, for each 25 gal. of oil produced is admitted into the spent-shale hopper and passes up through the shale in the retort. The steam serves to absorb the heat from the spent shale, to produce water gas from the fixed carbon remaining in the spent shale, to distribute evenly the heat in the retort, to produce ammonia from the nitrogen of the shale, and to carry off the oil products formed. Distillation with steam increases the yield of ammonia about two and one-half times as compared with dry distillation, and also produces more oil which is of higher quality.

Temperature and Heats

The maximum temperature to which the shale is subjected it not much in excess of 1,500 deg. F., although temperature measurements have never been accurately made within the retort itself. The retort operators are skilled in judging retort temperatures by heat colors, and keep temperatures under careful control by looking into the furnace through peepholes. In general, in retorting and refining practice in Scotland, one is struck with the very definite way conditions are controlled. Many years of practical experience have determined these conditions.

The spent shale is discharged continuously from the retorts and the mechanisms used for this purpose constitute the main points of difference between the types of retorts. The spent shale is refuse. No commercial use has ever been found for it, although it has been tried in road and brick making. The fixed carbon remaining in the shale amounts to only 1½ to 2 per cent. This is the economic limit with reference to fuel consumption, throughput of shale, and ammonia and gas yield. A greater yield of ammonia could be obtained by reducing the amount of carbon, but at the expense of throughput.

Vapors Separated From Gases and Refined

Vapors pass out of the retort through the vapor line, which is cast integral with the upper part of the retort. Large suction fans in the dry gas main, between the scrubbers and gas burners, put a slight suction on the retorts. The vapors pass to large headers and thence to a series of U-shaped, vertical, air-cooled condensers made of cast-iron pipe. Below each U is a

receiving box for condensate, and from this box the condensed oil and ammonia water are drawn off to separating tanks. Uncondensed gases pass through water scrubbers, which remove any ammonia remaining in the permanent gases, and through oil scrubbers, which remove the light hydrocarbons, commonly known as "scrubber naphtha." The gas is then led back to the retort furnaces, where it is burned.

Shale now being worked in Scotland yields per short ton approximately 10,000 cu.ft. of gas having a heat value of about 240 B.t.u. per 1,000 cu.ft., approximately 24.5 U. S. gal. of crude oil and 36 lb. of ammonium sulphate.

The crude oil, after having the bulk of the water separated, is run to the refinery. The refining of this oil is more involved and complicated than the refining of petroleum, as the oil must be subjected to more acid and alkali treatments and a greater number of distillations. Therefore a shale-oil refinery contains more small stills and agitators than does a petroleum refinery of equal capacity. More batch stills are used than continuous stills, and the Scotch shale-oil refineries have extraordinarily large wax plants compared with petroleum refineries of equal capacity.

Flow Sheet of Products and Plant Layout

Practically all refinery distillations are conducted with a large quantity of steam, which is admitted into the bottoms of the stills. The crude oil is run to coke, as are also some of the redistilled oils.

The yield of refined products in Scotland is somewhat as follows:

	P[illegible]
Naphtha (including scrubber naphtha) 450 deg. end point	9.9
Burning oils (kerosene and like) ..	21.7
Gas and fuel oils.....	24.4
Lubricating oils	6.7
Wax	9.5
Still coke	2.0
Loss	22.8
	100.0

A general idea of the complexity of shale-oil refining in Scotland can be gained by referring to Fig. 1, a generalized flow sheet of refinery operations at a typical Scotch shale works. This figure and Fig. 3 are presented through the courtesy of Scottish Oils, Ltd. The writer wishes to express his appreciation particularly to H. R. J. Conacher of this organization for the use of these figures.

Scrubber naphtha, which is the gasoline or naphtha recovered from the retort gases by washing them with oil and subsequently distilling the latter, amounts roughly to 2.4 gal. per ton of shale.

Ammonia water from condensers and scrubbers is run to ordinary continuous ammonia stills. Ammonia gases pass off and are dissolved in dilute sulphuric acid, much of which is recovered from the acid tars. The sulphate solution is concentrated by a continuous system and is finally purified and sold as crystalline ammonium sulphate.

Fig. 2 is a plan of a typical modern Scotch oil-shale works, including retorting plant, oil refinery and ammonium sulphate plant, with accessories. It serves to indicate the outlay and equipment necessary in the production and marketing of refined oil-shale products, and gives an idea of the scale under which Scotch operations are carried on. Such a plant represents the investment of several millions of dollars.

The principal objection in the minds of American shale operators to the Scotch retort is its low throughput and its use of steam. Scotch operators find that it is necessary to heat their shale slowly and to use plenty of steam if a satisfactory oil is to be produced, and the past tendency in Scotch practice has been to lengthen the time of treatment and use more and more steam. As a matter of fact, the amount of steam used is largely determined by the amount of oil a shale will yield. Rapid production of oil from Scotch shale has meant that an oil of poor quality resulted, though not enough work has been done on American shales to determine if they will behave the same way.

The use of steam in retorting apparently does so much more than merely produce ammonia that its use cannot be abandoned without further consideration even if ammonia recovery is not desired. The spent shale coming from the Scotch retorts is very hot (perhaps 1,500 deg. F.) and if not steamed would be discharged

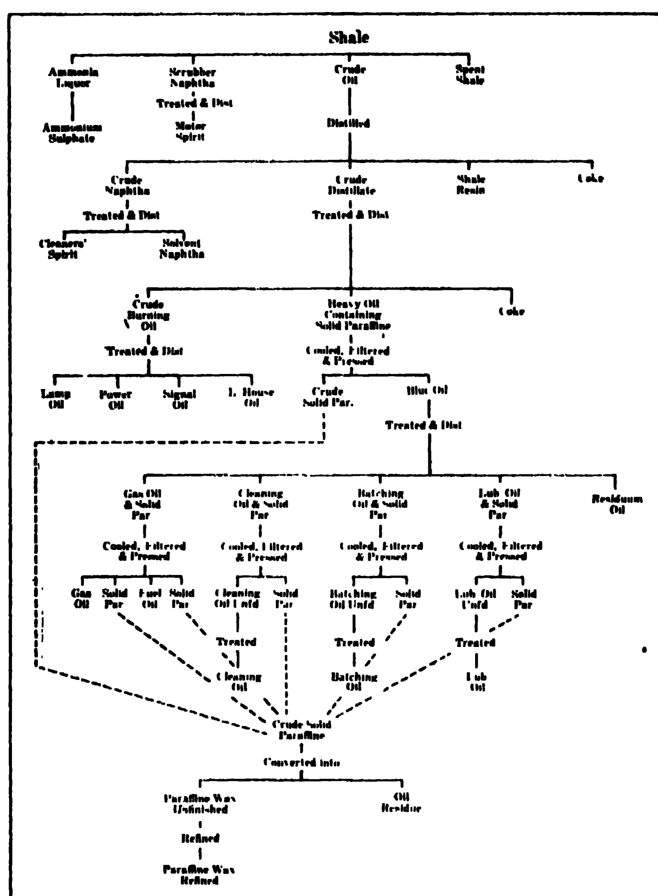


FIG. 1. FLOW SHEET OF SCOTCH REFINERY OPERATIONS

in that condition and contain from 6 to 10 per cent of fixed carbon the fuel value of which would be wasted. The use of steam, as described, cools the shale, while heating the steam, thus carrying heat back into the retort; in addition, the steam and fixed carbon in the shale react, producing a gas of good fuel value, since it is composed mostly of hydrogen and carbon monoxide, thus utilizing much of the fuel value of the fixed carbon in the spent shale. As the carbon is burned out, ammonia is produced, and the excess steam and other gases protect the ammonia from decomposition at the high retort temperatures, and sweep it at once into the cooler zone. Oil production in the upper part of the retort goes on slowly and oil vapors made are at

once swept away to a cooler zone and out of the retort by the excess steam and gas, thus effectively protecting the oil from excessive decomposition.

Byproduct Ammonia

The question of producing ammonia from oil shale is one that has been discussed at considerable length by those interested in oil shale in this country. The average American oil shale compares favorably with Scotch shale in nitrogen content and it is to be expected that the nitrogen in both shales can be recovered with equal ease. The general tendency among American oil-shale processes seems to disregard ammonia recovery except the small amounts incidentally produced in ordinary dry destructive distillation. It is felt by many that the conversion of the nitrogen in a rich oil-yielding shale into ammonia is not a desirable thing, as such conversion would reduce the retort capacity for oil. While this is probably the case, there is nevertheless a fair probability that the increased returns made by producing ammonia would more than counterbalance the decreased oil-producing capacity of the retort, assuming a satisfactory market for the ammonia exists. This may particularly apply if it is found that steaming the retorts is necessary to produce the best grade of oil. To produce maximum economic yields of ammonia from oil shale, Scotch operators find a maximum temperature of about 1,500 deg. F. and an excess of steam necessary. While 900 to 1,000 deg. seems to be the highest temperature necessary to produce oil from oil shale, the increased heat needed to produce the ammonia is nearly if not completely supplied by the combustion of the gas produced by the action of steam on the carbon of the shale in the ammonia-production part of the retort.

The use of steam in retorting is said by the Scotch operators to increase the yield of ammonia over two and one-half times the amount recovered by straight dry destructive distillation. In discussing the ammonia-recovery problem, it is necessary to point out the possibility of recovering part or all the nitrogen of the shales in some form other than ammonia, such as pyridine compounds and the like, and also the conducting of the oil-recovery and nitrogen-recovery operations in separate and more or less independent apparatus. Both of these possibilities require thorough study, and whatever is done in the way of recovering nitrogen must take into account the main purpose of oil-shale treatment—that is, oil production.

Quality and Quantity of Yield

The writer has examined oils from Scotch plants and oils produced by different processes from various American shales, and has found that the quality of the Scotch oil is in every way much better than any oil he has thus far seen from American shales. Whether this is mostly due to the nature of the processes or to the shales themselves he is not definitely prepared to say, although it is known that the conditions under which oil is produced from shale have a very decided influence on the quality and quantity of oil yield. However, it has also been determined that different shales, retorted under identical conditions, do yield somewhat different oils. Both factors undoubtedly influence the quality of the oils yielded to a considerable extent.

The problem of those working in oil shale seems to be the production and subsequent refining of the best possible quality of shale oil consistent with economic practice. Once these conditions have been determined, they must be controlled and held as uniform as possible in commercial practice. The quality of oil produced will perhaps depend on the kind and amount of products desired, but it seems that the crude oil should be obtained in as undecomposed or uncracked state as possible. This has plainly been the aim of the Scotch operators. Every successful change in Scotch retort design can be noted in the greater production of burning oils and wax from the Scotch crude, a plain indication of less cracking.

Perhaps, in the United States, it may be desired to obtain a greater yield of gasoline or light oils by cracking the crude shale oil. Even then it would appear that the crude should be obtained from the retort in as uncracked a state as possible, and only those fractions of the crude most adapted for cracking be so treated. Cracking the crude itself, either during production or subsequently, can reasonably be expected to yield more light oils, but at the expense of some of the desirable heavy fractions of the crude. The production of a crude yielding a maximum amount of gasoline directly from the retort is thus apt to be a decidedly wasteful and uneconomical practice and moreover likely to yield a very unsatisfactory grade of gasoline, since the cracking of the crude during production cannot be so easily controlled as the cracking of a selected fraction in a separate apparatus designed solely for cracking, where exact control is possible.

As a rule, American shale oils thus far examined differ from the Scotch crude in that the former are heavier (specific gravity 0.900 to 0.980) than the latter (specific gravity 0.875), fractions from the former are more highly unsaturated and the odor more disagreeable than those from the Scotch crude. The American shale oils thus far examined were of a mixed paraffine and asphalt base, while the Scotch oil is distinctly of a paraffine base. It may not be possible to make as good oils from American shales as from Scotch shales, possibly because of the nature of the shales themselves, but undoubtedly better oils can be made than are being produced here today once the proper study of retorting methods has been conducted.

Oil production from oil shale is a process of destructive distillation which is not a haphazard affair, but one which must be properly controlled if good results are to be obtained. Obviously there are certain factors influencing oil production from shale, and for any shale the proper thing to do is to determine optimum conditions for producing an oil which will yield the greatest profit.

Factors Influencing Yields

The Bureau of Mines, in co-operation with the State of Colorado, is investigating certain of these factors in its investigation at Boulder, Col., on Colorado oil shales, with the idea that best conditions, as determined from small-scale experiments, will later be applied commercially in so far as commercial considerations permit. Some of the factors which can be expected to influence oil yield and quality, and the influence of which should be studied, are set forth below.

a. Size of shale particles treated.

b. Thickness of charge in the retort.

c. Rate of rise of temperature of the charge.

d. Maximum temperature to which shale is submitted.

e. Time of contact with and maximum temperature to which vapors are submitted.

f. Effect of steam and other vapors and gases.

g. Pressure under which retorting takes place.

If greatest economic returns are to be obtained from oil-shale operations, the effect of such factors as these should be determined.

Figs. 3 and 4 show, respectively, the retorting and laboratory equipment established at Boulder in connection with the above-mentioned investigation.

The Shale Oils

Once the oil is produced, it must be studied to determine its refinability. The high refining loss incurred in Scotch operations has been noted, and efforts should be made, of course, to keep this figure to a minimum in the refining process. New processes of refining and treating may be worked out when the oils produced are thoroughly studied and tried out in commercial operations. The Bureau of Mines, at its Salt Lake City Station, in co-operation with the State of Utah, is studying the oils produced from various shales and by various processes, correlating its work in this regard with the co-operative work in Colorado.

All American shale oils thus far studied by the Bureau are highly unsaturated and contain a considerable amount of nitrogen bases. Some of the unsaturated compounds can probably be allowed to remain in the finished products, but others polymerize and deposit gums and resins which must be removed in refining. The use of steam in Scotch retorts seems to prevent the occurrence of nitrogen bases in the oil to a large extent. It seems that ordinary methods of refining petroleum will have to be modified for shale oil, and such modification can be the result only of thorough study of the oils themselves.

Particular attention is directed to the high loss incurred in refining Scotch shale oil. The refining loss, as has been noted, amounts to about 23 per cent of the crude treated. Thus, although average Scotch shale yields about 24.5 gal. of crude oil to the ton, only about 20 gal. of this is marketed. As compared with this high loss, the average loss in straight run refining of petroleum in American practice does not exceed 3½ or 4 per cent. If the shale oils thus far examined by the Bureau of Mines are a fair indication of what can be expected from American shales in commercial operations, apparently the loss in refining them by Scotch methods would amount to nearly twice the loss in refining Scotch shale oils. If ordinary petroleum-refining methods are used, probably the loss would be still larger.

Oils are refined for the purpose of making marketable products from them. In refining operations undesirable or offensive substances are removed from the oils in order to make the finished products acceptable to the consumer, but in refining oils which suffer high refining losses, such as shale oils, it is probable that not only are objectionable substances removed but a considerable amount of material which might be retained in the finished products to good advantage.

Therefore probably a major problem in shale-oil refining is the reduction of refining losses, either by the development of new or modification of old methods. Such development or modification can come only as the result of technical study of the oils.

A refinery loss is a loss from more than one standpoint. In the first place, there is an actual loss of material, and in the second, treatments in which losses are incurred are more or less expensive. So the refiner not only loses a part of his oil but pays for losing it.

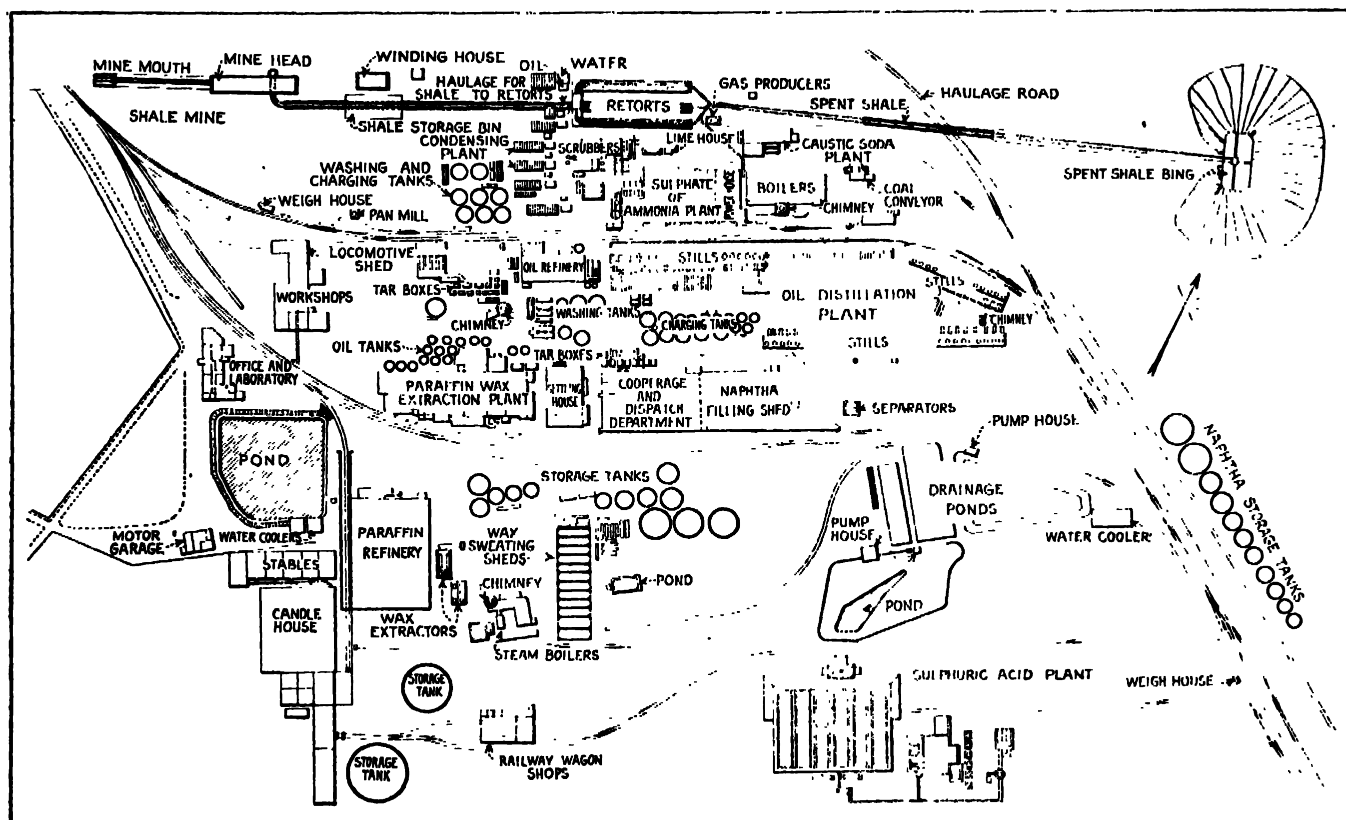


FIG. 2. PLAN OF TYPICAL SCOTCH SHALE WORKS

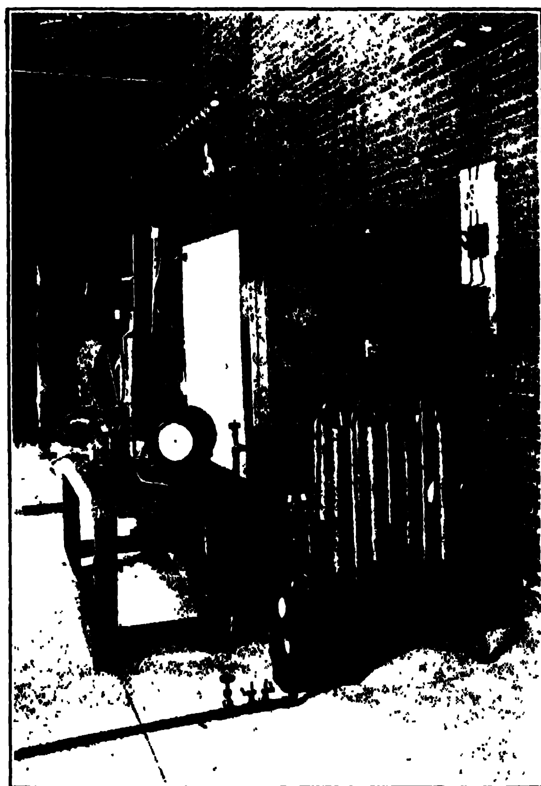


FIG. 3. OIL-SHALE RETORTING EQUIPMENT AT BOULDER, COL.

A large part of the refining loss in any event will probably be in the form of acid and alkali tars, and a field of research to utilize these tars is plainly indicated.

This discussion is intended to call attention to the fact that conditions of retorting and refining should be worked out on a scientific basis if maximum returns are to be expected in oil-shale operations. Each operator should know with scientific accuracy the optimum conditions for treating his shale and refining his oil. The chemist and chemical engineer will probably have a greater field for research in oil-shale operations than in petroleum production and refining. Particularly the oils need study. It is not possible to predict with accuracy the possible profits a plant can expect, or its costs, until the quality and quantity of products of marketable value it can make are known, as well as the conditions under which they can be made and refined.

When the problem of producing satisfactory products has been solved, there may be a field for research in the study and production of byproducts. Discussion of byproducts seems premature now, it is true, but later the oil-shale industry may develop an important byproduct industry. As a matter of fact, few realize the importance of the present petroleum byproduct industry.

When the Scottish oil-shale industry was started, economic conditions were such that the oils produced could be marketed with profit, but these conditions have changed, and since about 1864 the industry has been successful only because of continual improvements that have been made in the technology of shale-oil production and refining. In this regard, Steuart[1] writes:

"The Torbanehill mineral[2] yielded the raw material for about a dozen years, much of it being used in Scotland and some being exported to America and the Continent for distillation.

"In 1862, the supply from this source was being exhausted, and the material became too valuable and expensive for this industry, hence shale was resorted to, but with widely different results. While the Torbanehill mineral yielded about 120 gal. of crude oil per ton, the shales first used furnished 40 to 50 gal. and soon the yield was 30 to 35 gal. The expiry of Young's patent in 1864 led to a rapid expansion of the Scottish oil industry, but ere long it sustained a severe check. The discovery in 1859 of oil wells in Pennsylvania by E. L. Drake was soon followed by the importation of petroleum lamp oil into Britain, the quantity increasing year by year. Owing partly to this competition and partly to the increase in the number of oil works, prices gradually fell. . . .

American and Russian Competition

"At first the Americans exported to Britain only burning oil, but they soon began to introduce supplies of lubricating oil and subsequently of solid paraffine. Then the smaller works (whose retorts had been mostly for the production of burning oil) tended to decrease in number, and the larger ones to increase in size, thus concentrating and cheapening production. Retorts were improved to suit the circumstances, and to produce a purer oil with a larger proportion of heavy products. Mechanical labor-saving arrangements were devised, refining was improved and cheapened, and economies of every kind were introduced. The chemicals used in refining were recovered; and the tars separated by them, the removal of which had involved expense, now became a source of profit as fuel. The supply of Peruvian guano began to fail, hence the price of sulphate of ammonia rose to £22 (1880) and even to £24 per ton; but as the importation of nitrate of soda increased greatly, it fell below £8 per ton about 1890, when burning oil sold at less than 6d. per gal. These conditions led to further concentration. Retorts especially designed for the manufacture of sulphate of ammonia were universally adopted, and improvements were introduced to secure greater economy of working. With the older type of retorts a shale had to yield about 30 gal. of crude oil per ton in order to be profitable; but with the new retorts, and the increased yield of ammonia and fuel gas, a shale furnishing 20 gal. is remunerative. Not more than 16 lb. of sulphate of ammonia per ton was formerly obtained as a maximum, now 35 to 70 lb. is got, according to the quality of the shale. By these methods the quality of shale that can be worked with profit has been increased and the life of the Scottish industry has been lengthened.

"Since 1873 the Russian petroleum industry has developed rapidly, and in recent years competition from this source has become very severe. Russian crude oil, however, produces no solid paraffine; and America shows signs of not being able to respond as easily as formerly to the increased demands of the world for petroleum, any increase in American output being fuel oil. In 1905, however, it succeeded by great effort in making up for the Russian deficiency caused by troubles at Baku. In 1909 and 1910 there was a definite decrease in the export of burning oil from America to Britain. Sulphate of ammonia is being produced in greater quantities from iron works, coke ovens, Mond gas producers, etc.; but the demand also increases. New competitors are always

[1] Steuart, D. R., "The Oil Shales of the Lothians"—Part III. "The Chemistry of the Oil Shales." "Memoirs of the Geological Survey," Scotland, pp. 137-138.

[2] A very rich oil shale.

arising; recently, for instance, Galicia with solid paraffine, Rumania with burning oil, and the Dutch East Indies with motor spirit. But notwithstanding this prolonged and fierce struggle for existence, the Scottish industry still survives. The Scottish companies vie with one another in their efforts to improve and cheapen the processes, and show signs of mutual helpfulness and co-operation. In the early days of the industry operations were carried on in a simple but expensive fashion. Sometimes the shale was carted miles to the retorts, and the crude oil carted miles to the refinery, and breaking shale, pumping oil, etc., were done by manual labor. But through all these years evolution has been at work in developing a high state of organization, resulting in economy and efficiency. The most of the existing works have adopted electricity for lighting and for the conveyance of power for all purposes.

"In 1894 there were thirteen oil companies in Scotland; now there are only seven (three of which produce crude oil only), but the output has not been reduced."*

New and Improved Practice Being Developed

Thus there is seen the continual application of new and improved practice in the Scotch industry, a practical seeking after better methods, perhaps not by means of strictly scientific research, but nevertheless by research, which, conducted in a practical manner and with a definite objective in view, has kept the industry alive. It may be noted that the only companies in Scotland which have survived during the long years of competition have been those which could afford to experiment and had the capital at hand to conduct operations in a large way under the supervision of trained technicians and executives. Once a market had been established for certain products, efforts have continually been made to increase the yield of these products and lower production cost.

The oil-shale industry in this country will afford a field for the mining and mechanical engineer, as well as the chemist and chemical engineer. Mining the shale is bound to furnish a very important item in the total cost of producing refined shale-oil products. In Scotland the cost of mining the shale is well over 50 per cent of the total cost of making refined shale oils. The mining of oil shale in this country should offer the mining engineer an opportunity to devise new methods of drilling, breaking down, hoisting, conveying, crushing and the like, and permit the reduction in total costs by supplementing high priced mine labor with mechanical devices.

Retort Construction

Retort construction is a problem for the mechanical and chemical engineer. The Scotch retort, when carefully examined, is found to be admirably suited for its task. A notable feature in its design is the manner in which provision is made for the expansion and contraction of each retort in a unit, independently of any of the others. The average life of the best types of Scotch retort is well over twelve years; the value of this figure can be appreciated when it is learned that the life of the first retorts used was only one and a half to two years. The mechanical engineer may be asked to adapt the Scotch retort to American shales, and the writer believes it to be capable of considerable modification for certain definite purposes. Its freedom from complicated mechanical devices, long life and satisfactory performance for so many years in Scotland make it difficult to disregard for use in this country without complete trial. A shale retort must be rugged enough to operate continuously for long periods at comparatively high temperatures handling an abrasive material. As has been the case in coal byproducts plants, the engineer may be able to substitute ordinary firebrick with other refractories, such as silica brick, and there may be a new field for the use of alloys and metals with protective coatings designed to resist oxidation at high temperatures. In the refining of the oils it is expected that while much of the ordinary petroleum-refining equipment can be used, probably much of it may have to be modified, and there are distinctly seen the possibilities of new refining processes, equipment for which the chemical and mechanical engineer will be called upon to supply.

*The largest of these consolidated into one company, Scottish Oils, Ltd., in 1919.—Author.



FIG. 4. OIL-SHALE LABORATORY AT BOULDER, COL.

Success Ahead

The future of an oil-shale industry in this country is practically assured by the increasing consumption of petroleum and its products in this country over domestic production of petroleum. Indications are that in the comparatively near future the United States must import the bulk of its petroleum or find a substitute or new source of hydrocarbon oils. While possibilities in the use of such substitutes as alcohol and coal-tar products cannot be disregarded, the writer sees in oil shale the natural and logical source of oils to make up in large part the coming deficit between domestic consumption and production of natural petroleum. It seems certain that motor fuels, burning oils, fuel oils and paraffine wax can be made from shale oil, but there is considerable doubt as to the possibility of producing more than moderately viscous lubricating oils from them. Between the knowledge that certain oils can be produced and their actual commercial production is a large gap which must be filled by properly directed research and investigational work. There are reasons to believe that a company, well organized, with plenty of capital and well equipped with business and technical men, if situated favorably, would have a reasonable chance of establishing successful commercial shale-oil production, if not at the present time, at least in the near future. The necessity for technical investigations and control, however, cannot be too strongly emphasized, because the oil-shale industry, in its final analysis, is nothing but a low-grade raw material chemical manufacturing enterprise, which, when economic conditions are right, depends on capital and business and technical ability for success.



AN INDUSTRIAL RESEARCH LABORATORY DEVELOPED FROM AN OLD MILL IN A FAVORABLE LOCATION

A Novel Laboratory for Industrial Research

A Description of a Research Laboratory Organized to Study and Develop New and Economical Problems Relating to Chemical and Metallurgical Processes and Equipment, With a Succinct Enumeration of Some of the Problems Which Are Being Studied

WE HAVE been preaching the doctrine of intelligent research in industry so earnestly that it is always a pleasure to tell of the successful operation of a laboratory devoted to the purpose. Of course, a laboratory is only a shell; it is the men in it that count; but wisdom begins in regard to this subject with the selection of the men, the selection of the subjects for research and the establishment of proper facilities and surroundings for the work. Certain principles seem to be pretty well established: The men engaged in research must not be taken from their work to do incidental testing for production control; they must not be teased and hectored by problems of administration; their business is abstract thinking and corroborative testing, and these things are incompatible with union hours, the time clock or the whistle.

In a way, of course, research is speculative, but the word needs qualification. Anybody with money in the bank can speculate if he wants to but the number of persons who can engage successfully in true research is severely limited. This calls for constantly more and more specialized knowledge, and the laboratory which the writer is about to describe was organized to study and develop new and economical methods for the separation of particles in suspension and for their more intimate admixture. The special requirements necessary for work in this field were happily already possessed by the Dorr Company's scientific staff, inasmuch as the field in question indicates the general scope of the Dorr apparatus. But the successful operation of the laboratory staff in the solution of problems within the domain mentioned has led to the undertaking of work quite outside of these limitations, so that its scope has been greatly extended beyond the original plans for the establishment.

A research laboratory differs from everything else under the sun. Generally speaking, the more we know of a thing the better can we tell what it will do or accomplish. With a research laboratory, however, the more scholarship and scientific understanding we bring to it the less can we tell what will come out of it.

The metallurgical and chemical apparatus invented by J. V. N. Dorr have been fully described in previous issues of CHEMICAL & METALLURGICAL ENGINEERING.[1]

They were thoroughly established in the cyaniding industry, but the inventor set himself the problem of introducing them generally into industry wherever a use for them might be found. Outside of cyaniding they were practically unknown until Mr. Dorr moved East from Denver, leaving a metallurgical branch and testing laboratory behind him when he established headquarters of the company that bears his name in New York, and surrounded himself with a competent scientific and technological staff.

NECESSITY OF RESEARCH APPARENT

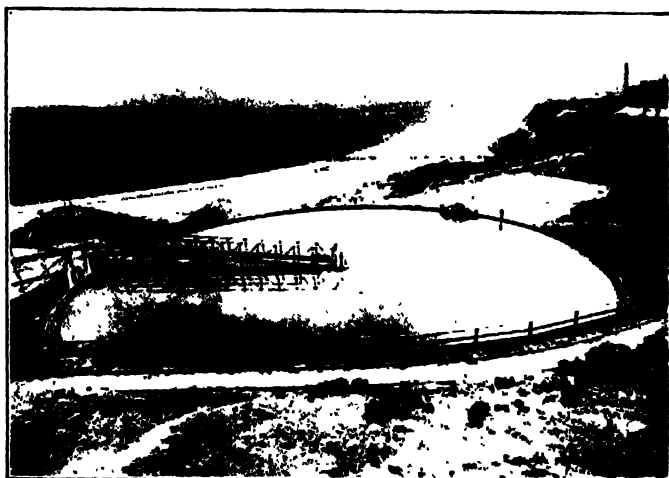
At this point the necessity of research became evident to fill in the gap between Why and How. It was easy enough to ask, for instance, why wouldn't a thickener

[1] "The Use of Hydrometallurgical Apparatus in Chemical Engineering," by John V. N. Dorr, January and February, 1915, pp. 55-59 and 91-98.

clarify the waters coming from an anthracite coal washer, save the coal and avoid the pollution of streams? But you can't sell apparatus or anything else on a question. Men of affairs are singularly averse to buying problems. On the other hand, if you can tell them how to solve their problems they become interested immediately. Here is the direct incidence of research. And very fortunately the substance of the little homily at the beginning of this article in regard to the subject was clear in the mind of the inventor. He wanted a place where work might be done in peace and quiet, apart from noise and distractions, and where the men at work would be free from the misery of a high-rent time clock to worry them to undue speed or omissions. It is remarkable how closely allied is academic calm to industrial research. The very thing to avoid is the slap-dash bustle and the emphasis of so-called "scientific" management in such a laboratory. If a man can think better when he dawdles with his figures there is no reason why he shouldn't dawdle with his figures. If the man in authority lacks scientific understanding his only safety is to leave the place alone. It is much better for such a person to say his prayers over the laboratory than to give instructions in it.

Old Mill Becomes a Laboratory

Mr. Dorr purchased for the use of his organization an old mill at Westport, Conn., built way back in the seventeen hundreds, with good water power and about thirty-five acres of mostly wooded land. The mill was



200-FT. DORR THICKENER

reconstructed for laboratory purposes and for semi-commercial and commercial testing. It was provided with a considerable variety of small, medium and some full-sized apparatus for grinding, separating, drying, etc., besides a good metallurgical outfit, and an extensive chemical and a fair physical laboratory equipment.

An excellent library is provided with a big fireplace and comfortable chairs and tables, there are comfortable sleeping-rooms, and—the writer is speaking from experience—a grand breakfast may be prepared there. There are trout in the stream which runs under the mill, the woods about it are a bird refuge, and near by a couple of houses are approaching completion for the greater convenience of those engaged there. The place is forty-four miles from New York and about four miles from South Norwalk, which is an express passenger station on the New York, New Haven and Hartford R.R. The laboratory has a permanent staff of four research engineers, together with attendants and laborers, and usually there are four or five more chemists or engineers trying out new ideas, or working on improvements in methods of separation or mixing, or in research along other lines. These extra men may be members of the company's own staff or from those of its clients.

Some of the Problems Studied

The scope of the work undertaken at the laboratory may best be set forth by a list of the subjects of some of the problems already studied, and it also indicates how far beyond the original field of wet metallurgy the use of these apparatus has been brought by the application of intelligent research. The list includes: Leaching copper and tin ores, flotation of copper, tin, iron and lead ores; studies in connection with the production of Chilean nitrates, clays, bauxite, alum, feldspar, iron ores, phosphoric acid, acetylene, abrasives, coal, cement, dye wastes, fluedust, kaolin, lithopone, limestone, magnesia, oils, paper pulps, paints and pigments, rubber, starch, sewage, soap, etc. A curious example of research in this laboratory was one which resulted in an advance in the technology of making false teeth.

Operations of the Laboratory

The operations of the laboratory may be divided under the following main headings:

Research dealing with the development of the company's ideas in connection with processes and equipment;

Research for clients often along lines which do not involve the use of the company's apparatus; and

Testing for the enlightenment and instruction of the sales forces.

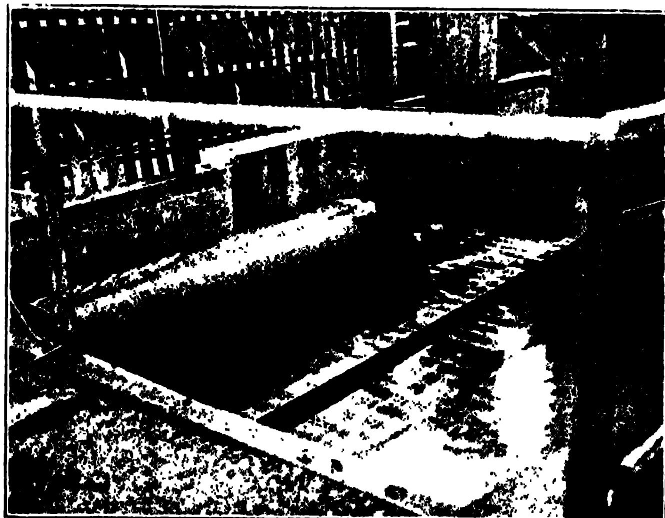
Experience has demonstrated that what may appear to be a simple testing problem generally calls for careful research before a definite report can be rendered, and in view of this the company has adopted the policy of charging for all but those forms of simple testing in relation to sales which do not in any way call for analysis or research. Here we have an excellent example of laboratory growth: starting as a testing out plant to aid sales, as its competence develops it becomes a commercial laboratory. And the policy of charging for the study of manufacturers' problems enables the corporation to avoid tacking the cost of special research on the price of apparatus. It also makes it possible to maintain standard prices for apparatus.

Wholly apart from the services mentioned the laboratory plays a further important rôle as a mistake eliminator.

Some of the Things Accomplished

Some of the things accomplished that began in the laboratory as ideas which were tested out on a theoretical scale and later developed in part in the apparatus installed and in part in field work are the following: The art of "closed-circuit grinding," for instance, was well known in wet metallurgical work, but new to chemical technology outside of that domain. It needed the laboratory to demonstrate its usefulness in such industries as the production of pigments, floated silica, milk of lime, etc. Here, too, the idea was first considered to use thickeners to recover the dust from blast-furnace gases in which up to 47 per cent of iron is entrained. The method of introducing Dorr apparatus into clay

industries was worked out here, as also the saving of large quantities of coal from anthracite washeries, already referred to, and, at the same time, avoiding the pollution of streams. One of the sequelæ of this work was the establishment of a branch office in Scranton, Pa. A later development is in the bituminous washeries, also saving coal and avoiding the pollution of streams. It required preliminary testing to prove the use of apparatus in cement mills and in the separation of fine phosphate rock from clay. A major problem had to do with the handling of hot saccharate in the Steffens house of beet sugar establishments and for concentrating this precipitate under conditions of heat control prior to filtering, and for thickening the first carbonization precipitate. An allied problem worked out and successfully put into practice in the operation of a cane-sugar mill was the production, without filtration for subsequent evaporation, of a bright juice which is practically free from suspended solids. An unlooked-for secondary result which developed in field tests was that the underflow was much denser (liquid : solid ratio) than is otherwise obtained. This promises to eliminate a second decantation, which is a fertile source of loss.



REVOLVING SCREEN FOR TRADE WASTE

IMPROVED TREATMENT OF SEWAGE

Another field in which research in the improved separation of solids from liquids was indicated and begun was in the treatment of sewage. The work started several years ago with problems relating to trade wastes which led to the development of a self-cleansing rotary screen, and this in turn warranted an attack upon the great question of the disposal of domestic sewage. Success in handling trade wastes led to the organization of a special sanitary department of the Dorr Company.

The domestic sewage problem is so pressing that it will probably be of interest to indicate the incidence of the work, although a complete solution of the problem is not yet at hand. When stream pollution is to be avoided, an affluent of high purity is required, which will be allowed to flow away without nuisance resulting. A desirable method of producing this purification is to activate the sewage—that is, to bubble air through it until oxidizing bacterial cultures are formed which destroy and absorb the offensive matter in the sewage. A clarified stable water effluent is produced, the impurities being separated in solid form by settling as "activated sludge."

The great difficulty with all sewage activation processes is that they require so much air that the factors of cost and time become a heavy burden. The new revolving screen operates in conjunction with this process by removing the sizable tough and non-digestible solids from the raw sewage prior to activation, thereby lessening the purification work of the bacteria. The activation takes place in a specially designed clarifier (or thickener) which effects distribution of circulation of the air bubbles in one chamber and separation of sludge from clear effluent in another. The indications are that aëration may thus be accomplished in less time and at lower expense than by other means. The aërated sludge then passes to final treatment.

Undeveloped as yet, but making progress under the auspices of this company as well as in other research laboratories, is the biological treatment of the sewage so that it shall have enough nitrogen when dried to be a high-grade rather than a low-grade nitrogen fertilizer. Dried activated sludge is not a nuisance. The other features, the removal of grease by mechanical means, the immediate treatment of sewage as it flows from the sewer and before it has become septic, with the avoidance of great settling tanks; the enclosed, unsmelled and unseen mechanical treatment from start to finish; the chlorinated clear and harmless effluent that flows away and the dried sludge fertilizer brought out as the final product of one operation, all push along toward the solution of these perplexities. The research of this company's group of chemists and engineers, in conjunction with the work done by others during the past twenty-five years, leads to hope that the Desired Thing is not far off: the inoffensive disposal of municipal sewage, an end to the pollution of surrounding waters and neighboring streams, the resolution of a present danger to health into an inoffensive sanitary disposal plant; a boon to agriculture and a source of profit rather than an expense to municipalities.

Research and Industrial Wastes

In a paper read by George S. Hessenbruch at the Indianapolis meeting of the American Society of Mechanical Engineers the following points were emphasized: In many instances the financial returns from the wastes when properly processed and obtained from the raw materials in a manufacturing plant have been greater than the return from the actual manufactured article made in the same plant. Today we are confronted by the cry of increased production. Every manufacturer is striving his utmost to help this movement. In fact it is the solution or at least an amelioration of many of the evils that threaten us seriously, and it is natural to turn toward the utilization of wastes and waste materials, which is the most economical and beneficial way to help this movement. Reducing the wastes or utilizing them in some way or other by suitable processing will not only save the national resources from being depleted more rapidly, but it will also reduce costs, establish new industrial undertakings, give employment to more people, open up new channels of commerce and induce capital to invest in new enterprises. The meaning of all this is fully realized and industrial as well as pure scientific research is gradually receiving more and more attention.



GENERAL VIEW OF CLINCHFIELD PLANT

Low-Temperature Carbonization of Coal and Manufacture of Smokeless Fuel Briquets

Low-Temperature Carbonization of Coal Compared With High-Temperature Carbonization—The "Carbocoal Process," Retorts, Machinery, Etc., Installed at the Clinchfield Plant

BY HARRY A. CURTIS, PH.D.*

THE conversion of bituminous coal into a smokeless fuel by any commercially feasible process is a project of first-rate importance, not alone because of the interesting engineering and chemical problems involved but also on account of its vital economic bearing.

LOW-TEMPERATURE CARBONIZATION COMPARED WITH COKE-OVEN PRACTICE

When a given coal is distilled or carbonized, there are several factors which influence the quantity and the composition of the various byproducts, but of these factors temperature is the dominant one. In the ordinary byproduct coke oven, where the prime object is to turn out a special product for the metallurgical industry, the carbonization is carried out at a temperature far above that which is favorable to a high yield of oils. The resultant coke is too inert and too high priced a product to find favor in the domestic fuel market or in the industries generally.

If coal be carbonized at lower temperatures, say at about 900 deg. F., the yield of oils per ton of coal will be more than doubled, while the gas yield is correspondingly much less. If a coal of the following proximate analysis be used

	Per Cent
Volatile matter	35
Fixed carbon	58
Ash	7

*Chief Chemist, International Coal Products Corporation.

the yield of the various products will be as follows (assuming that a coke oven could handle so high volatile a coal):

	High Temp.	Low Temp.
Coke residue, per cent	66 (1%, volatile)	72 (10% volatile)
Gas, cu ft	10,000	4,000
Tar, gal	12	24
Light oil fr[illegible], gal	3	1½
Ammonium	20	10

The coke residue in the two cases will be quite different in character, the higher-temperature product being harder, coarser grained and more inert in the fire, while the low-temperature residue is light, relatively soft, friable and easily burned.

The high-temperature carbonization in the coke oven yields much more gas than does low-temperature carbonization, but the coke-oven gas will be lower in average heat value, say 550 B.t.u. as compared with 750 B.t.u. for the low-temperature process. This difference is, of course, due to difference in composition, the low-temperature gas corresponding more nearly to that which is produced in the coke oven during the earlier stages of coking.

The tars produced are quite different in composition. An indication of this is that while the specific gravity of good coke-oven tar will run about 1.17 at 60 deg. F. and the tar will show a free carbon content of about 6.5 per cent, the low-temperature tar will run less than 1.1 specific gravity and have a free carbon content of less than 1 per cent. In general, the low-temperature tar contains more paraffine bodies and less aromatic

compounds than does coke-oven tar, but the tar acid content of the low-temperature tar is higher. For example, on distilling the tars, the 170 deg. to pitch fraction of the low-temperature tar will contain about 40 per cent tar acids, while the distillates from coke-oven tar will run less than 15 per cent tar acids. The low-temperature tar distillate contains only a trace of the phenol which is characteristic of coke-oven tar, but the "phenol coefficient" of the low-temperature tar distillate will run higher, due to the fact that the cresols are more powerful disinfectants than is phenol. Naphthalene is evidently a high-temperature product, for it is absent in the low-temperature tar.

The light oil recovered from the gas in low-temperature carbonization differs from that obtained in coke-oven operation in that the former contains about 20 per cent of paraffines mixed with the usual benzene, toluene, etc. In war times, when pure benzene and toluene are needed, this is a disadvantage, since the paraffines must be removed, but in peace times, when this oil will normally be worked up into motor spirits, the presence of the paraffines is an advantage because it lowers the freezing point of the mixture, whereas the corresponding product from the coke oven must be mixed with gasoline for winter use.

The ammonia produced in low-temperature carbonization is only about half that yielded by the coke oven. It is known that when coal is distilled, evolution of ammonia begins at about 650 deg. F. and practically ceases at about 1,450 deg. F. The distillation at an intermediate temperature, 900 deg. F., without steaming, necessarily gives a low yield of ammonia.

THE "CARBOCOAL PROCESS"

The Carbocoal process for producing an anthracite-like fuel from bituminous coal is not purely a low-temperature process, since the soft semi-coke obtained in the initial low-temperature carbonization is subsequently briquetted with pitch and then carbonized at a relatively high temperature. This point should be borne in mind in comparing the yields of the Carbocoal process with simple low-temperature processes. Also it is not correct to compare the yields of the Carbocoal process directly with the yields of the byproduct coke oven, for while the tar from a coke oven is marketed as such, in a Carbocoal plant the tar is distilled



FIG. 1. BATTERY OF SIX LOW-TEMPERATURE RETORTS IN COURSE OF CONSTRUCTION



FIG. 2. FEED AND DRIVE MECHANISM

and the pitch returned to the process, tar oils being marketed in place of tar.

In the Carbocoal process the coal is first crushed to pass a ⅜-in. screen and is then fed by screw conveyors into horizontal retorts. Each retort is about 7 ft. in diameter and 20 ft. long, lined with carborundum and carrying two heavy paddle shafts running lengthwise through it. Each shaft carries about forty paddles, so arranged that when the shafts revolve the paddles stir the coal continuously and advance it slowly through the retort. The advantage of moving the coal up to the hot walls of the retort instead of depending on the transfer of heat through the coking mass is obvious.

The yields obtained in this step of the process are those represented under low-temperature carbonization discussed above—i.e., about 4,000 cu.ft. of rich gas, 24 gal. of tar, 1½ gal. of light oil and 10 lb. of ammonium sulphate.

The semi-coke which is continuously discharged from the retorts may be used directly under the boiler of a power plant or may be charged directly into a gas producer. It is, however, not in shape to market for general use, being too soft and carrying too many fines. In the next step in the process this soft semi-coke is ground and briquetted with hot pitch, heavy roll presses being used for this work. These raw briquets are like the usual smoky coal briquets which have done much to prejudice the market against briquetted fuel. In the next step in the process, the raw briquets are charged into inclined rectangular retorts and carbonized for about six hours at 1,800 deg. F. During this time the briquets shrink about 30 per cent in volume, the pitch binder is coked, and the hard, dense briquets resulting finally are quite smokeless when burned.

The high-temperature carbonization results in a further yield of byproducts—viz., about 6 gal. of tar per ton of coal, about 5,000 cu.ft. of gas, an additional 10 lb. of ammonium sulphate and a little more light oil.

In a Carbocoal plant, the byproducts from the primary or low-temperature carbonization are combined with the corresponding byproducts from the secondary or high-temperature carbonization, and worked up as usual.

In order to compare the output of a Carbocoal plant with that of a byproduct coke oven, it may be assumed that the tar is distilled in both cases, the pitch in the case of the Carbocoal process being turned back. In the accompanying table the pitch from coke-oven tar

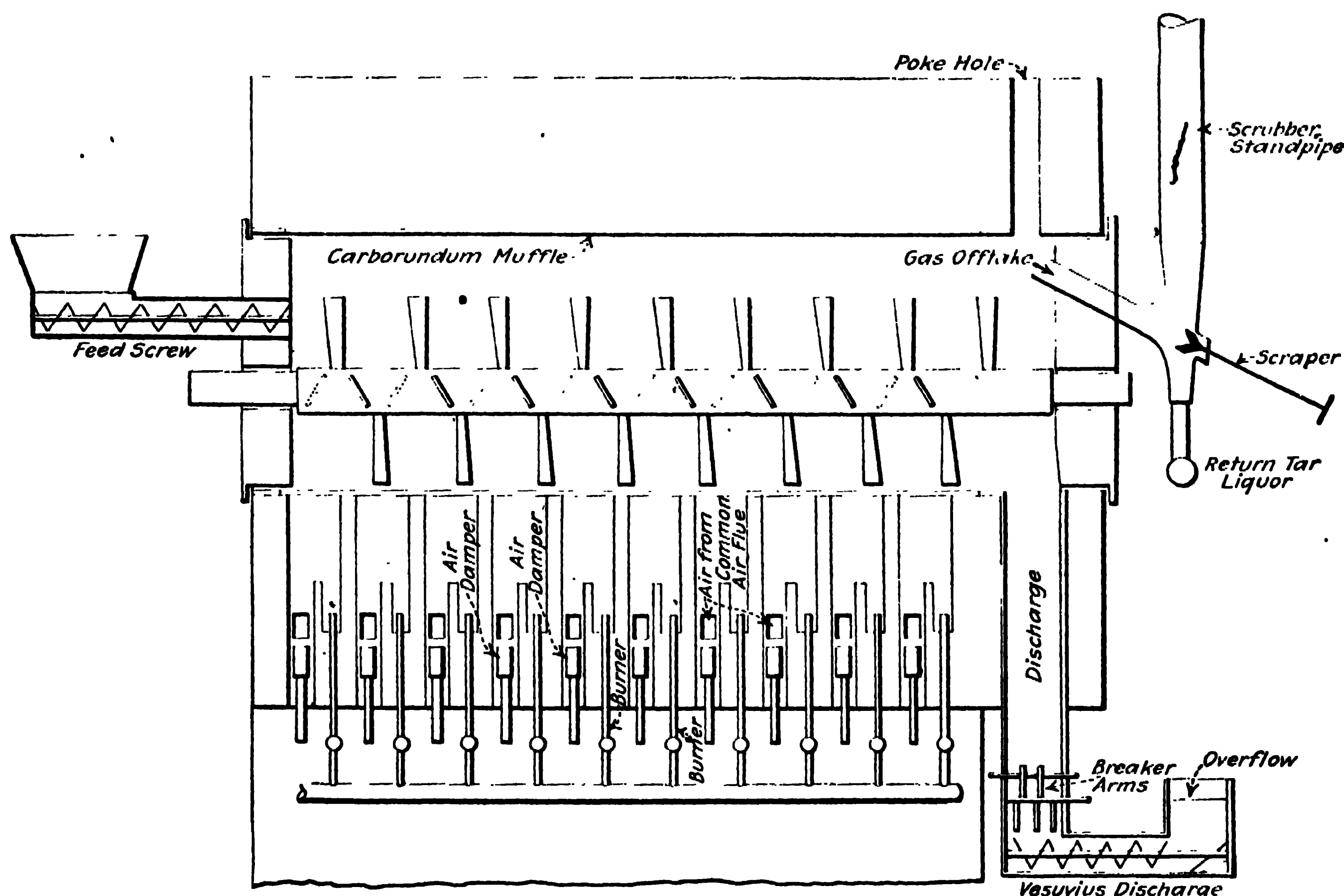


FIG. 3. CROSS-SECTION OF PRIMARY FURNACE

is taken at 68 per cent the volume of the tar and the pitch from the Carbocoal process at 50 per cent the volume of the tar. The yield of Carbocoal will be a few per cent higher than the coke for two reasons—one that the Carbocoal still carries 3 to 4 per cent volatile, and the other that the pitch used in briquetting yields some coke in the secondary carbonization.

YIELDS FROM A TON OF DRY COAL
(See analysis in text)

	Coke Oven	Carbocoal Pro
Coke or Carbocoal, per cent	66	68
Gas, cu.ft.	10,000	9,000
Light oil from gas, gal	3	2
Ammonium sulphate, lb.	20	20
Tar oils, gal.	3 8	15
Pitch, gal	8 2	Used

The coal is assumed to have the analysis given earlier in this paper, which makes the coke-oven yields appear a little unusual, since a coke oven seldom uses so high volatile a coal.

The Clinchfield Carbocoal Plant

The Carbocoal process[1] was developed during the past five years by the International Coal Products Corporation at its experimental plant in Irvington, N. J. Most of the work here was done with commercial-sized retorts, since it was clear from the nature of the problem that small-scale apparatus would not yield the necessary mechanical data on which to design a commercial plant. The experimental plant at Irvington has a capacity of about 100 tons of coal per day, but this plant is operated strictly for experimental and development purposes.

[1]See Chem. & Met. Eng., vol. 19, p. 579.

During the war the United States Government financed the construction of a 500-ton-per-day plant at Clinchfield, Va. This plant was finally put into operation in June, 1920, and has been running steadily since. Full-capacity production will be reached during the present summer.

The Clinchfield plant is equipped with twenty-four primary, or low-temperature retorts, each having a capacity of 24 tons of coal per day. The coal used is a good grade of bituminous coal coming from mines a few miles from the plant. After crushing, the coal is delivered to feed hoppers over the retorts from which it is carried into the retorts by self-sealing screw conveyors. The semi-coke is discharged continuously by similar self-sealing screws and falls onto closed conveyors which deliver it to storage bins in the briquet plant. Here it is ground, fluxed with pitch, and briquetted on heavy roll presses. The raw briquets fall onto a long, cooling conveyor and are delivered to storage bins at the secondary or high-temperature retort, whence they are charged into the retorts from steel larry cars.

There are ten secondary retorts arranged in batteries of six and four, each retort about 12 ft. wide and 20 ft. long, inclined at about 30 degrees and divided into six carbonizing chambers. After the final carbonization of about six hours at 1,800 deg. F., the finished briquets—Carbocoal—are discharged by gravity, quenched and loaded for shipment.

The byproducts are handled as in coke-oven practice, the Clinchfield plant including a complete byproduct plant, tar-distilling plant, light oil plant, power plant and all auxiliary equipment necessary to make it a self-contained unit.

The Chemical Profession—Its Opportunity and Responsibility

An Outline of the Growing Effective Effort of the Chemical Profession and of the Necessity and Duty of Chemists to Enlist Capital, Brains and Natural Resources for Concerted Action in the Development of the Chemical Industry

By R. S. McBride*

THE chemical profession today stands at an open door of opportunity. Indeed, every indication of the times is an invitation to enter upon a new era of growth and achievement that is most alluring. With the opportunity comes also a duty. The duty is one requiring not only service but also expansion and growth of the profession in many lines. Never before has the chemical profession seen such an ideal blending of a promising future for itself with a splendid chance to render a large service to the world. The profession is young, but it deals with basic and essential activities. It goes into all branches of industry with far-reaching influence. No one can today prophesy the immediate opportunity, much less foresee the increasing power, of effective chemical effort properly developed in future years.

All of this would seem to be a statement of generalities of little interest or practical value if there were not at hand readily available means for the realization of these dreams. A simple analysis of professional activity makes many of these points clear.

The Basic Chemical Reaction

Chemistry is principally applied for the control of industrial processes. In this application we can write one simple basic "reaction" which covers practically all of its activity.

Resource + process + labor and power + management and scientific skill + money = product + byproduct + profit.

This industrial reaction goes on successfully under a wide variety of conditions. American business methods and the atmosphere of American science seem particularly conducive to high yields of all of the products of the reaction. Particularly does skill in science and management furnish a splendid catalyst for the reaction.

The Yardstick of Chemical Success

Measuring the speed of this reaction we cannot use the unit of product or unit of time, but we have two most effective yardsticks. The financial measure of success, of course, is expressed in terms of the dollar; and to the extent which the third product of the above reaction predominates, our financial and business interests would say that we had achieved success. On the other hand, we have the measure of scientific success. There is first the extent to which we have conserved our resources. There is also that measure of success which depends upon the improvement in quality of product or lessening the cost of a product of given quality. And the still more rigid test of achievement is that we shall have furnished something novel which is useful either as a substitute in old work or for the accomplishment of new results.

Profession or Trade

Chemistry is unquestionably practiced in this country as a profession. It has, however, many hangers-on who lend to it the characteristics of a trade. As a profession it believes fundamentally in the application of knowledge. In this it is distinguished from a trade, which inevitably rests largely upon the application of experience rather than application of knowledge. This distinction between profession and trade is fundamental. Without clear recognition of it the advancement of chemistry will be much handicapped and delayed. Fortunately, however, chemistry has through very recent years been granted a new vision which gives promise that it will recognize this distinction.

As a science, of course, chemistry dates back into early times, but modern chemistry has successfully avoided the pitfall of ancestor worship. It has taken all of the Anglo-Saxon characteristics of independence of thought and vigorous advancement of new ideals. There remains, however, additional responsibility. Particularly with respect to organized professional effort it has not correspondingly advanced.

Organized Chemical Duty

Turning back to the basic reaction of industrial activity, we should ask ourselves, What has organized chemistry done or what is it doing today in the direction and control of industrial reaction? To what extent has it gone into the market for capital, for brains, for natural resources? How has it encouraged the development of the process and machinery, patents and inventions? Wherein has it influenced the market conditions for its products and byproducts tending always to produce well-balanced industry?

In almost every case we are forced to reply that *collectively* chemists have done almost nothing. What might or should have been done is all too obvious to the careful student of the situation. In impetuous, youthful attack upon its everyday problems, however, the profession has ignored these duties and today seems to stand in need of reprimand. However, it is by no means too late to induce those efforts which will be effective in this work, for they are only latent in the chemical profession.

The Bid for Capital

Chemical industry today is not recognized as such—that is to say, that potent element of industrial development, the financier, does not recognize chemical activity collectively as such. This is in striking con-

*Engineering Representative, McGraw-Hill Co., Inc., Washington, D. C.

trast with the railroads, the public utilities, the mining and metallurgical interests of the country. All of these and others go into Wall Street as a group and demand there and receive financial attention and backing. To date, however, the chemical profession has not developed a similar respect and attention for the chemical demand of the country.

Recently the electrical appliance interests of the country were urged to attend to matters such as this. Editorial comment to them emphasized: "Your banker is your best business friend. Get acquainted with him and see that your bank officials become acquainted with your business and with the facts about the great electrical industry of which your business is a part." The comment continued to set forth the more essential and less essential lines of electrical merchandise and supply that demand financial support during the coming year. The amazing total of estimated sales aggregated about two billion dollars in merchandise for 1920. Surely the chemical industries could make an even more impressive showing, but they have never even attempted such a demonstration.

The electrical business taken at large is regulated. Profits are severely limited in many lines by the price-fixing activities of our public authorities, and yet this business successfully commands the interest of the banker and his support. How much more readily the chemical industry, young, rapidly growing and prosperous as it is, can command this attention may well be appreciated. But not only is this opportunity greater, the financial demand is greater too, for it is the growing industry which needs the greatest amount of new capital. In greater proportion, too, is our responsibility for this important aspect of professional effort.

The Search for Resources

The chemist should not be content to let the geologist, petrographer and mineralogist alone seek the resources of the country. He, too, must go into the field, not in person, perhaps, but by proxy, always seeking the natural industrial resource which is to be basic for his processes. Economic geology today is really resource chemistry. The industry of tomorrow must depend upon explored resource of today. Imports, exports, tariff and many other related questions are only beginning to receive their deserved attention by chemists. Individually we have begun to appreciate their importance. Collectively they are as foreign to the profession, it appears, as Greek or archæology.

Processes and Machinery

For successful development new processes and new machinery must continually be furnished. Only by individual effort and private support can invention be first conceived, but much of this invention which promises well for the industry will fail unless it receives more than this individual support. Full records of progress must be made in order to facilitate wider expansion, wider application of new developments must be always encouraged, and co-operative effort in support of new and worthy undertakings must never fail, if the chemical profession is most quickly to realize upon the new ideas.

Chemists must work together in these lines. They must co-operate to speed up the progress from research to achievement. This process is not simple, as we all know. Research leads to discovery. Discovery leads to invention. Invention leads to development. Development leads to industrial accomplishment, and accomplishment leads to industry. It is a stairway of achievement having many steps. Individually many of the steps are far too high to be negotiated. Collectively the profession need fear none of them.

Today in the chemical industries we find many striking examples of widespread application of simple equipment or process, as, for example, the filter press. Many industries have borrowed this device and put it to good use. Colloid chemistry, first studied by the "pure" scientist, who thought only of its theoretical meaning and possibilities, today is being recognized as a dominating influence in many industrial fields. Innumerable other examples might be cited. However, set against these we have whole industries neglected by the chemist. Fertilizers are prepared almost without the thought of chemistry. Coking except in a very few cases is undirected by science; it remains a mechanical-engineering art, almost in fact a trade, so largely is it guided by rule-of-thumb methods. It is almost inconceivable that the chemical profession will permit these and many others to remain without the dominating influence of proper professional attention.

Labor and Power Problems

Today the chemist for greatest industrial success must be something of an engineer economist. He must study labor, immigration, emigration, finance, and related problems diligently.

Much of the chemical progress will result in reducing the demand for labor in industrial processes; but simultaneously we create corresponding increase in demand for mechanical power. We thus add a need for study in the field of water power, electric power transmission, fuel prices, and related industrial requirements.

Today all industry is in competition for the supply of labor and for the supplies of fuel and power. The chemical industry cannot ignore this competition. To be sure, a young and thriving industry can usually afford to pay almost any price for essential materials or services, because the margin of profit is great; but the measure of *permanent* success will be determined by the extent to which efficient use is made of labor and by how fully the well-co-ordinated intelligent bid for power and fuel is made while directly meeting other industrial competition for these items.

The chemists working together must study these questions. They are not simple nor will they be solved in a year, nor even a decade. They will continue so long as industry continues, but ignoring them will at no time be safe.

The Needed Brains

Individually the chemist has done much in each of the fields which has been mentioned. Collectively he has done little. Least of all has he been attentive to the problems of training up for the future of the profession the needed younger men.

Chemistry offers a romantic field for study to the youngster who may desire to consider science as a life work. More effort should be made to encourage this selection. Recently there has been some such movement, but all too little has been done along these lines. As the chemist of today goes forward in his profession, advancing from year to year in responsibility of position and size of organization directed, he will feel in-

creasingly the need for younger men to assume direction of the details of his work. Unless there is soon a strong effort made to advance the professional standards in teaching and to strengthen the college curriculum, a most distressing lack of talent will confront the executive in the not distant future. It will not be enough to have many students studying chemistry. In fact, it is doubtful whether great numbers of students in this field will be any advantage at all. Much greater effort must be made to develop the quality of work done and the standards of performance required in the chemical curriculum so that the men coming out will be the very cream of our student body. In order too that the best and most vigorous minds among the younger men will choose to go along these lines, the rosy future in opportunity for service and achievement must be clearly painted before their eyes.

Persistent advertising of a profession makes for its future success. It is perfectly proper that there should be developed a dignified sense of professional self-importance. There is nothing to criticise and everything to commend in such a policy. Of course we will find amusing results from this and some criticism will doubtless follow from time to time. Particularly striking exaggeration of this sort was spread broadcast by the much-advertised U. S. Marines quite recently. In emphasizing the opportunities of this "wonderful" service, they blazoned forth on billboards the natural steps in achievement for a young man as follows: The steam fitter becomes the steam engineer, the steam engineer the mechanical engineer, and the mechanical engineer finally achieves still higher plane as electrical engineer, who in turn may attain the highest pinnacle by a certificate of proficiency in the U. S. Marines.

We certainly do not agree that electrical engineering should be placed above mechanical engineering—rather they are on a par. Still less would we agree that a certificate of marine proficiency is the pinnacle of all achievements, but the electrical engineer working vigorously through all proper professional channels has put across the idea that electricity is the most modern of activities, and we have through this poster a reflection of the success in advancing this idea.

We wonder what will be achieved when the chemist starts a similar campaign. Certainly we may anticipate that the popular conception of today regarding the chemist will be much improved, for today the chemist varies in the popular mind from a wizard to a glorified bottle washer. Either extreme view is popular. The correct impression of his purpose and function in our modern economic life is rare indeed; and he has only himself to blame.

The Major Remedy

There is today in the chemical profession ample vision, ample knowledge, ample energy, but all potential and undirected. The need is not greater enthusiasm; rather we require co-operation, co-ordination and concerted action. In every case the element of working together must stand foremost.

Approximately 20,000 men in this country today can properly be styled "chemist." Every year the numbers are increasing by thousands. The potential force of this group is tremendous if the group will work together. They can command attention in any field. The professional spirit, quite the equal of that to be found in our major engineering activities, will be assured; and we shall have one tremendous asset which up to the present time the engineer has always lacked—that is, a single professional group.

The American Chemical Society stands today perhaps as great a scientific achievement as has been recorded by any group in any natural science. It has, however, been compelled to neglect practically all of the professional responsibilities to which the engineering bodies in the electrical, mechanical, civil and metallurgical field have given attention. It is these activities and these functions for which the need today is greatest. Individual effort or effort of small groups in individual industries will not suffice. We should not discard the tremendous asset of working altogether in a single big body, including all chemists, organic, inorganic, theoretical, industrial or otherwise. However, this group must more keenly appreciate and more vigorously prosecute these professional lines of effort.

Chemists and Chemical Engineers

On the occasion of the official inspection of the new laboratories at University College, London, Lord Moulton delivered an address on "The Training and Functions of the Chemical Engineer." In this address, as reported in London *Chemical Age*, vol. 2, p. 300, Lord Moulton said that the chemist as opposed to the chemical engineer reminded him of the difference between the mathematician and the mechanical engineer. The mathematician figured out his calculations, and his plans did not wear out. The mechanical engineer, on the other hand, worked with materials that did wear out. When the chemist became a chemical engineer he stepped from the ideal into the material world. His methods were practical, and he found himself forced to follow in the steps of the great chemists without their advantages yet bound to obtain their success. The chemical engineer worked for production on a scale that the needs of mankind demanded and he therefore abandoned the scale of the laboratory. Change of scale was more important than people imagined. It seemed very little different to work with bigger plant, and to deal with more substance than to deal with the same substance on a smaller scale. But just because it seemed not to make so great a difference change of scale was more likely to lead clever men into trouble than almost any change of conditions one could think of. Change of scale was a very difficult thing to allow for, but it was the secret of successful chemical engineering. As an illustration of the expense which change of scale involved, and the reason he put it down as the great characteristic of chemical engineering as contrasted with research chemistry, Lord Moulton said he once knew the head of a great engineering business in the North of England who prided himself on having cooked an ox whole so that it was well cooked in every part. Many people could cook a joint, but he doubted whether any of the professors of the college would undertake to cook an ox whole, and have every part well cooked. There they had the chemical engineer. This change of scale brought into the task of the chemical engineer some very difficult problems, for he had to see that everywhere the right conditions ruled. Whenever Lord Moulton had seen chemical engineering on the scale at which it had to be done to satisfy our wants, it had impressed him that things one never dreamed of as being important became serious considerations when dealing with large masses.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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A Little Homily on The Brooklyn Strike

AS THESE lines are written the Borough of Brooklyn is tied up tight on account of a strike of the street railway employees. They were under agreement not to strike—and the Mayor of New York went to their meeting and took from them a pledge to withhold all action until he should have had a conference with their employers. His Honor is a comedy character whose ambition seems to be to make the laborin' man feel sure that the Mayor is with him, right or wrong, no matter what he does—as long as he belongs to some union. Unless he has a big organization with many thousand votes behind him he is not a laborin' man—down at City Hall. At 2 o'clock in the morning when the night gang left work they had another meeting of their own, and they voted to strike, despite the previous resolution at the general meeting, because somebody is said to have said, which it is admitted was not true, that a number of men had been discharged. Then those who voted against the measure at the general meeting followed the strikers out. Now chaos reigns and brickbats fly.

This speed on the trigger, this German military principle of smashing up everything and making the results as *schrecklich* as possible in order to give emphasis to an opinion, is both expensive and, in the long run, bound to be unprofitable. Now to be a street-car conductor is to engage in a respectable and honorable calling. The intellectual demands may be slight, but some of us do not respond successfully to intellectual demands, and it is well for the world that there are plenty of jobs that do not require the burden of thought. But a respectable and honorable calling does not warrant either one man or a thousand of them to throw a million people into misery and to rob them of their chance to gain a living. Surely the world is neither so stupid nor so bad as to make it necessary to paralyze a whole community every time a number of persons engaged in similar employment want something.

What we need is the application of the doctrine of relativity to life. Relativity teaches us first to consider the dimensions of ideas, and then to compute the effect of their application. That is EINSTEIN'S procedure, and it is a very good one. We talk of collective bargaining, and most of us are disposed to favor the abstract idea, but isn't it time we began to think of what we mean by collective bargaining? What is bargaining? It means to negotiate beforehand; to trade. Its dimensions which we must study, in order to understand the effects of bargaining, are service, or goods, and money. Bargaining means bargaining whether done by two persons or by many. Force or compulsion does not enter into it, because, as soon as it does, bargaining ceases. If A has a house and B wants to buy it, they may bargain to reach an agreement and sale, but if B knocks A on the head and threatens to keep it up until A turns over the house to him at the price he wants to pay, we cannot call it a bargain. A strike is not a part of collective bargaining; it is compulsion, and compulsion inhibits bargaining. Discharging one man or locking out a thousand is not bargaining, either. It is also compulsion.

We are in favor of rapid and effective punishment of the employer who exploits labor; who tricks the men that work for him, or even who does not recognize his great obligations to those who cast their lots with him and throw their lives and fortunes into his enterprise. We believe that every employer is in bondage to his obligations and that the man who is unfair to those who work under him should be deprived of the privilege of administering affairs that involve the employment of men and women. But we are equally convinced that the man who works with his hands by the day is also in bondage to his obligations. And if many of them form a union the union also has obligations, not only toward its members but to the general welfare. The doctrine of relativity applies here too, but we forget it in practice, and so, often, do the strike leaders. Just because we sport a union card is no reason why we should think we have privileges which are denied to others. Neither this nor the election to executive office by a board of directors will release us from our obligations.

Relativity teaches us this, and it is very sound philosophy. We need more of it; and more quantitative thinking. Whenever the Rule of Wrath begins we lose our count, and then there is the devil to pay. Should we not profit by the example of Germany?

Chemical Industries Need Government Help

MORE recognition of the domestic chemical industry on the part of the Government is being demanded. Chemists from all sections of the country are letting it be known that they feel that the Government has a real obligation to this industry, whose recent expansion has been so notable. At present there is no Government agency with an appropriation sufficient to be of material help.

There is a great deal of research as well as the gathering of information concerning industries which can be done successfully only by the Government. The general recognition of that fact has resulted in the constant upbuilding of this governmental activity until certain industries are very well served in matters where confidential information can be submitted to the Goverment by individuals so that all may profit by the reliable statistics which can then be compiled. In the same way the Government has taken up problems in research which are of general application. Most of these are

problems which a small concern could not afford to work out for itself.

While some chemical work is done by the Bureau of Standards and the Bureau of Chemistry, it has been for the most part along specialized lines. A large portion of the work at the Bureau of Chemistry is on food problems. At the Bureau of Standards, as the name indicates, most of the chemical work has been done with the view toward standardization. The general impression conveyed by letters reaching Washington seems to be that the chemical division of the Bureau of Mines should be expanded to take care of the chemical industry in the same way that the petroleum and mining work is conducted. As is well known, the Bureau of Mines is a part of the Interior Department, which is the great engineering branch of the Government.

The chief demand at the present time seems to be for the compilation of information concerning raw materials of the chemical industry, uses for waste products and means of obtaining greater efficiency within the industry. There is also an insistent demand for research, especially in the development of uses for byproducts which now are going to waste. Whether the Bureau of Mines could handle these investigations, except as they involve the use and conservation of minerals, is a question, yet in view of the admitted importance of an American chemical industry to America, it is reasonable to agitate for active governmental interest in its behalf.

Future Lines of Progress in Steel

THE steel industry still finds itself in the position it has occupied since it came into being: in need of making expensive improvements. There is always something more to be done. The steel manufacturer never gets to the position of feeling himself "on Easy Street" with nothing to do but operate his plant as it stands and make the money.

Building of byproduct coke ovens has had a wonderful vogue, as such things go, but with all the additions to coke-making capacity the market for Connellsville furnace coke for two months past has averaged about $18 per net ton at ovens. Those who held back from building byproduct ovens thinking that what others were doing would make beehive coke cheap have been completely disappointed. There is more money than ever in byproduct operations, and those who have byproduct ovens have occasion to carry farther their operations of winning byproducts.

The course of the pig iron market has shown that a steel works is not safe in depending upon the market for supplies. When, years ago, the major part of the merchant pig iron made was used in making rolled steel, the steel industry made the pig iron market. Now the pig iron market is made by the foundries, chiefly the gray iron and malleable foundries, but a considerable part of the bessemer and basic iron made for sale is taken by steel foundries. The remaining works making rolled steel will in most cases find it desirable to build their missing blast furnaces.

As a very large consumer of fuel the steel industry has had forced upon it the fact that it must go in for much greater fuel economy in future, for while coal will decline from the particularly exorbitant prices lately ruling, it will never be relatively as cheap as it was before the war. In addition there is the changed outlook regarding supplies of oil, which the steel industry can hardly count upon as it recently thought it could.

In the matter of introducing labor-saving machinery and devices the steel industry has as much before it as at any time in the past, for high wage rates have come to stay and in addition there is within the discernible future the elimination of the 12-hr. day, which means that in some cases a given improvement will save the work of three men in the twenty-four hours instead of the work of two.

The steel industry has only begun to make special steels. The demand for special steels, suited to the particular purpose, has grown while it slept. For a year past there has been a "sellers' market" in steel and the buyer hesitated to express his new-found wants, being glad to accept almost any kind of steel, but no such condition can last indefinitely.

Possibly in the quality competition that is to come the steel industry will go considerably farther in the matter of vertical integration, carrying its products to a greater degree of finish. Hitherto there has been a strong disposition on the part of steel manufacturers to stop with the ordinary rolled products, carrying vertical integration backward to the minerals in the ground rather than forward into the manufactured wares, but it seems rather unscientific for rolled steel producers to sell large annual tonnages to single consumers, who in turn have but few customers and whose operations are more or less simply forming operations, when success depends as much upon the character of the steel purchased as upon the skill with which the relatively elementary forming operations are conducted.

Whether the steel industry will become more scientific in marketing its wares remains to be seen. It has the much criticised "open contract," but it has been running as full as it could up to date, while the woolen mills, which have the "binding contract," have been largely closed. One cannot predict what the steel market will do, when this year it has exhibited a phenomenon no one would have believed possible, that of about 45 per cent of the production being sold at a set of stabilized prices now seventeen months old, while the rest has been sold practically at what it would bring.

Chairman Bancroft's Report To the National Research Council

WHENEVER Professor WILDER D. BANCROFT writes or says anything it is worth reading or hearing. He has been for the past year Chairman of the Division of Chemistry of the National Research Council, and his annual report of the Division was published in the September number of the *Journal of Industrial and Engineering Chemistry*. The restriction of the chairmanship to a single year's incumbency was designed to provide for the incidence of the greatest variety of tried and experienced directing minds upon chemical research. Instead of systematizing the organization until it runs itself while everybody does routine work, the very opposite is provided for, and this is as it should be. It is easy to kill research with too much system, although in selecting Dr. BANCROFT for the post all possibility of dullness was avoided. He is a man of infinite variety, who couples with this engaging quality the accomplishment of profound scholarship and the habit of thoroughness. As for the work done, he refers

to the reports of the chairmen of the various committees which have already been published. He then proceeds to indicate questions that need answer.

An interesting point which he brings out is the work which is needed and called for along the borderland between chemistry and one or more other sciences. "The conditions at Washington," he says, "are peculiarly favorable for such a development, because the chairmen of the different divisions are under the same roof and can discuss matters informally in the most satisfactory manner. It is easy to see that if we bring together, for instance, men representing three different sciences involved and if each man knows a quarter of a given problem, then the problem is three-quarters solved before any further work is done." And he proceeds to note some of the borderland problems which interest him.

In baking, the American Institute has recently been founded with Dr. H. E. BARNARD in charge and Dr. MORRISON to direct research. The Advisory Board consists of Messrs. BANCROFT, BARNARD, CLOWES, HENDERSON, MCCLURG, MCCOLLUM, MENDEL, MENDENHALL, MORRISON, MARLIN, PRESCOTT and TAYLOR. We congratulate the Institute of Baking on such a distinguished and capable selection of advisers. One of the unanswered problems has to do with the nature of gluten. A high gluten content seems to provide generally for superior bread, but the rule has too many exceptions. Bakers refer to "strong" and "weak" glutens, and yet the different glutens appear to have the same chemical composition. It is not known whether the differences are due to structure or to the presence of salts. Staleness seems due to a displacement in the distribution of the water content between the gluten and the starch. To prevent this is another problem in colloid chemistry. Again, why is homemade bread better than baker's bread? Why is French bread better than American bread and Vienna bread better than the French? Thus far the microscope does not appear to have been used in the study of bread. What will it tell?

The problem of stimulating pine trees to give a better yield of turpentine is discussed at length, the work of TSCHIRCH, HERTY and Miss GERRY is considered with a view to getting more light—and more terps and gum. The plan involves the study of a botanist, a microscopist, an organic chemist and a colloid chemist. Then he proposes the application of similar research to the collection of rubber, and finally to shellac.

The study of protoplasm is recommended in connection with the study of emulsions, and the further study of war gas problems is important in that it opens the way to the study of the chemistry of blisters and burns and also leads up to the important general subject of chemotherapy, which calls for joint research by medical men, biologists and chemists.

Other investigations recommended have to do with special sugars, with the normal weight of men and the search for whatever the regulator may be which determines and controls his normal weight, structural colors, sedimentary rocks—just as the Geophysical Laboratory studies igneous rocks—clay, pressure phenomena within the earth, thunderstorms, surface colors, Brownian movements, adsorption of gases, criteria of purity, quicksands, metallic luster, and educational tests.

Dr. BANCROFT says that the Division is still "long on promises and short on results," and he mentions it apparently with regret. We hope on the other hand that its aspirations will always be greater than anything that is or even can be achieved. This is only possible when men of inspiration lead it.

Pyrolytic Distillation and Pyrogenesis of Hydrocarbons

NOW is the time to choose between the terms "pyrolytic distillation" and "pyrogenesis of hydrocarbons." If one expression is not wide enough in scope for technical purposes, both should be used after precise definitions have been established. W. A. HAMOR, co-author with Dr. BACON of the best treatise on petroleum, is sponsor for "pyrolytic." Etymologically it is a gem. It will make a good team mate for its brother adjective electrolytic, while pyrolysis can associate with electrolysis among the nouns. The second term was put into use in England after BERTHELOT demonstrated the fact that acetylene could be polymerized into liquid hydrocarbons under heat and pressure. That our so-called petroleum cracking process does not come under this class of reactions is amply demonstrated elsewhere in this issue by Mr. PADGETT. In our opinion pyrogenesis should be limited to cases when the benzenoid hydrocarbons are produced.

At a future and probably not distant date we shall hear of pyrochemists. The chemical phenomena of heat well merit special training on a similar basis with electrochemistry. Demands for such training now exist in the petroleum industry and are being met about as satisfactorily as were the unanswered calls for electrochemists voiced by DAY at Niagara sixty years ago.

Cook's Tours à la Mining Engineers

WHEN a technical society—or rather a few fortunate members—go touring, as recently did the Mining and Metallurgical Engineers, they usually return with at least two uniform impressions. One is that they have been spending several days with some very fine people, getting acquainted as would otherwise require years in our modern cities, and the other is that they need quantities of rest and quiet after the exhausting hospitality tendered by the various hosts en route.

Indeed, if the trippers realized what was before them when they start as well as they know what happened to them after it is all over, they could easily be organized into a temporary union with a principal "demand" for a 12-hour day (maximum). Anyone who crawls into a berth at midnight after attending a banquet, only to travel 200 miles and be awakened by the porter at 6:15 the next morning so as to have breakfast and be ready for another 15- or 16-hour "shift" starting at 8 o'clock, has reason to exclaim with the poet, "A truce to so much hospitality!"

Doubtless, though, unionization will fail. We shall have to put ourselves unreservedly in the hands of our friends. But at the same time we hereby serve notice upon the Secretary of the Institute that he will be held personally responsible for arranging it in the future so that in case one day ends in a midnight "athletic contest" the next day may not start before noon! Or, if the next day's hosts insist upon a 10 o'clock start, to demand an earlier athletic contest—for we certainly can't miss anything so exciting!



HUDSON RIVER MILL OF THE INTERNATIONAL PAPER CO.

Fall Meeting of T. A. P. P. I. at Saratoga

Résumé of Special Papers Presented at the Meeting of the Technical Association of the Pulp and Paper Industry—Visits to the Paper and Pulp Mills and Other Plants Allied to the Paper Industry—Social Features—Abstracts of Speeches

THE fall meeting of the Technical Association of the Pulp and Paper Industry was held at Saratoga Springs, N. Y., Sept. 1 to 3 inclusive. The meeting was called to order in the Casino by Chairman Raymond S. Hatch, who after a few introductory remarks introduced the first speaker, Edward B. Ashton, chairman of the Chamber of Commerce. Mr. Ashton greeted the members of the association heartily and welcomed them to the hospitality of the city.

George S. Witham, Sr., manager of mills of the Union Bag & Paper Corporation, replying in behalf of the society, emphasized the appropriateness in the choice of Saratoga for such a gathering, as it was located in the heart of the Adirondacks, replete with the history of paper making. He also spoke in the highest terms of our neighbors on the north who are closely allied with us in the paper industry and who have lived for so many years in close proximity without even so much as a single modern fortification on the whole borderline. Mr. Witham also commented on the lack of foresight on the part of American paper manufacturers in the past in their wasteful manner of lumbering, and strenuously urged the necessity of concerted action in the future to conserve our present timber supply if the paper industry in this country is to remain independent of outside sources.

Improvements in the paper industry due to the application of chemical and engineering technology, and the contribution and importance of paper in the dissemination of knowledge and advancement of education were also brought out.

For the executive committee, Chairman Raymond S. Hatch reported a steady increase of membership since the annual meeting held in New York four months ago, the total membership now exceeding 602. Two members had been lost by death, George C. Sherman and Henry Earl Surface.

It was stated in the report that after long and careful deliberation the executive committee had decided to abandon the idea of publishing a trade journal through the Tappi Publishing Corporation. Instead of this the association is to undertake the publication at least semi-annually of a volume of proceedings, transactions, abstracts of literature and original articles. The committee said that a beginning has been made by the publication of a revised edition of the paper testing committee's report. The work bears the title "Paper Testing Methods," and constitutes a practical treatise on approved modern methods for testing papers by microscopical, chemical and physical means. The work is illustrated and one of the chapters deals with the fibers used or proposed for use in papermaking.

The committee recommended an increase in the annual dues of members and associate members to $25, the subscription for juniors being allowed to remain at $5 as at present. As this necessitates an amendment to the constitution and bylaws, unanimous consent was asked and granted for a suspension of the rules. The amendment was adopted by unanimous vote.

In conclusion the executive committee expressed hearty appreciation and thanks in behalf of the association to the paper manufacturers of the Hudson River and associated industries for the splendid entertainment and educational features which had been provided for the fall meeting.

After various committee reports the remainder of

the first day was devoted to the reading and discussion of the technical papers.

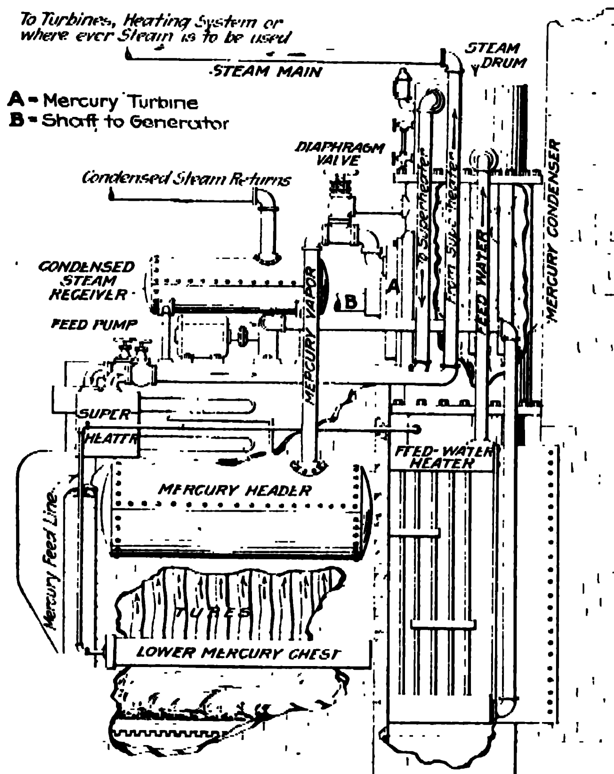
R. E. Lofton and M. F. Merritt of the Bureau of Standards, Washington, gave an interesting paper on a quick method of determining the presence of sulphite fiber in pulp. This method depends upon the selective action of certain dyes for sulphate and sulphite fibers.

New Felt-Cleaning Device

In a paper on "New Felt-Cleaning Device" C. A. Woodstock discussed a new device for cleaning the felts of paper machines without the necessity of shutting down the machine.

This suction effect is adjustable, and can be applied to the felt, which has previously been treated with water or some other cleansing solution to loosen any included material, and clean it without interfering with the operation of the machine. This saves considerable time, effects a large saving in cost and increases the production greatly.

The results in economy on three Fourdrinier paper machines running on newsprint at a speed of 650 to 675 ft. per minute were an increase of production of



SKETCH OF EMMET MERCURY BOILER

12½ per cent, increase of speed 7⅜ per cent and an increase of efficiency of 5½ per cent.

Boiler Room Efficiency Increased by a New Mercury Boiler

Probably the most interesting subject discussed was the mercury boiler designed and described by W. L. R. Emmet of the General Electric Co.

In this device Mr. Emmet has made use of the physical properties of mercury to increase the boiler efficiency. He has designed a mercury boiler in which mercury vapor under a pressure of 10 lb. is first used to drive a mercury turbine and the exhaust mercury vapor is condensed in a surface condenser under a vacuum. In condensing it gives up its heat of condensation to the cooling water, which now becomes hot enough to act as a source of heat energy in an ordinary steam boiler. This steam drives a steam turbine. Great care must be taken to have all mercury lines and joints perfectly tight, as mercury is very poisonous, especially in the vaporous state.

According to *Power*, Mr. Emmet claims that by the addition of this device to an assumed good modern power station, with an increase of 15 per cent in the amount of fuel used, the same amount of steam can be supplied to the steam turbine as under present conditions, and the mercury turbine will generate power equal to about 66 per cent of the power generated by the steam turbine. This results in a gain in station capacity of approximately 66 per cent with an increase of only 15 per cent in the amount of fuel required.

Curtailing Bleach Consumption by Adding Sulphur to Digester Liquor

George K. Spence gave a summary of the results of his experiments on the effect of added sulphur to digester liquor on curtailing bleach consumption. Since it requires 11 lb. of sulphur per 100 lb. of stock to save 92 lb. of 35 per cent bleaching powder there would be very little advantage in its use under ordinary conditions. However, it is claimed that increased strength is produced by its use in the digester liquor, which will furnish material for further experiments in order to determine the extent of this increase.

Automatic Continuous Mixing System

A new automatic method of handling paper stock so as to economize on floor space, labor and power was presented by E. J. Trimbey.

Ground wood and sulphite are furnished continuously, either by gravity or by pumping to their respective compartments of a double vat. Each compartment is provided with an overflow dam and a float valve of special design for maintaining a constant level in the compartment regardless of the rate of flow of stock. Mounted in one end of this double vat is an outlet spout communicating with both the ground wood and the sulphite compartments, and so arranged with a separating partition and an adjustable top that the cross-sectional areas for the outflow of ground wood and sulphite will give the desired proportion of each, and at the same time the total flow can be varied to meet the changing requirements of the paper machines.

In addition to being adjustable for both total volume of flow and relative proportions of ground wood and sulphite, the outlet spout has valuable regulating features which automatically compensate for minor variations in the consistency of each. With a constant head and varying velocity and consistency, a proper design of apparatus can be made whereby the increase in velocity of the paper stock flowing through it can be made to counterbalance the increase in consistency, so that within a given consistency range there will be a constant rate of discharge of dry stock per unit of time.

C. A. Allen read a paper on the Automatic Cooking Control for Sulphite Digesters, which will appear in a subsequent issue.

H. P. Baker, secretary of the American Pulp and Paper Association, as toastmaster at the T.A.P.P.I. ban-

quet, spoke of the part chance had played in the past in the paper industry and how the association was fast doing away with chance and substituting facts in its place. He also emphasized the greater need for a broader knowledge of the paper industry as a whole among the general public.

Other speakers were L. H. Shipman, of the Spanish River Pulp & Paper Co. and chairman of the technical section of the Canadian Pulp and Paper Association, and George Sisson, Jr., president of the American Pulp and Paper Association. Mr. Sisson complimented the members of T.A.P.P.I. on their efficient service and spoke of the spirit of modern business, emphasizing the spirit of co-operation and the tendency to get together to solve the common problems. He also spoke of the ever-increasing demand for paper and of the untold value of research to the industry.

Visits to Plants

Thursday was devoted to visiting the various paper mills located in the immediate vicinity. Automobiles took the members to the Hudson River Mill of the International Paper Co. at Corinth and the Finch Pruyn Co.'s plant at Glens Falls, where the members, divided into small groups, were conducted by guides through the mills.

Hudson River Mill

This plant is situated on a water site which gives an 84-ft. head which is used in two stages to develop approximately 20,000 hp. In addition the plant is equipped with five 520 B & W boilers equipped with Coxe stokers for handling fine anthracite. In the paper mill there are Curtis mixing tanks, nine news and one wrapper machine. The wood room has one Paulson drum, six Portland drums of twenty-five cords per hour capacity. Ground wood mills have fifty-six grinders, six improved first screens, twelve flat second screens, twenty-two deckers and twenty-eight presses. The shredding system consists of Jeffrey shredder, Mitts & Merrill shredder and three Allen mixers. There was stored in the yard for use during low water 22,000 tons of lap ground wood pulp. The pulp is carried into the mill by a belt conveyor, which drops it into a Jeffrey shredder, whence it is taken away by another conveyor to the Allen mixing system. The daily production of the mill is 275 tons news, 12 tons mill wrapper, 60 tons sulphite and 320 tons ground wood.

Finch Pruyn Co.'s Mill

This plant, located at Glens Falls, N. Y., is a ground wood and newspaper mill. It has a total water-power development of 15,000 hp., the rating of the grinder wheels at an average head of 39 ft. being 12,000 hp. There are twenty-five 27 to 32 x 54-in. grinders, which have a maximum production of 200 tons in twenty-four hours. Production for 1919 was 32,061 tons. Grinding is done by the Hall's process method. Tailings run under 2 per cent. The mills make newsprint and hanging. There are three Fourdrinier machines, one 90 in., one 116 in. and one 148 in. with 70 ft. wires; three presses and thirty-two 34 to 48-in. diameter driers. These machines run at speeds of 650 to 675 ft. per minute and at present average of standard newsprint is 775 to 790 lb. per day per inch trim. Average for July was 784 lb. All machines are equipped with Woodcock & Walker felt-cleaning system.

Visit to Paper Machinery Manufacturing Plant

A short recess for luncheon as guests of the Hudson Valley Manufacturers at the Glens Falls parish house was followed by a trip through the Sandy Hill Iron & Brass Works, where the members had an excellent opportunity to see the paper machines and screens in the process of manufacture.

Union Bag & Paper Co.

A plant capable of turning out 14,000,000 bags and sacks daily next took the attention of the visiting members. This factory contains thirty-four printing presses and complete equipment for composing, stereotyping, etc. All printing is done from stereotypes, no original type being used. There are twelve rotary suction presses with automatic feed and counting attachments printing in one and two colors; fourteen platen or hand-feed presses and eight rotary web presses for printing bags in rolls. Total capacity, 1,750,000 impressions daily.

The machine room of the factory contains forty-five machines, all of which make square and flat or old-style grocery bags. The smallest of these machines, making ¼-lb. and ½-lb. bags, will turn out as many as 225,000 bags per day.

In the finishing department the bags were tied in packages of 500 each and wrapped in bundles of heavy kraft paper for shipping. The largest machine room had eighty machines, all making the automatic or self-opening style of grocery bag in sizes from ¼-lb. to 35-lb. The last room visited was equipped with fifteen machines for making various sizes and weights of sacks for flour, charcoal, poultry lime, fertilizers, etc.

Across the river stands the big Fenimore pulp and paper mill of the company. This plant uses the sulphite process and is a model of neatness. The logs are floated to the chipper and the chips carried by belt conveyors to the four digesters, which have a capacity of twenty-five cords each, when they are cooked for seven to eight hours. The pulp from the digesters is then pumped to the mixers and screens to be made into paper.

A three-hour delightful sail on the beautiful Lake George, where the guests were entertained with a concert given by the Union Paper & Bag Corp. band, followed by a luncheon, completed the second day.

Members Visit G. E. Plant at Schenectady and Felt Plants at Albany

Wednesday was devoted to visiting the General Electric Co.'s plant where the society was conducted in small parties through the mammoth plant. Special interest centered in the new mercury boiler and in electrical machinery designed for the paper industry. After a luncheon in the dining hall, at which General Manager Erben welcomed the visitors, the rest of the day was consumed in visiting the felt plants of F. C. Huyck & Sons and the Albany Felt Co. In these plants the process of manufacture of felts for Fourdrinier machines was shown from the raw wool to the finished product.

About 350 of the 600 members attended the convention, which was the largest and most successful gathering yet held. It was with a feeling of great satisfaction for the results accomplished and gratitude to the officials of the various paper companies for their generosity and cordial hospitality that the meeting closed.

The Separation of Air Into Oxygen and Nitrogen

Use of Oxygen in Chemical and Metallurgical Processes Retarded by Inefficiency of Existing Systems for Air Separation—Power Requirements for Theoretical and Existing Systems—Liquefaction of Simple Gases — Condensation and Distillation of Mixed Gases — Improved System for Air Separation

BY FRED E. NORTON

THE industrial use of oxygen gas for welding and cutting has been developed almost entirely through a distribution system involving the use of steel bottles as containers for the highly compressed oxygen. On the other hand, the fixed nitrogen industry demands that the nitrogen be produced immediately at the fixation plant, and hence the separation process becomes a part of the fixation system, because of the enormous volumes of gas to be handled.

RESTRICTIONS OF PRESENT PROCESS

It is evident that if oxygen is to be used for large chemical or metallurgical processes, it will be necessary to install the air separation plant adjacent to the point of application of the oxygen. It is out of the question to expect that bottles or other containers can be used where such immense masses of oxygen have to be considered. Where bottles are employed the charges for interest, demurrage and handling so far exceed the present plant cost of the oxygen that the latter item is almost negligible, and hence the manufacturers are not greatly concerned about the plant cost of oxygen, since it is not a deciding factor in respect to sales. Oxygen is demanded, and the sales price is many times the plant cost. The purchaser's interest need not be considered in this respect.

The case is far different if oxygen in bulk is in question. The development of the application of oxygen in many chemical as well as metallurgical problems is now reduced to the simple one of cost. There is no question as to the desirability or feasibility of applying oxygen to oxidation processes in general, such as the burning of sulphur, the oxidation of ammonia to nitric acid, all smelting operations, and the manufacture of water gas.

FEASIBLE COSTS

The industrial applications of oxygen depend very largely on the cost of the oxygen.

A fair estimate may be made of the value of the oxygen by considering the cost of burning one ton of carbon to CO_2 or to CO.

For high-temperature work, such as iron blast furnaces, the bulk of the coke is burned to CO only.

Taking a base cost of oxygen at 1c. per thousand (16 lb. of oxygen per 12 lb. carbon), we have 33.63c. for the oxygen to burn one ton of carbon (2,240 lb.) to CO, say 34c. If the combustion is complete, the cost would be (32 lb. oxygen per 12 lb. carbon) 67.26c. to burn one ton of carbon to CO_2, say 68c.

It is estimated that for a production of, say, 4,000 cu.ft. of oxygen per minute the cost of oxygen may be reduced to, say, 6c. per thousand (including all fixed and daily charges).

The cost of blowing a smelting furnace with pure oxygen would, therefore, amount to $0.34 \times 6 = \$2.04$ per ton of carbon burned. However, it would probably be advisable to use a blast of, say, 35 per cent O + 65 per cent N of which half the oxygen would come from air to be mixed with the oxygen blast. We may, therefore, estimate that the oxygen blown to the furnace would come equally from normal air without cost, and from a separation plant, at, say, 6c. per thousand, or, say, average cost 3c. It would, therefore, cost $3 \times 0.34 = \$1.02$ for the oxygen to burn one ton of carbon to CO or, say, $2 to burn one ton of carbon to CO_2. These figures are easily seen to be within reason, and include all interest and depreciation charges.

For smaller plants, the cost would rise, and on the scale of existing plants, a cost of perhaps 25c. per thousand would be reached. This is because of the heavy ratio of plant charges for small capacities, and also because in any thermal process the loss per cent diminishes rapidly as the size increases. However, the new system has the advantage in all except the laboratory sizes. It may be said that the advantage increases rapidly with the capacity of the plant, and there is no limit as to size in sight.

A cost of 25c. per thousand for oxygen means $8.50 for the combustion to CO, or $17 for complete combustion (per ton of carbon with pure oxygen). These figures would be halved in the case of 35 per cent O + 65 per cent N mixed blast.

The present indications are that 25c. per thousand is about the limiting cost. For ultimate economy 65 per cent nitrogen is too high.

NEW FIELDS OPENED

Returning to 6c. basis for oxygen. What an enormous field lies open before oxygen at such a cost! The smelting of manganese and chrome, as well as high silicon and carbon irons, is most directly affected. With control of the oxygen content of the blast, and much higher temperature (and available heat), come an approach to electric furnace conditions, without excessive cost.

The possibility of making steel direct from the ore is not to be disregarded. In this connection, a whole new field lies open in the making of carbides by direct heat in an oxygen-blown furnace and in the treatment of these carbides with nitrogen.

The whole nitrogen-fixation industry may very possibly depend on the cheap production of carbides by oxygen-blown furnaces, independent of cheap power, or pure materials of extraordinary cost; and in unfavorable localities. The disintegration of such slags by gas blast instead of by grinding is an incident to this development worth consideration. The developments may take many years, but they cannot begin until a cheaper source of oxygen is available, and this first step is assured in the immediate future, the technical basis being completely solved.

Turning to the applications which are already well developed, the welding of large masses of metal is hampered by the necessity of using acetylene gas to *save oxygen*, and the reduction in the cost of oxygen will permit the use of cheaper *gas*. It may be expected that even the acetylene will be indirectly cheapened by the more economical production of carbide by oxygen-blown furnaces. The welding of tubes and large structural parts thus assumes a new aspect as to cost.

In the matter of gas manufacture, there is the possiblity of driving a water-gas producer continuously. A producer may be fed with raw coal, and if oxygen and steam be mixed in the proper proportions, a continuous partial combustion of the carbon to CO (with a small per cent of CO_2) will keep the remainder of the fuel at a high enough temperature to decompose the steam into hydrogen, and the oxygen thus released will combine with the incandescent carbon to furnish CO. With such a producer, a high quality of gas may be made, quite suitable for use in stoves and incandescent mantles. In view of the rising cost of city gas, this is a most economic advance. It is easy to calculate the approximate cost of gas making, and even if the base cost of oxygen be doubled or tripled, a very great saving is inevitable.

The smelting of all volatile metals, such as zinc, is an obvious application, and many uses of cheap oxygen will appear in this field.

In the manufacture of sulphuric acid, nitric acid, ammonia, and in fact the whole of the chemical industry, oxygen is the live element which carries all else with it. There is no need to multiply the examples of useful application, but there is great need of a better understanding that the cheap oxygen is within reach and that plans for the immediate future should consider this fact.

Existing Systems Inefficient

The costs stated are so far removed from any possibility with the present systems that it may appear that some error may exist in the estimates. The very fact that such costs are possible changes the whole status of the oxygen industry, and makes it difficult for those closely engaged in the oxygen business to credit the figures. It can only be said that the estimates have been very carefully made by means of accurate data, and that the basis of the liquefaction system is one which has a theoretical efficiency of unity.

On the other hand, the existing systems, to which comparisons will unavoidably be made, have a basic efficiency of less than 10 per cent. The demonstration of this fact is not complicated -it is so extremely simple that one is unwilling to accept the evidence of plain facts, because the existing systems give unavoidable prejudice. If the waste of power is kept in mind the whole will be clear.

It is evident that if the very low efficiency of existing systems is due to a mistake in the choice of physical conditions the probability of error of judgment lies heavily on the advocates of such defective systems. It is not to be expected that enthusiastic indorsement will be given to a clear proof of the mistake in fundamental physical conditions which are essential to high efficiency. Unavoidably, the exposition may appear to reflect unfavorably on the judgment as to what may afterward appear to be obvious facts. We wish to emphasize the fact that there is a fundamental error in the separation cycles as developed along the lines of the old processes, and that these processes cannot be improved by "doctoring" them here and there. The basic defects are:

First, the total destruction of the primary work of compression. This is not a necessary requirement of nature, and results from bad thermodynamics.

Second, a false step in the distillation of the air—i.e., the introduction of outside heat into the still.

Radical Change Required in Existing Processes

These matters are of extreme simplicity in themselves —they will be demonstrated in another place. Our object now is to point out that the present estimates are based on new developments, and the figures for cost must not be considered as arising out of trivial modifications of existing processes. We admit at once that no existing system can produce oxygen at a cost which will permit of commercial use in metallurgical processes. By the application of proper thermodynamic steps (which are radical) the existing apparatus can be made to give costs approaching our estimates. The systems would then be distinctly new and have been thoroughly protected by broad patents.

Development Prospects

In view of the wide application of the process, it has been determined to keep it free from exclusive control and yet to preserve the incentive of sufficient control to encourage development in as many lines as possible. No operating system has been constructed, and it will be realized that since high economy may only be reached with a large plant, it is a serious financial undertaking. The history of such developments in the United States is not encouraging. The telephone, telegraph, electric light and air brake are typical of purely American ventures requiring small capital in the beginning and large and steady returns from the first. The exception of the Atlantic cable is remarkable. The railroad, steamship, deep mining, steel making, the gas and oil engine, the airplane, the aniline dye industry, the nitrogen-fixation industry and even the automobile and so many other developments are typical of European enterprise, in the middle stage of developments, if not in the earliest period. So many of these developments originated in this country and languished here for want of capital that there is ample ground, on precedent, for fear of a repetition of history in this new oxygen field. There is not an immediate possibility of great gain, in money, without investment of large sums for plant and development work. The prospect is not enticing from the stock-market point of view.

Retarded Development

While the development of oxygen production on a large scale is undoubtedly an expensive matter, the immense field which lies undeveloped constitutes perhaps the most evident attraction in sight for the adventurous and progressive pioneer in chemical and metallurgical enterprises. Granting that if oxygen be cheap enough, there are numerous applications, it may seem strange that so little has been accomplished in the direction of lower costs for the oxygen.

The situation is not a creditable one to American industry. Our path has been strictly in the footsteps of German and French pioneers, and no independent thought seems to be evident in the design or construction of air separation plants in this country. The

reasons for this conservatism are perhaps good, for apparent commercial reasons; but it is believed that it can be shown that the reluctance to strike along original lines is owing to an imperfect understanding of the real problems and not the nature of the problem itself.

It is a strange fact that the oxygen business today is practically a monopoly, though air is free to all, so the business has the great attraction that nature furnishes the raw material free of cost. Perhaps this fact has hindered development, since cheap raw materials often lead to crude methods. The secrecy which has been maintained for so long seems to be equally based on ignorance and timidity on the part of the commercial element in the oxygen business. The purpose of this article will, therefore, be to clear up such of these obscurities as may lead to at least an elementary idea of the possibility of advance in the direction of lower costs of oxygen and nitrogen and hence in the development of industries which have unbounded prospects of economic advance.

Obvious Difficulties in Air Liquefaction

In the first place, the idea that the extreme cold required to liquefy air in a counter-current system (and this is always a preliminary to the separation into oxygen and nitrogen) is a difficult and dangerous state to reach is false. This idea has been cultivated and imaginary obstacles to air liquefaction have been multiplied by those interested in the protection of existing monopolies. It is a perfectly easy matter to liquefy pure, dry air, and no unusual precautions are needed to do it with standard commercial compressors and a little copper pipe. The use of steel instead of copper apparatus is perfectly feasible, and high pressures are not essential.

The one vital preliminary, however, is always that the water vapor and carbon dioxide in the ordinary air must be absolutely removed, and it may be said that 90 per cent of the problem is solved, so far as the operation of an air system is concerned, when this has been perfectly accomplished.

Without going into details, it may be said that the preliminary freezing of the air down to, say, —100 deg. C. will remove sufficient of the water vapor to permit continuous running of the separation system without clogging or coating of the heat transfer system. By means of pre-coolers, in duplicate, and so arranged that the units are alternately cooled and thawed, the moisture removal is a demonstrated success. This problem is solved. The CO_2 removal may or may not be required, since its ice forms an emulsion in liquid air which does not interfere with an apparatus which is free from restricted passages or small pin-hole throttles. However, it may be cheaply removed by preliminary washing with weak soda or lime solutions in mechanical washers. This difficulty is serious for some types of apparatus, but trouble may be avoided either by the chemical removal of the CO_2 or by a change in the design of apparatus.

The system to be described has no restricted passages and no throttles or other mechanisms which may become clogged with water or CO_2 ice. This is perhaps the most important practical element in the whole problem.

It should be emphatically stated that clean, dry air is easy to separate. Ordinary moist air cannot be liquefied continuously, because of obstructions in the apparatus. It should also be stated that there are many other unsuspected things (solid and gaseous) in ordinary air; and provision must be made to get rid of them, or explosion and choking will occur. These are easily provided for and are matters of good design. It is in respect to such apparently trivial things that great advance is possible in the practical operation of air separation systems. Owing to the past history of the development, it is quite probable that the existing methods do not form a good basis for estimating the possibilities of improvement.

While the existing methods of air purification are crude and unsatisfactory, they are not so vitally defective as the liquefaction and separation cycles which have so far been used. It is not too much to say that this defect is so little understood, even by those familiar with the existing systems, that the argument may fall on ears deaf to the facts, because no sound basis is available to evaluate the real situation. These rather harsh statements are justified by the claims, so often made, that the existing systems do not fall far short of theoretical efficiency.

Elements of Cost

Let us see what the separation of air by liquefaction demands in respect to total cost.

First—Interest and depreciation of plant.

Second—Cost of labor.

Third—Purification.

Fourth—Power.

The first item will depend on the effectiveness of the apparatus—i.e., on per cent oxygen recovered out of the total in the air which enters the apparatus. In a minor degree, it is affected by the efficiency—i.e., the ratio of power used to theoretical power required; since the cost of machinery, such as motors, etc., will depend on the wasted power. However, this item may be set aside, since it will be shown to follow, as a consequence of the proposed improvements, that the first cost of plant will be reduced as compared with existing systems. It is not the controlling variable, though a very large element of cost of oxygen.

The second item, labor, may be set aside as practically the same for all systems.

The third item is of utmost importance, as it affects continuity of operation, and hence the production factor of a given investment. It may be reduced to a point of minor importance, as will be shown.

The fourth item is the critical one, and it is here that all existing systems fail in basic principle to realize in any way the moderate demands imposed by nature as the true cost of air separation. It is very easy to evaluate the power requirements of any existing system.

Theoretical Power for Separation of Air

The separation of 1 kg. of air into oxygen and nitrogen demands simply the isothermal compression of about 0.23 kg. oxygen from 0.2 atm. to 1 atm., and a similar compression 0.77 kg. nitrogen from 0.8 atm. to 1 atm. That is, the two components, oxygen and nitrogen, must be compressed isothermally at atmospheric temperature from their individual partial pressures in the atmosphere to the total pressure of 1 atm. on pure separated gases. And however much the fact may be disguised by complicated stills and interchangers, it is only this effect which the whole must, in theory, produce.

We may take 300 deg. C. abs. (27 deg. C. or 80 deg.

F.) as the temperature of the atmosphere, while the gas will be measured at zero deg. C.

Hence $W_N = 0.77 \times 0.163 \times 300 \log 1.25$
$= 3.649$ cal. per 0.77 kg. nitrogen
$W_O = 0.23 \times 0.1423 \times 300 \log 5$
$= 6.896$ cal. per 0.23 kg. oxygen
10.545 cal. per kg. air

This amounts to $10.545 \div 10.69$, or, say, 1 hp. per kg. of air separated per minute.

Since 1 kg. air has a volume of 0.7734 cu.m. at zero C. we have $1 \div 0.7734 = 1.2931$ hp. per cu.m. air separated per min. giving 0.21 cu.m. oxygen or, say, $1.293 \div (60 \times 0.21) = 0.103$ hp. per cu.m. oxygen per hr. (2.92 hp. per 1,000 cu.ft. oxygen per hr.)

For all practical purposes, we may take 0.1 hp. per cu.m. oxygen as the theoretical power required for separation (per hr.).

Now, existing systems may produce oxygen when the air is compressed to, say, 30 atm. (435 gage). The compression of 1 kg. air to 30 atm. at 300 deg. C. abs. (27 deg. C.) requires (adiabatic 2 stage) $W_A = 2 \times 0.236 \times 300\ (30^{0.2[illegible]} - 1) = 90.2$ cal. per kg. air, or $90.2 \times 1.293 = 116.6$ cal. per cu.m. air.

Since about 5 cu.m. of air is required to contain 1 cu.m. oxygen, and existing processes must compress, say, one-third more air than is separated, we have $116.6 \times 5 \times 1.333 = 777$ cal. per cu.m. oxygen delivered pure, or, say, $777 \div 10.69 = 72.7$ hp. per cu.m. oxygen per min. Therefore, such a plant would require $72.7 \div 60 = 1.21$ hp. per cu.m. oxygen per hr. (34.27 hp. per 1,000 cu.ft. oxygen per hr.). The efficiency would be $0.103 \div 1.21 = 0.085$, or 8.5 per cent, and surely this is not a very creditable figure for a process which may be shown to be reversible in theory.

Existing Systems

There are two systems in use for separating air by liquefaction and distillation.

One of these depends on the cooling effect produced by the simple expansion of very highly compressed, imperfect gas. A simple nozzle may be used, and a small cooling effect may be realized. This cooling has been determined, by experiment, to be about 45 deg. C., when the initial pressure is 200 atm. and temperature 0 deg. C. If the initial temperature is —60 deg. C. and pressure is 200 atm., the drop through a nozzle is increased to 73 deg. C. This cooling effect is therefore equal to $0.241 \times 45 = 10.8$ cal. per kg. for the first case or $0.241 \times 73 = 17.6$ cal. per kg. for the second case.

These figures are interesting, when compared with those for the heat which must be discharged during the separation of the air. This figure was shown to be 10.54 cal. per kg. air, and this is practically equal to the cooling effect possible with a plain nozzle working 200 atm. to 1 atm. and at 0 deg. C.

For the purpose of actual air separation, however, an auxiliary refrigeration machine is used, and by pre-cooling to —60 a margin of $17.6 - 10.54 = 7.16$ cal. per kg. may be had, to abstract heat entering the separation system from other causes, such as conduction through the insulation, or along the metal structure. This analysis is borne out by the practical operation of such machines, which require pre-cooling by a refrigeration machine to secure any useful effect. In this case the main current of separated gases can carry the excess of cooling—i.e., 7.16 cal.—up to the temperature at which the auxiliary system can pick it up, and so discharge the heat to the surroundings.

There is no way possible in nature to increase the cooling by the Joule-Thompson effect, for a given difference of pressure, and starting at a given temperature. Hence this feature is incapable of improvement, except by pre-cooling or by increasing the range of pressure. The pre-cooling appears to be an inexpensive way, and this system really amounts to a double, or binary system; in which the heat liberated by the separation of the air is picked up at, say, —60 deg. C. by a CO_2 refrigeration system, and is then rejected to the atmosphere or surroundings. This is not the usual explanation, but it is a sound presentation of the matter. There is a fallacy in the current idea that this process has a claim to efficiency. The explanation is not difficult.

It will also be found that the other system, which uses expansion engines, has a vital defect in common with the nozzle system and is little better in fact than the nozzle system with pre-cooling refrigerator. The expansion engine may remove 20 cal. or so per kg. of expanded air, and may be said to be from 20 to 25 per cent more efficient than the nozzle system, if the term efficiency is allowable, in a case where the effective work done is less than 10 per cent of the applied work of compression. It may appear that a loss of 90 per cent of the applied work would create some visible or evident result in connection with the apparatus. This is not true; the work of compression may be altogether lost without the appearance of any compensating heat or energy in the system. It is this point which requires clearing up, and it must be said that it is unfortunate that the point has been obscured by defective explanations so that some perfectly simple physical facts have become involved, making the true simplicity difficult to expose. It will be shown that by far the largest loss of power in all existing systems is caused by the simple transmission of heat contents from a high-pressure gas to a low-pressure gas without any apparent or useful effect other than the loss of pressure on the gas. It is not the act of throttling, but the improper heat transfer, which is the true cause of loss of power.

Elements of Liquefaction

To fix our ideas, we may take a simple gas, such as oxygen alone, and suppose this to be compressed to a considerable pressure. We may construct an elementary exchanger in the form of a simple U tube, Fig. 1. Suppose oxygen to be compressed into this tube, which may be kept cold at the U end, so that liquid oxygen will collect in the bend of the tube. An auxiliary refrigeration system may be used to keep the tube cold against inward leakage of external heat. Now suppose a throttle valve be placed in the bend of the tube so that the liquid formed in the high-pressure leg will be expanded, say, to 1 atm. pressure. The result would, of course, be that the liquid would become much colder and would at once evaporate, if it could get any heat. If the high-pressure-entering branch be in close contact with the low-pressure-exit tube, it is evident that the liquid may evaporate at low pressure in the second leg, while condensing fresh liquid at high pressure in the first leg. This is a simple form of the nozzle or Linde system, or perhaps it should be called the Hampson type. This very simple apparatus would

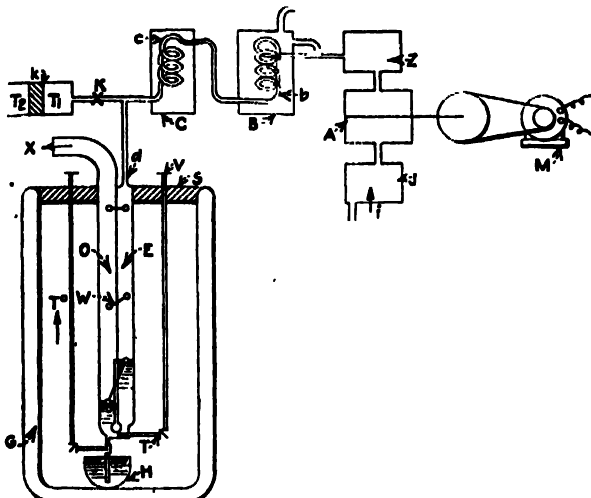


FIG. 1. LIQUEFACTION SYSTEM WITH THROTTLE. LINDE OR HAMPSON TYPE

A Air compressor for 3,000 lb. pressure. *B* Water vessel contraining coil *b*. *C* Vessel with ice and salt freezing solution and coil *c*. *d* Copper tube leading to leg of *U* tube of very thin copper. *O* Other leg of *U* tube. *T-V* Throttle valve. *X* Escape passage for air at low pressure. *G* An insulating chamber. *S* Cover for insulating chamber. *Z* Chemical drier. *J* Chemical purifier. *M* a motor. *k* Porous plug apparatus for demonstration only.

liquefy air or a simple gas if a pressure of 200 atm. be used. The efficiency is absolutely zero if a simple gas be expanded in this way, except that, in fact, the liquid would accumulate at the bend of the tube and a considerable amount of liquid might be removed as liquid air, oxygen, or whatever the substance might be. In all cases, however, the whole of the work of compression will have been lost, because the gas will issue without pressure, and hence cannot be made to do any useful work—i.e., the gas has lost potential.

Now, suppose that the system is maintained cold by an auxiliary refrigeration, Fig. 2, and that the pressure is only slightly less in the exit tube than it is in the entering tube. Then there would be a slightly lower temperature in the low-pressure tube than in the high-pressure one, and the liquid formed at high pressure could be evaporated at slightly lower pressure in the other leg. In fact, the re-evaporated substance could return to atmospheric temperature at practically its initial pressure. A portion of the issuing gas can evidently be used to refrigerate the system against external heat leakage and losses if desired. We are neglecting this factor for the present, in favor of more vital matters. The gas would have been liquefied, and hence would have passed through a suitable state for distillation (the still is not shown), but the larger portion would issue from the apparatus at high pressure.

Recovery of Compression Work the Essence of Low Cost

It is obvious that since the high compression of the original gas is the main cost of the whole operation (which, if lost, becomes prohibitive for large-scale operation), we have an obvious means for recovering the primary compression work—simply to heat the escaping gas at high pressure and expand it in a motor cylinder. If a moderate drop in pressure may be maintained (and in fact such an apparatus may work with less than 1 atm. drop in pressure), it is perfectly feasible to heat escaping gas enough, not only to drive the primary compressor, but even to do some extra useful work. This is in essence the fundamental basis of the Jefferies-Norton system—i.e., to preserve, or conserve, the potential of the compressed gas. This is the primary improvement in the direction of lower cost, simply to avoid throttling.

Now, the case is different for a mixed gas, such as air, from that for a simple gas.

Condensation of a Mixed Gas

A mixed gas will not all condense at constant pressure and temperature, and conversely it evaporates at constant pressure with a rising temperature. If in our air apparatus we have in some way caused the oxygen and nitrogen to separate, we have the further difficulty that air condenses at a much lower temperature than the boiling point of oxygen at the same pressure. That is, air condenses at 80 deg. C. abs., while oxygen boils at 91 deg. C. abs., both being at 1 atm. pressure. Hence, in our simple U tube we must increase the pressure on the air tube until air will condense while boiling oxygen in the other leg, and the air must be compressed to about 2.8 atm. in order that this may happen. Exactly similar relations hold for higher pressures, and a ratio of 3 may be taken as the compression required. It is evident, on the other hand, that the nitrogen will easily be evaporated while condensing air at equal pressure, since nitrogen boils at 77.35 deg. C. abs. and air condenses at about 80 deg. C. abs., both being at 1 atm. pressure. It is plain, therefore, that the desirable feature of maintaining the escaping gases at substantially the pressure of primary compression will meet an obstacle in the fact that the air cannot be condensed by free exchange of heat with the condensed oxygen, and unless this obstacle can be removed, the project of recovering the work of compression will fail. Unless we can maintain sufficient gas throughout the process at a sufficient pressure, we cannot drive our primary compressor *WC* (see Fig. 3) by heating and expanding the escaping gas in a motor, and a very desirable economy will be lost. The device of transferring the latent heat of condensation of the condensing air to the evaporating oxygen will now be described.

The distillation of a mixed liquid is a very complex operation to analyze in detail. A few facts stand out

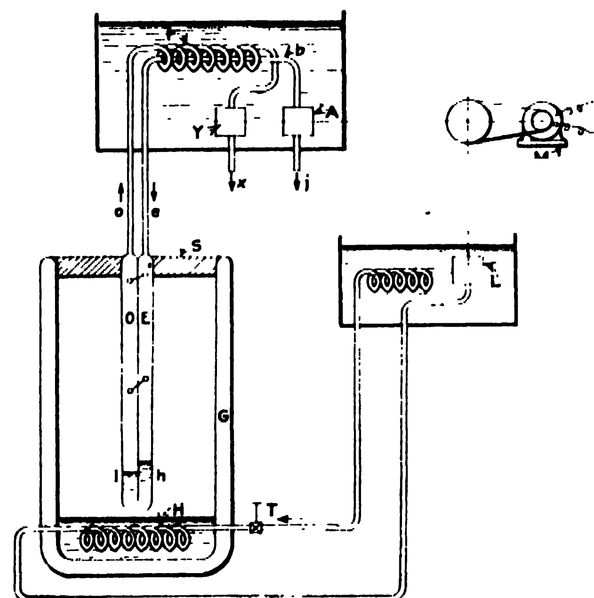


FIG. 2. LIQUEFACTION SYSTEM WITH AUXILIARY REFRIGERATION

clearly, and it will be found that these are the vitally effective points as respecting the economy of the system.

First. The liquid oxygen at the bottom of the still column is hotter than any other part of the column, hence no heat can flow by itself into the oxygen from any other part of the column itself. This fact is self-evident, but the consequences are so far reaching that the full treatment would require more space than we can give. It must be concluded that heat must be added to the oxygen from some outside source, if natural heat flow is to be depended upon. The use of a condensing coil which contains highly compressed air, to be condensed while evaporating the oxygen, evidently amounts to adding heat from an outside source, and this heat must afterward be removed from the still. (This is the plan usually followed.)

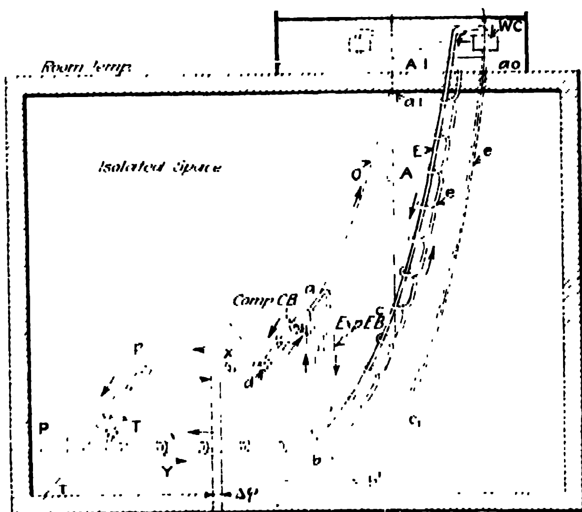


FIG. 3. SKETCH OF JEFFERIES-NORTON SYSTEM IN FORM OF ENTROPY DIAGRAM

Second. The oxygen in any column must reach the bottom as a liquid. This follows since the still functions solely because the descending liquid always contains more of the less volatile substance (i.e., oxygen) than the ascending vapor, and it is the liquid reflux in the column which carries out the separation of oxygen, by "washing" it to the bottom.

Third. The oxygen must be evaporated in exchange for an equivalent amount of liquid air. This must be true, since no system which wastes the cooling effect of such a large amount of such a cold liquid can possibly be commercial or effective.

Fourth. The liquid toward the nitrogen (cold) end of any column will exchange latent heat with condensing air at the same pressure. This is evident, because pure nitrogen always boils at a lower temperature than that of the air mixture at the same pressure. Granted a sufficient quantity of liquid nitrogen, or high-nitrogen liquid, it is possible to exchange this for an equivalent amount of liquid air by free or natural heat flow at equal pressure.

Fifth. The column must be heated at the bottom and be cooled at the top. The logical proceeding is an unusual one, followed by the Jefferies-Norton system alone. It is this very vital step which advances the art of air separation into the region of fair efficiency and effectiveness. Since a cold spot must be cooled (nitrogen end) and a warmer spot must be heated (oxygen end), it is evident that a proper proceeding would be to take heat from the nitrogen and reject this heat to the oxygen.

Mechanical Transfer of Latent Heat

The very simple expedient of placing a coil in the oxygen space at bottom of still, in which compressed oxygen may be condensed, at a pressure very little above the still pressure, will evidently cause the oxygen in still to evaporate (as it must by third condition). The oxygen which has condensed in the coil at the bottom may then be throttled into another coil, at the top of the column, to a low enough temperature to condense nitrogen. If we work the still at 10 atm., we can condense nitrogen at 104 deg. C. abs., by boiling oxygen at 3.5 atm. somewhat below 104 deg. C. abs. In this way we evaporate the oxygen at the bottom of the still in almost perfect exchange for an equal mass of liquid oxygen which would be formed in the coil at bottom of the still. This "transfer" liquid, when throttled to 3.5 atm. and evaporated in the coil at the top of the still, will exchange for liquid nitrogen, which would be condensed out of the vapors at the top of the column. We may have 0.23 kg. oxygen to be evaporated in the upper transfer coil at 3.5 atm., latent heat 49.3 cal. per kg.; the latent heat of nitrogen being 37.5 cal. at 10 atm. Therefore, $0.23 \times (49.3 \div 37.5) = 0.3$ kg. of liquid nitrogen may be condensed at the head of the column in exchange for 0.23 kg. liquid oxygen which is evaporated at the bottom of the column by the action of the cold compressor and the heat "transfer system"—i.e., coils at top and bottom of the still. The liquid nitrogen, which would be condensed at the head of the column, would run downward through the usual form of trays, and would cause the condensation of the air in these trays in exchange for higher and higher oxygen liquids which would pass on to the bottom.

Removal of Losses at High Temperature

If we could build an adiabatic compressor, the transfer of heat could be made without introducing any heat into the still. Taking the operation as a whole, exactly as many calories would be withdrawn from the nitrogen space into the substance of the transfer fluid as would be given up by the transfer fluid to the liquid oxygen which must be evaporated at the bottom of the column. The heat would simply be taken away from the top of the column and would be restored in equal amount to the bottom of the column, but at a higher temperature. The transfer circuit is thus a simple refrigeration system, taking heat from a colder spot and rejecting it to a warmer one, with the necessary result that work must be used up to drive the compressor.

Now, no compressor is perfectly adiabatic. However, it is fortunate that the effect of imperfection is to superheat the discharge of the cold compressor, which, being at a much higher temperature than the still itself, may be cooled by an expansion engine or other refrigeration means. The temperature being 162 deg. for the adiabatic compression of oxygen at 3.5 atm., we may expect 181 deg. abs. for the actual compressor; so that this extra heat has to be removed between —92 deg. C. and —113 deg. C., in order to compensate for the mechanical imperfection of our cold compressor. Now, the amount of heat which an expansion engine may remove per kg. of fluid varies directly as the temperature of the inlet, or the exhaust; and by raising the temperature to 162 deg. as com-

pared to, say, 100 deg. in the older systems, we have increased the cooling effect of the expanders by 62 deg.; or, in other words, the cooling effect per kg. expanded has been increased to 1.6 times that for an engine working at 100 deg. C. abs. exhaust temperature. The superheat may be absorbed into the inlet gas of the expansion engine with a great gain.

The novelty of introducing a compressor to work at these very low temperatures is thus seen to be justified on practical grounds.

The heat transfer system is the direct, natural way to abstract heat from the air to be condensed, and to reject this heat into the oxygen and nitrogen, which have been separated in the still.

The New System

The theory of this subject forms a very interesting problem in thermodynamics. It may appear that the positive statements made may not be susceptible of proof, but there are two satisfactory methods available. The first of these is by actual heat content calculations by means of an entropy diagram. Such a diagram has been made, and has been found fairly accurate, so that heat contents may be compared over the whole range of temperatures and pressures. This is a very intricate matter.

The more satisfactory proof is by means of a simple sketch diagram. The idea is to consider a plain tube (*E-O*, Fig. 3), to be bent to the approximate form of the entropy diagram. The passage of a portion of gas, say the oxygen, through the tube will be represented in heat contents and temperature, if it is remembered that areas under the representative line show heat contents.

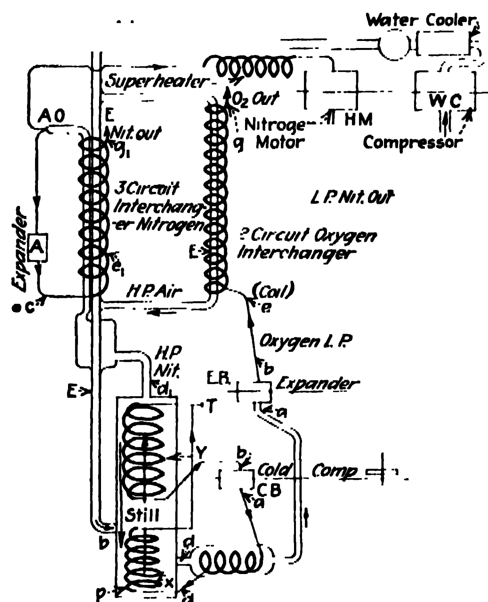


FIG. 4. JEFFERIES-NORTON LIQUEFACTION SYSTEM

By the device of superposed coils, like *e*, which are wound around the plain tube, we may perform various cooling and heating operations on the substance in the plain tube. It will be noticed that the plain tube is in reality the U tube of Fig. 1, but that the throttle has been replaced by a pump. This pump is only ideal, and its function is actually performed by heat in the actual apparatus.

This method is an extension of the Carnot theorem, but using adiabatic-constant pressure lines instead of the adiabatic-isothermal cycle of Carnot. By either method a conclusive proof may be made, but space does not permit the full analysis, which may be found somewhat tedious. We will, therefore, pass on to a description of a working system.

We refer first to Fig. 4 for a schematic apparatus which is lettered to correspond to Fig. 3.

Fig. 3 is a sketch entropy diagram, made closely to scale. Fortunately our proof will not involve any of the peculiar properties of entropy. The working of the apparatus may be followed easily from Fig. 4, which has been reduced to the simplest terms. There are three novel features concealed in this apparent simplicity.

First. The heat exchange is, so far as possible, between gases at as near equal pressure as the friction of the apparatus will permit. That is, the two main currents in the nitrogen-air exchanger E_1 are at equal pressure. The oxygen-air interchanger *E*, however, is cooled by a low-pressure stream, and this is according to the strict theory of the laws of compression of gases in such a system.

Second. The oxygen at the bottom of the still is to be boiled (evaporated) by the introduction of heat at that point, and this heat will be abstracted from the column at the colder top, where nitrogen is to be condensed.

Third. All the expanders work on gas which has passed through the still.

These gases are in both cases warmed up before expansion, by heat which is abstracted from the high-pressure gas in the system. This feature is particularly to be noticed in the case of the oxygen compressor *CB* and the oxygen expander *EB*. All super heating and loss of the oxygen compressor is to be rejected to the *inlet* of the oxygen expander (*a* to *d*, Fig. 4). The cold exhaust of this cylinder is applied to the compressed air in the exchanger *E*, and this exhaust and the escaping nitrogen from the top of the column are cold enough to condense a considerable amount of liquid out of the entering air. This liquid flows into the still, where it is available to neutralize the external heat leakage and other imperfections of the apparatus. This action is aided by the nitrogen expander *A*, which may, in fact, consist of a pair of engines which are powerful enough to produce a considerable amount of liquid air, to protect the system against external heat leakage. The expanders *A* have no other duty than to overcome imperfections of insulation. The whole of the theoretical cooling required by the separation of the air (compression from partial pressure to total pressure of oxygen and nitrogen) would be performed by the pair of engines, compressor *CB* and expander *EB*. In the 10 atm. system, the oxygen would actually be expanded in *EB* to 1 atm., while it would enter at 2 atm. partial pressure, and this overexpansion provides a margin of cooling, since the compressor need only work through a pressure range from 3½ atm. to 10 atm., while the expander *EB* will work from 10 atm. to 1 atm. The device of cooling the discharge of the compressor *CB* by the high-pressure oxygen vapor from the still will again be noted, as it is most essential that the system be stabilized in this way.

The transfer circuit may easily be followed, remembering that oxygen must be boiled at the bottom of the column and nitrogen must be condensed at the head of the column.

The throttle *T* differs from the usual throttle, since the coils at bottom are carried up, so the liquid oxygen will be cooled from its boiling point, at 10 atm., to the temperature of liquid air at the entrance of the still; and hence the release of pressure by the throttle *T* will result in very little fall in temperature and very little evaporation during the throttling. In fact, there would be no loss at this point. This conception is a little difficult to grasp. If the comparison is made with an ordinary water tap, where water, far below its boiling point, is released from pressure without any perceptible drop in temperature, it will be seen that if the oxygen is already cooled to, say, 104 deg. it will evaporate very little in expanding to 3.5 atm., where it boils at 104 deg., while condensing nitrogen in the other side of the tube. This is not throttling in the usual sense. Practically there are certain imperfections of apparatus, but fortunately they may be made to closely approach the vanishing point.

The critical part of this whole system is the possibility of retaining enough nitrogen at high pressure to be superheated to, say, 1,000 deg. F., before expansion in the heat motor *HM* in order to drive the compressor *WC*. If 50 per cent of the original air can be returned to *HM* as superheated nitrogen, the heat will drive the system. The cost of fuel for such a system is very small, since a thermal efficiency of 60 per cent or more is easily reached.

It will be noted that the only useful mechanical effect produced by this system is the separation work—i.e., 10.54 cal. per kg. of air—and this is met by the expansion of the oxygen. The removal of heat leakage has required the expansion of, say, 0.5 — 0.23 = 0.27 kg. of nitrogen. There is left 0.5 kg. nitrogen to be heated, enough to make good these expenditures of power.

Conclusion

The investigation on which these notes are founded has consumed about seven years of research into the problems involved in gas separation. A great mass of information has been accumulated as to the properties of the greatest variety of substances, and the practical side of the matter has been attacked in translating the experimental data into useful form.

It is not to be expected that all points of interest or doubt can be covered in the scope of such a summary as we have been able to make here. There is one fact which stands out clearly beyond any possible doubt: The whole basis of the present oxygen and nitrogen systems is extravagant and uneconomical.

The future of oxygen developments depends on the courage of the industry, in first daring to depart from precedent, and then on active prosecution of both the production and consumption processes. The process of oxygen production is without value unless the demand for oxygen is certain and insistent. We have endeavored to present the claims as to the cost of production fairly, with the view that the application may be as seriously considered. There is no doubt that oxygen and nitrogen will be produced at a price allowable for the fullest development of chemical and metallurgical processes through a process founded on sound thermodynamic principles.

The fact that no ideal process can be carried into practice with perfect effect does not alter the fact that no process which is defective in its basis can be made to exceed its fundamental efficiency. The existing systems are fundamentally defective in two respects, neither being in any way a necessity in the air separation process.

First. The expansion of all the air at very low temperatures, which results in a total loss of primary compressor work, without any compensating benefit.

Second. The introduction of external heat into the still (by the condensation of air at high pressure). The separation of the air requires the compression of the oxygen and nitrogen from their partial pressures at entry to the still to the total pressure on pure gases leaving the still. This means the expenditure of work to a moderate degree, if performed at the temperature of the still. The usual systems violate the natural demands, by compressing air at atmospheric temperature, to perform indirectly the work of separation at a very low temperature, and add to this defective process the further false step of introducing heat into the bottom of the column, which may only be removed by the evaporation of liquid air, as such, without separation.

These defects may be removed by modifications of the cycles; the mechanical processes and the structure of the apparatus may undergo little apparent change.

To secure favorable results:

First. Transfer the heat contents of all high-pressure gases to return current of high-pressure gas. All heat contents of low-pressure gas to low-pressure gas return. Absorb all heat leakage and loss into high-pressure gas at as high temperature as possible.

Second. Carry out all heat leakage and the heat liberated by separation of gas in the smallest possible current of low pressure gas at the highest possible temperature.

Third. Reduce the temperature difference between any two streams of gas, particularly at the cold end of the apparatus, to the lowest possible amount.

Fourth. Exchange the latent heat of condensation of entering fluids, as exactly as possible, for the latent heat of evaporation of escaping fluids, and avoid the production of liquid air by the cooling effect of nozzles or expansion engine.

Fifth. If any compression work must be done to separate any mixture, do this work at the temperature of separation, rejecting all heat to high-pressure return circuit, with subsequent high-temperature expansion to compensate the system.

By careful attention to these principles in detail, there is no doubt that the costs of oxygen (and nitrogen) may be so reduced that all the applications considered in the first part of this article are feasible. This may be accomplished, without introducing any new physical or mechanical actions, by simply following closely the principles of sound thermodynamics as applied to the relation between heat and work, and to the effect of the transfer of heat contents from a high-pressure gas to a low-pressure gas.

The work represented by the transfer of heat from one temperature to another depends not only on the amount of heat transferred but also on the temperature at which the transfer is to be accomplished. The free transfer by conduction of heat contents from a high-pressure substance to the same substance at low pressure results always in the total loss of potential—i.e., in the loss of the primary work of compression of the high-pressure gas.

No separation process which violates these principles can reach any degree of efficiency which deserves the name.

Production of Sodium and Sodium Compounds in the U. S. in 1919

THE production of sodium and sodium compounds in the United States in 1919 amounted to 9,190,000 tons, valued at $114,700,000, according to preliminary estimates made by R. C. Wells, of the United States Geological Survey, Department of the Interior. These figures show a decrease of 10 per cent in quantity and 20 per cent in value as compared with those for 1918. The figures showing the production of the various compounds in 1919 together with the corresponding final figures for 1918 are given in the following table.

SODIUM AND SODIUM COMPOUNDS PRODUCED IN THE UNITED STATES IN 1918 AND 1919

	1918		1919	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
Sodium (metallic)	264	$153,437	(a)	(a)
Sodium acetate	622	460,783	(c) 2,540	$129,400
Sodium benzoate	203	886,058	184	575,000
Sodium bicarbonate	118,535	3,293,153	137,005	3,526,204
Sodium bichromate	28,334	9,868,118	(c) 26,700	6,407,000
Sodium bisulphite and sodium sulphite	16,362	478,482	(c) 2,000	693,000
Sodium bromide	574	438,730	924	493,319
Sodium carbonate:				
Soda ash	1,390,628	35,635,520	981,354	29,824,245
Monohydrate and sesquicarbonate	22,678	482,958	30,796	710,748
Sal soda	82,465	2,020,271	(c) 74,200	22,082,000
Sodium chlorate and sodium perborate	2,413	1,004,250	1,217	64,959
Sodium chloride (b):				
Salt in brine	2,830,600	1,245,265	2,809,000	
Rock salt	1,683,941	5,684,661	1,637,300	27,296,000
Evaporated salt	2,724,203	20,010,435	2,618,200	
Sodium citrate, tartrate, and bitartrate	(a)	(a)	32	56,553
Sodium cyanide and sodium peroxide	9,077	5,361,000	9,196	4,558,126
Sodium iodide	(a)	(a)	12	85,451
Sodium ferrocyanide	4,525	2,690,110	3,437	1,346,285
Sodium fluoride, acid sodium fluoride, and sodium fluosilicate (silicofluoride)	1,879	387,234	(c) 1,680	343,000
Sodium hydroxide (caustic soda)	513,363	31,854,470	347,440	20,368,306
Sodium nitrate (refined)	......	.....	6,512	651,047
Sodium nitrite	1,701	609,779	431	151,621
Sodium phosphate (including all sodium phosphates)	15,630	1,427,947	(c) 17,370	1,935,000
Sodium silicate	317,161	5,870,973	(c) 174,000	3,390,000
Sodium sulphate:				
Salt cake	141,054	2,844,897	(c) 125,470	2,173,800
Glauber's salt	50,715	1,041,070	(c) 45,000	914,000
Niter cake	143,155	595,660	(c) 61,000	169,600
Sodium sulphide	43,490	2,293,304	(c) 19,740	1,249,000
Sodium tetraborate (borax)	26,673	3,907,565	28,518	4,351,891
Sodium thiosulphate (hyposulphite)	26,868	1,051,623	(c) 19,400	897,000
Miscellaneous sodium compounds	390	1,188,792	560	253,513
	10,199,493	$142,788,545	9,190,000	$114,700,000

(a) Included in miscellaneous compounds.
(b) Insley, Herbert: "Salt, Bromine and Calcium Chloride," U. S. Geol. Survey, Mineral Resources, 1919, pt. 2.
(c) Figures for 1919 are partly estimated.

The production of sodium compounds derived from natural sources, exclusive of common salt, amounted to 31,890 tons, valued at $841,903, in 1919, as compared with 24,053 tons, valued at $992,788, in 1918.

Imports and Exports

The imports of sodium salts in 1919 amounted to 522,000 tons, valued at $20,704,000, as compared with 2,111,000 tons, valued at $90,939,000, in 1918. This great decrease in 1919 was caused almost entirely by a decrease in the imports of sodium nitrate, which is the sodium salt imported in largest quantity, the imports of all other sodium compounds having actually increased in 1919 over those in 1918. The imports of sodium cyanide, sodium ferrocyanide and sodium sulphide were notably greater in 1919 than in 1918.

The exports of sodium salts in 1919 decreased about 17 per cent as compared with those in 1918. As the accompanying table shows, this decrease was due largely to smaller exports of soda ash, as the exports of caustic soda and miscellaneous sodium salts show an increase.

DOMESTIC SODIUM SALTS EXPORTED IN 1918 AND 1919, BY CLASSES

	1918		1919	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
Sodium carbonate:				
Soda ash	119,217	$7,805,550	50,481	$2,656,608
Sal soda	6,358	213,855	5,563	178,285
Sodium chloride (common salt)	136,783	1,677,577	119,415	1,396,625
Sodium hydroxide (caustic soda)	48,689	5,602 813	82,116	6,748,762
Sodium silicate	14,125	404 796	12,150	338,818
All other sodium salts		6,587,134		7,226,322
Total		$22,291,735	....	$18,545,420

Effect of the War on the Use of Sodium Compounds

The use of sodium compounds in place of potassium compounds, which was begun of necessity during the war, was largely continued in 1919. The war left the United States with a greatly augmented capacity for producing certain chemicals, especially those used in making explosives and dyestuffs. The manufacture of these materials consumes large quantities of sodium nitrate, all of which is imported, and the work of building up an independent nitrogen industry in the United States has been and still is difficult. The large Government plants projected or built during the war were intended to produce fixed nitrogen compounds in the form of lime-nitrogen, ammonia, and ammonium nitrate. No sodium nitrate produced by the fixation of atmospheric nitrogen has yet been marketed in the United States, but as ammonia is a necessity in the Solvay process of making soda and is used also in making sodium cyanide, any developments in the ammonia industry will eventually affect to some extent the soda industry.

Uses of Sodium Compounds

Sodium compounds are valuable either for their basic part or for their acid part. The price of the compounds that are used for their basic part is very low, as the sodium acts only as a carrier of the other elements in the compounds; the price of the compounds that are used for their acid part differs according to the value of that part. Although the price of soda ash is low, the value of the total soda ash produced annually in the United States amounts to millions of dollars and nearly equals that of the total annual production of lime, which is the next cheapest alkaline substance. Soda ash has many and various applications. It is used in making glass, soap, paper, chemicals, drugs, paints, leather, enamel ware, and cleansing agents, in refining oils, and in metallurgy. The uses of the other compounds of sodium vary according to the elements of which they are composed. The uses of the individual salts of sodium, together with a list of producers of each salt, are given more fully in the chapter on sodium compounds in "Mineral Resources of the United States," published annually by the U. S. Geological Survey.

Prices

The prices of most sodium compounds were considerably lower in 1919 than in 1918. At the beginning of 1919 the prices of nearly all compounds were the lowest for at least three years, but later in the year they improved somewhat and the improvement has continued practically up to the present time.

Legal Notes

By Wellington Gustin

Compensation for Death Hastened by Aggravation of Disease Due to Explosion

As a result of an explosion of a still in 1917 in the plant of the National Aniline & Chemical Co. an employee was apparently but slightly injured in the jaw. While the bruise quickly disappeared, a pain in the jaw continued to increase. Upon an examination a malignant cancer was found. The affected parts were shortly removed by an operation, but the disease recurred within a few months and the employee died within six months after his injury.

The State Compensation Board awarded compensation to the employee's widow on the ground that the accident aggravated the cancerous condition and caused death at an earlier period than would otherwise have occurred, the medical testimony indicating that "a local injury might cause an otherwise slow-growing cancer to light up and develop with great rapidity." The award of the Compensation Board was upheld by the Supreme Court of Pennsylvania.

Obligations Upon Agreement to Surrender Contract of Exclusive Right to Handle Product

The Appellate Division of the Supreme Court of New York has affirmed judgment in favor of James A. Cleveland and another in their action brought against Mason J. Clark for balance due on contract. It appears that on July 3, 1917, a contract was made between the parties whereby Mason should deliver f.o.b. the cars at Arnot, Pa., a bituminous product of coal, which he was producing and selling at a certain price, and Cleveland should sell the product and remit therefor, the contract to be in force to May 16, 1922. In July, 1918, the parties entered into another contract, providing for the cancellation of the former contract and in consideration of the surrender of this contract by Cleveland, Mason was to pay $1,000 down, and balance a later date. Mason refused to pay the balance due after the date fixed. It seems there arose the question of whose duty it was to first perform.

The court said whether the mutual terms of a contract are dependent, so that either party, in order to recover upon it, must show a tender of performance on his part, depends always upon the intent of the parties as gathered from the contract itself.

Where the defendant in a mutual contract is to pay plaintiff certain moneys on a day stated, and neglects to pay them, the plaintiff must tender or offer to tender performance on his part as a condition precedent to his right of recovery for the defendant's default. If there is no express provision in the contract, it will not be assumed that the one party is to pay and give credit to the other for the performance in the future, but upon making the payment he has the right to receive performance by the other party as a condition thereof. Where a contract requires contemporaneous performance, neither party can sue at law until he has, by performance or tender on his own part, put the other in default.

Therefore, the court said, if the subject of the contract was a sale of property, clearly there could be no recovery of the purchase price after the law day without an offer to deliver, as the delivery is the real consideration for the payment.

When the contract was executed and the $1,000 paid, Mason's liability and Cleveland's obligation under the original contract were at an end, said the court. It would be an idle ceremony for Cleveland to hand over to Mason the duplicate original contract which he held; there was no way prescribed in which their rights were to be surrendered. The contract under seal surrendered the original contract, and the rights of Mason thereunder.

In any event the payment of the $2,000 would effectually destroy the original contract, and no affirmative action on the part of Cleveland could be had after such payment, and he was not, therefore, required to do any act, as delivery of his duplicate contract, as a condition of maintaining his suit. Judgment for Cleveland was affirmed with costs.

Loss in Shipment of Menthol Acetate Depends on Duty to Unload Under Contract

A new trial has been ordered in the case of the Barton Lighterage Co. against La Brecque Co., Inc., by the New York Supreme Court in Appellate Term. The facts show that the former agreed to lighter 620 drums of menthol acetate from Greenpoint to the New Jersey Zinc Works on the Hackensack River; that loading of the drums began on March 14, but no evidence is given as to how long it was required to reach the zinc works.

The next evidence is that plaintiff's foreman saw the lighter tied to the bulkhead of the New Jersey Zinc Works on April 8; he did not know when it reached there. When he arrived the lighter was listing about 45 deg., and about five minutes after his arrival the lighter suddenly "groaned," turned over and spilled a number of the drums into the water. All but eight were subsequently recovered. Upon these facts the jury found for plaintiff for the full amount of its contract.

The court on appeal said there was no evidence as to whether the contract for lighterage included the loading and unloading of the drums in addition to their transportation. The contract is silent on that point unless the words "to lighter" include, in addition to transportation, the loading and unloading of the menthol acetate to be transported. If the contract included loading and unloading, then the Barton company did not show performance, for the drums were never unloaded completely at the New Jersey bulkhead, and no evidence accounts for the failure to unload, or for the listing of the boat, said the court. But, even if the unloading was no part of the Barton company's agreement and only a mere voluntary act on its part, still there was no complete performance of the contract proved, for it was the duty of the Barton company at least to transport the merchandise in question to the bulkhead in New Jersey in such a way as to give La Brecque company a reasonable opportunity, after the notice of arrival, to unload it.

No evidence was introduced to show these facts required, and for lack of sufficient evidence upon which to base a finding that the plaintiff had completely performed its contract the judgment in its favor was reversed and new trial ordered.

Production of Motor Gasoline From Heavy Oil Hydrocarbons

A Study of the Possible Specific Reactions Taking Place in Cracking Phenomena—Composition of Petroleum—Action of Catalysts Upon Heating—Deposition of Coke—Composition and Refining of Pyrolytic Distillates

BY FRED W. PADGETT

PETROLEUM consists essentially of a mixture of hydrocarbons which are in the main totally miscible with one another. Organic nitrogen and sulphur compounds are also present in varying amounts, and occasionally oxygen compounds, as well as water and inorganic material in dispersed form. When this complex of naturally occurring hydrocarbons is subjected to dry distillation at atmospheric pressure, the hydrocarbons of lowest boiling point are vaporized proportionally to their partial vapor pressures and pass into the condenser followed by those of higher boiling point as the temperature rises. Varying degrees of fractionation will obtain, depending upon the design of still and method of operation. From the point where gases first appear at the condenser outlet until the temperature in the still reaches approximately 625 deg. F., the products secured are in the main natural—that is, they exist in the crude oil as such. Above this temperature, however, especially if the distillation is carried out slowly, what is known as "cracking" takes place and a distillate is secured which upon re-distillation will yield more gasoline and kerosene, the quality, however, in most cases, not being comparable with that of the natural products.

TABLE I. GASES FROM CRACKING DISTILLATIONS UNDER 100 LB. PRESSURE

From Jennings Crude		2	3
	Deg. C.	Deg. C.	Deg. C.
Temperature in still	340	415	422
	Per Cent	Per Cent	Per Cent
CO_2	1.2	0.5	0 0
CO	1.2	0.5	1.3
Illuminants	15.4	15.3	13 0
Hydrogen	0.0	4 0	4.4
Saturated hydrocarbons	81.5	79.7	81.3
From Paraffine			
	Deg. C.	Deg. C.	Deg. C.
Temperature in still	417	432	437
	Per Cent	Per Cent	Per Cent
CO_2	0.0	0.0	0 0
CO	0.0	0.0	0 0
Illuminants	25.4	37.0	33.5
Hydrogen	0.3	0.9	3 0
Saturated hydrocarbons	74.3	62.1	63 5

If, instead of carrying out the distillation above the 625-deg. point at atmospheric pressure in an ordinary still, one of special design is used and the operation is conducted at a pressure varying from 50 to 150 lb. per square inch, profound decomposition or "cracking" occurs, and a yield of gasoline of 20 per cent or more, based on the original charge of residue or heavy distillate, may be obtained upon fractionating the pressure distillate secured. The residue remaining and the pressure distillate which has thus been freed from gasoline may again be subjected to the process and a further yield of gasoline secured, this being less than in the first case, and decreasing upon subsequent treatment.

The effect of pressure upon the yield of gasoline and the refining loss of sulphuric acid during pressure distillation is illustrated graphically in Fig. 1.[1] The volumes of gas evolved at various pressures during the course of the distillation is shown in Fig. 2,[2] while the variation in temperature during distillation and at various pressures is shown in Fig. 3.[3] The composition of the gas evolved during various stages of pressure distillation is shown in Table I.[4] The oil used in the

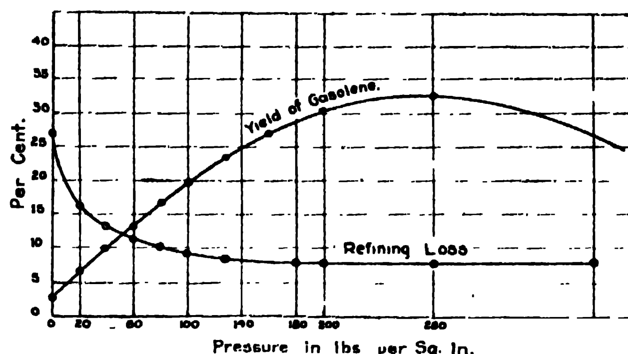


FIG. 1. EFFECT OF PRESSURE ON YIELDS AND LOSSES

above experiments was Oklahoma residual oil, and the apparatus a small experimental still of the autoclave type.

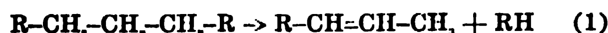
THE COMPOSITION OF PETROLEUM

Considerable knowledge has been gained concerning the composition of the lower fractions of petroleum due to the researches of Mabery and others. The presence of paraffines, naphthenes (cyclopentane, cyclohexane and their homologues), aromatics and olefines has been definitely established, while the evidence points to the presence also of cyclo-olefines, diolefines and possibly acetylenes.[5] Concerning the lubricating fractions of petroleum, there is some evidence pointing to the presence of olefines of high molecular weight which are but slightly acted upon by concentrated sulphuric acid,[6] also diolefines,[6] polynaphthenes,[7] and possibly compounds of the hydrogenated naphthalene[8] and anthracene[8] type. Pressed lubricating oil fractions show, by ultimate analysis, that the average general formula of the hydrocarbons is either C_nH_{2n} or C_nH_{2n-m}.

[1]Brooks, Bacon, Padgett and Humphrey, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 180.
[2]Brooks, *J. Frank. Inst.*, vol. 180 (1915), p. 653.
[3]*Ibid.*
[4]Brooks, Bacon, Padgett and Humphrey, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 180.
[5]The latter three may be formed during the distillation of the crude oil.
[6]Brooks and Humphrey, *J. Am. Chem. Soc.*, vol. 40 (1918), p. 822.
[7]See Gurwitsch's "Wissenschaftliche Grundlagen der Erdölbearbeitung," p. 19.
[8]*Ibid.*, p. 20.

The pyrolytic researches on individual members of the hydrocarbon series have been mainly carried out on the lower constituents and the data are often conflicting, due to differing rate factors and to inaccuracies in temperature measurements. As a general principle it is known that the relative stability of the hydrocarbons to heat decreases as follows: Aromatics, naphthenes, paraffines, unsaturated hydrocarbons. This general principle, however, must be modified in certain cases, as the following discussion will show:

Where paraffines are present in the residual oils the following will represent a reaction undoubtedly taking place to a considerable extent.[9]



$$R\text{–}CH_2\text{–}CH_2\text{–}CH_2\text{–}R \rightarrow R\text{–}CH{=}CH\text{–}CH_3 + RH \quad (1)$$

Gurwitsch[10] believes that the effect of pressure, among other things, is to cause the hydrocarbon chain of the heavier molecule to split nearer the center with resulting decrease in gas formation: namely, *symmetrical scission*. Other reactions, which may take place when hydrocarbons are "cracked," must be taken

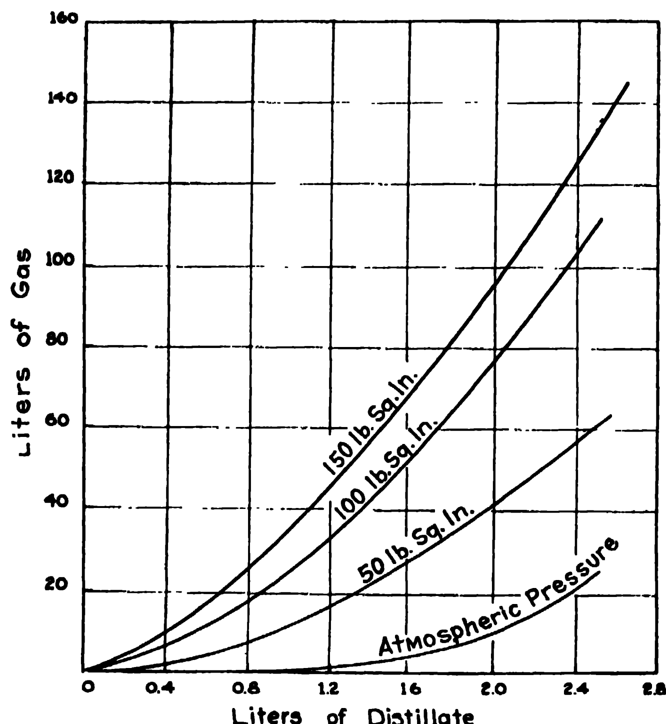
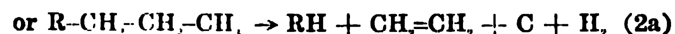


FIG. 2. VOLUMES OF GAS AT VARIOUS PRESSURES

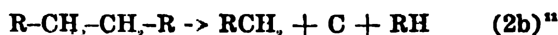
into consideration when it is known that carbon is one of the products always encountered during "cracking."



$$R\text{–}CH_3 \rightarrow RH + C + H_2$$



$$\text{or } R\text{–}CH_2\text{–}CH_2\text{–}CH_3 \rightarrow RH + CH_2{=}CH_2 + C + H_2 \quad (2a)$$



$$R\text{–}CH_2\text{–}CH_2\text{–}R \rightarrow RCH_3 + C + RH \quad (2b)$$[11]

Reaction (2b) is characteristic of "cracking" under pressure.

Local superheating of the oil in contact with heating surface seems to influence the amount of coke formed as well as the character of the hydrocarbons; the asphaltic hydrocarbons, for example, being unstable toward heat and depositing carbon at comparatively low temperatures. Iron also catalyzes the reaction in which paraffine hydrocarbons are broken down into carbon and hydrogen. (See *infra.*)

The paraffine wax of commerce is not readily acted on by anhydrous aluminum chloride, although the same initial substance upon pressure distillation will yield 20 per cent or more hydrocarbons in the gasoline range.[12]

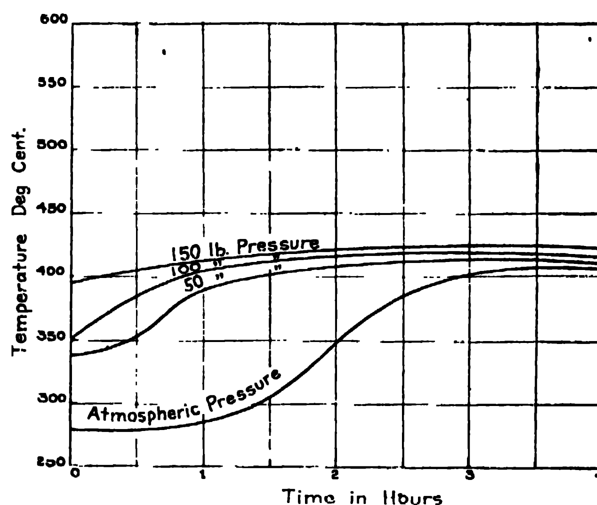
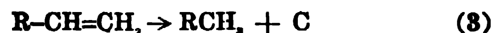


FIG. 3. VARIATION OF TEMPERATURE AND PRESSURE

Since the residual oils from petroleum may contain not inconsiderable quantities of olefines of high molecular weight, aromatics with long side chains, naphthenes with side chains, polynaphthenes, and even diolefines, it is interesting to speculate how these compounds may be modified by the action of heat, pressure and catalytic agents. Olefines, by the action of heat and pressure, tend to polymerize. It may be that olefines found in the residual oils first polymerize to give closed chain compounds with side chains which are then "cracked" to paraffine hydrocarbons and cyclo-olefines which in turn polymerize to give compounds of higher molecular weight and remain in the still. The following reaction is also one very probably for the olefines, the fact that some petroleums give but little gas during pressure distillation lending support to the hypothesis:



$$R\text{–}CH{=}CH_2 \rightarrow RCH_3 + C \quad (3)$$

Olefines may also be modified according to the following scheme,[13] diolefines evidently being present in cracked distillates:



$$R\text{–}CH_2\text{–}CH_2\text{–}CH{=}CH\text{–}R \rightarrow RCH{=}CH\text{–}CH{=}CH_2 + RH \quad (4)$$

This is a reaction which is characteristic of high temperatures.

The naphthenes are known to be more stable toward heat than the paraffines, but with sufficiently severe conditions may be decomposed into diolefines, olefines, cyclo-olefines, benzol, and even paraffines.[14] Hydrocarbons of high molecular weight such as the polynaphthenes, hydrogenated naphthalene and anthracene should be much more unstable than the naphthenes we are familiar with, namely, cyclopentane and cyclohexane.

Anhydrous aluminum chloride readily polymerizes olefines,[15] so that when olefines are present in residual oils, the first action may be the formation of closed chain hydrocarbons with side chains attached which

[9] *Liebig's Ann.*, vol. 165, p. 1. This reaction was first observed by James Young.
[10] Gurwitsch's "Wissenschaftliche Grundlagen der Erdölbearbeitung," p. 145.
[11] In Bulletin No. 14 of the Kansas City Testing Laboratory, p. 95, specific reactions of this type are given.
[12] Brooks and Humphrey, *J. Ind. Eng. Chem.*, February, 1916.
[13] Dunstan and Thole, *J. Inst. Pet. Tech.*, vol. 3 (1916), p. 26.
[14] *Ibid.*
[15] Heusler, *Z. Angew. Chem.*, vol. 9, p. 587. It is known that anhydrous aluminum chloride primarily forms double compounds with the olefines.

are then "cracked" to form paraffine hydrocarbons and cyclo-olefines, with the attendant polymerization of the latter. At this point should be mentioned the work of Pictet and Serczynska,[16] who advance the theory that the residual petroleum oils contain naphthenes with side chains which are acted on by the catalyst to form paraffines and cyclo-olefines, the latter polymerizing immediately by the action of the catalyst and remaining in the still:



$$C_5H_9-CH_2-R \rightarrow C_5H_8 + RCH_3 \qquad (5)$$

Brooks[17] believes that the higher fractions of petroleum contain aromatics with long side chains, basing his assumption mainly on the fact that upon pressure distillation of the paraffine wax of commerce at 100 lb. pressure no benzols are formed, while upon pressure distillation of various residual oils under the same conditions benzol is one of the products found in the distillate. Phenyl paraffine was synthesized by the Friedel and Crafts reaction and the final product was freed from benzol by steam distillation. Either pressure distillation of this synthetic product or treatment with anhydrous aluminum chloride gave a distillate containing benzol. In order to secure a saturated product from a compound of this type it would be necessary that coke be formed along with very little gas, a phenomenon which actually occurs when residual oils are treated with aluminum chloride:



$$C_6H_5-CH_2R \rightarrow C_6H_6 + C + RH \qquad (6)$$

Summing up the effects of heat alone on petroleum hydrocarbon mixtures of the gas oil type, Dunstan and Thole[18] state that at the lower temperatures where "cracking" occurs the products are a mixture of olefines and paraffines; at higher temperatures, near 700 deg. C., a mixture of olefines, diolefines and aromatics prevails, while at still higher temperatures tar and permanent gases containing much methane are produced. From the thermochemical point of view, the main reactions encountered during "cracking" are endothermal, reaction (1) being of this type. In testing the validity of theoretical possibilities the fact that the concentration of the reacting substances has its effect upon the equilibrium, and the law of Le Chatelier, are useful. The latter reads that when one or more of the factors determining an equilibrium is altered, the equilibrium is displaced in such a way as to tend to neutralize the effect of the change. As an example, consider equation (1), which is endothermal. The reaction proceeds toward the right, not spontaneously, but only when heat is supplied. On the other hand, the effect of pressure is to tend to remove the olefines from the sphere of reaction by polymerization, while the paraffine hydrocarbons, by virtue of their stability, find exit by way of the condenser.

That the diolefines have an important bearing upon the formation of aromatics is shown by Davidson,[19] who believes that the diolefines present in the vapors may combine with ethylene to form benzol:



$$C_2H_4 + CH_2{=}CH-CH{=}CH_2 \rightarrow C_6H_6 + 2H_2 \qquad (7)$$

The effect of pressure should be considered from several angles. In the pressure still it has the effect of raising the temperature to the point where cracking takes place rapidly; furthermore it tends to increase the yield of liquid hydrocarbons in the gasoline range by *symmetrical scission* of the molecule; and finally it causes the distillate to be less unsaturated. As the distillation proceeds the lighter products are removed as fast as formed. Those molecules which are decomposable at the lower temperatures disappear at the beginning, while the more resistant ones remain in the heated zone, where, by the nature of the operation, they are later modified as the temperature rises. This gives us the distinction between pressure distillation and "cracking" in the vapor phase only; in the former case the best results may be secured by means of *minimum* "cracking" temperatures, while in the latter case *maximum* "cracking" temperatures generally must prevail in order to secure the desired results, as the entire oil (in vapor form) is subjected to the action of heat for only a limited time. The effect of these conditions on the character of the distillate will be discussed later.

The conditions just mentioned as being peculiar to "cracking" in the vapor phase only are modified to some extent by placing expanding drums at the outlet of the coils, where cracking is permitted to continue by heat carried along with the vapors or formed by the reduction of their speed.

The Action of Catalysts

As a means of improving the quality of cracked distillates the method of hydrogenation, which has been so successful commercially for the production of solid fats from those which are normally liquid, suggests itself as a likely method. Hydrogenation of cracked distillates with nickel as a catalyst is made difficult in the case of petroleum for some reason not well understood.[20] That hydrogenation at lower temperatures without a catalyst does not take place may be illustrated by the following experiment, carried out in the laboratory of the Mellon Institute: A sample of cracked naphtha of iodine value 51 was heated and stirred in the presence of hydrogen at a pressure of 3,000 lb. to the square inch and a temperature of 165 deg. C. for 30 hours, with the result that the iodine value was practically unaffected. If hydrogenation of olefines is to take place during cracking, it must evidently be at the time of their formation.[21]

At higher temperatures (above 200 deg. C.), nickel, platinum and palladium evidently catalyze the reverse action whereby hydrogen is removed from naphthenes, partially or completely.[22] In fact, it has been shown[23] that in the presence of nickel at 600-700 deg. C., Russian crude oil gave only coke and saturated gas composed of hydrogen and methane.

It is interesting to note here the work of Jackson and Lawrie,[24] who claimed that acetylene by the action of high-frequency electric discharge gave a solid polymer which, upon heating, decomposed to methane and liquid hydrocarbons; Losanitsch,[25] who exposed isopentane to the action of the silent electric discharge in vacuo and claimed the formation of hexamethyl

[16]*Arch. Sci. phys. nat.*, vol. 44, p. 400 (1917).
[17]Brooks and Humphrey, *J. Ind. Eng. Chem.*, February (1916).
[18]*J. Inst. Pet. Tech.*, vol. 3 (1916), p. 86.
[19]*J. Ind. Eng. Chem.*, vol. 10 (1918), p. 901. The reaction is characteristic of high temperatures.

[20]Brooks and Humphrey, *J. Am. Chem. Soc.*, vol. 40 (1918), p. 822. On the work of Ellis see *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 1029.
[21]Brooks, Bacon, Padgett and Humphrey, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 180. Whitaker and Leslie [*J. Ind. Eng. Chem.*, vol. 8 (1916), p. 593] conclude that the absorption of hydrogen is greater as the temperature increases, rate of oil flow decreases, and concentration of hydrogen increases.
[22]See Ubellohde and Woronin (*Petroleum*, Berlin, 1911, pp. 7, 9), also Zelinski (*Ber.*, 1912, pp. 45, 3678).
[23]Ostromisslenski and Bujanadsa, *J. Russ. phys.-chem. Ges.*, 1910, p. 195.
[24]*Proc. Chem. Soc.*, vol. 22 (1906), p. 155.
[25]Mentioned by Dunstan and Thole, *J. Inst. Pet. Tech.*, vol. 3 (1916), p. 36.

cyclobutane, also noting the rapid polymerization of olefines and aromatic hydrocarbons; Beilstein and Kurbatow,[26] who secured dinitrobutane by nitrating a petroleum fraction boiling between 40 and 50 deg. C.; and finally Gurwitsch,[27] who reports that florida earth and alumina will cause polymerization of olefines, even at ordinary temperatures and pressures.

In certain patents the presence of substances such as coke, iron scrap, alumina, lime, copper, etc., is specified as catalysts to be placed in the cracking zone, the oil sometimes being mixed with steam before entering. If any beneficial action results from these substances it can be attributed more to surface action than to anything else. Davidson[28] states that iron, cobalt and nickel catalyze the reaction wherein paraffine hydrocarbons are decomposed into carbon and hydrogen.

TABLE II. RESULTS OF THE CRACKING OF TEXAS SOLAR OIL AT ATMOSPHERIC PRESSURE

Contact Substance	Per Cent Boiling Below 150 C	Temp Deg. C	Time in Hours	Per Cent Loss Gas and Coke
None	8.3	500	0.5	8.7
Pumice	8.8	420	2.0	12.8
Pumice	15.6	500	2.0	17.5
Nickel wire	12.3	500	2.5	[illegible]
Nickel wire	18.8	500	5.0	16.5
Nickel on $Al_2O + H$	10.5	500	2.5	15.1
Nickel on $Al_2O_3 + H$	17.9	600	2.0	30.8
Copper on charcoal	14.7	500	2.0	13.1
Copper on charcoal	9.4	450	6.0	12.0
Copper gauze	14.1	500	2.0	11.4
Copper gauze	15.2	500	2.5	11.8
Copper gauze	18.8	500	4.5	17.1
Copper gauze + H_2O	15.5	600	2.0	11.1
Iron	4.5	400	2.7	....
Iron + H_2O	8.6	450	2.0	
Iron + H_2O	8.5	480	3.5	...

In the laboratory of the Mellon Institute,[29] it was found that the "cracking" effect "produced in a given quantity in a given time was approximately proportional to the heated surface in contact with the oil," so that if certain metals which are good heat conductors are attached to the apparatus in such a way that heat be transmitted to the oil through a larger surface, advantages might result. An interesting table of experiments in which Texas solar oil vapors were passed over various contact substances is given in Table II.[30] It should be noted that the use of these substances is not to be designated as additional "heating surface," but rather as additional "surface effect."

The statement that the "cracking" effect is proportional to the heated surface in contact with the oil must necessarily be modified when the basic principle of the process is the use of superheated fluids such as steam or waste furnace gases.

THE DEPOSITION OF COKE DURING PYROLYSIS

It has already been mentioned that one of the most serious difficulties encountered during "cracking" is the deposition of coke. Unless removed from the walls of the apparatus very soon after its formation, the coke produced becomes very hard and is difficult to remove. Superheating (hot spots), consequent softening of the metal and finally "blowing out" may be the result of this condition. A majority of the processes include, among other things, methods of eliminating the coke from the heating surface. Thus the Burton process involves a modification in which false bottoms are used, the Rittman process a revolving rod and chain, the Bacon process vertical heating surface in the presence of liquid,[31] and so on.[32] One patentee specifies the use of steel balls which are passed intermittently through the "cracking" coil.

It is becoming the practice to utilize heavy distillates for the purpose of cracking rather than the residual oils. In this way the amount of coke produced during the operation is materially lessened. For example, a heavy asphaltic oil may be distilled to coke at atmospheric pressure and certain of the distillates used for the purpose of cracking.

While coke is always formed during "cracking" and is likely to cause trouble if permitted to collect on the heating surfaces, the writer does not wish to convey the idea that "cracking" is always a wasteful process. In carefully operated and properly designed pressure stills using distillates as a starting material, it is claimed that the yield of coke, figured in percentage or original oil charged, is almost a negligible factor, and that the total loss during operation is less than 3 per cent of the original charge. In fact, a "cracking" process in a refinery equipped to separate the crude oil completely into its products consumes less useful or "waste" products, and transforms them, largely, into the more useful product gasoline. The density of the charging material for the pressure stills corresponds to that of gas oil, but is, in fact, a mixture of "odds and ends" from various processes in the refinery.

The analysis of pressure-still coke usually shows rather considerable quantities of iron sulphide.

THE COMPOSITION AND REFINING OF "CRACKED" DISTILLATES

Unrefined "straight run" or "natural" gasoline distillates are composed of varying proportions of paraffines, naphthenes, aromatics, small percentage of olefines and a quantity of organic nitrogen and sulphur compounds generally small, but depending upon the character of the original crude petroleum. Oxygen compounds such as naphthenic acids may also be present in traces. Some of the straight run gasolines which have been secured where direct steam was used in the distillation process require little or no treatment with sulphuric acid.

The gasoline distillates produced by "cracking" contain diolefines in addition to the compounds mentioned above, while the proportions of aromatics are larger.

Mr. Jenkins has subsequently submitted to the writer the following data secured from a run which may be considered as more nearly representing average results:

Time of operation (including heating up), 56½ hr.

Fuel used, 175,975 cu.ft. of natural gas [1,000 B.t.u. at 2½-lb. pressure (gage)].

Total oil charged, 44,467 gal. (gas oil, 33.4 Bé.).

Products:

- Gasoline (56-58 deg. Bé., 130 i.b.p., 450 end point), 29.19 per cent.
- Naphtha (48 deg. Bé., 470 end point), 9.13 per cent.
- Kerosene distillate (39-40 deg. Bé.), 31.98 per cent.
- Gas oil (35 deg. Bé.), 3.66 per cent.
- Pressure still bottoms (24-26 deg. Bé.), 20.70 per cent.

[26] *Ber.*, 1881, p. 1620.
[27] *J. Russ. phys.-chem. Ges.*, vol. 47 (1915), p. 827.
[28] *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 901.
[29] Brooks, Bacon, Padgett and Humphrey, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 180.
[30] Brooks, *J. Frank. Inst.*, December, 1915, p. 653.

[31] The deposition of coke on vertical surfaces is only about one-fifth the amount found on horizontal surfaces.
[32] In some refineries it is the practice to simultaneously agitate the oil slightly and to scrape the bottom of the still by means of a sweep with chains attached. In the Jenkins apparatus the oil is circulated rapidly by means of a propeller.

Coke, 1.5 per cent.

Uncondensed gas and other losses, 3.84 per cent.

Cracking in the vapor phase only, because of the higher temperatures generally employed, produces larger proportions of unsaturated hydrocarbons and aromatics than in the case of the pressure still.[33] Cracked distillates upon standing may precipitate a resinous product, which is derived, no doubt, from the diolefines and possesses explosive properties when heated.[34] The disagreeable odor of these distillates is attributed by some to the unsaturated hydrocarbons, particularly the diolefines. Brooks and Humphrey,[35] however, record that this disagreeable odor is to be attributed more to the presence of organic nitrogen, oxygen and sulphur compounds.

Sulphuric acid acts both chemically and physically upon unrefined distillates, colloidal coloring matter being precipitated and dissolved by the acid, unsaturated hydrocarbons, nitrogen, sulphur and oxygen compounds entering into reaction, the last two mentioned being by no means completely removed. The rise in temperature which is especially marked in the case of unrefined "cracked" distillates when treated with sulphuric acid is no doubt due mainly to the diolefines. According to Brooks and Humphrey, the lower olefines react to form alkyl esters, tertiary and secondary alcohols, some polymerization also taking place. Above the hydrocarbon $C_{12}H_{24}$ polymerization takes place to form di- and tri-polymers which contain but one double bond. In the case of gasoline distillates these polymers dissolve mainly in the hydrocarbon layer, raising the final boiling point.

Likewise, neutral esters of sulphuric acid remain in the gasoline and are not removed when the product is washed with alkali solution; upon standing, the product is likely to precipitate a resinous, viscous layer due to these esters.

It is well known that "cracked" distillates are more difficult to refine successfully than the "natural" products. The loss is likely to be large and the resultant product may be colored, this color tending to deepen upon standing. Ellis and Wells[36] report that by hydrogenation of "cracked" gasoline was secured a water white product, but they do not give the specific method used nor the constants for the gasoline before and after treatment. Brooks and Humphrey[37] recommend that the unrefined product be treated with not more than 6 per cent of 85 to 90 per cent sulphuric acid followed by redistillation. The writer and his students find that the best results, both so far as *color* and *odor* are concerned, were secured by treating the cracked gasoline distillate with concentrated sulphuric acid (1.84 sp.gr.) at from 32 to 40 deg. F., followed by redistillation and washing with dilute alkali[38] or sodium plumbite solution.

In the refineries it is customary to mix the pressure distillate with a large excess of straight run naphtha followed by acid treatment and finally redistillation. In this way a satisfactory product is secured.

For purposes of comparison, constants for crude pressure still gasoline and crude straight run gasoline, both from the same crude oil mixture, are given below:

Constants	Crude Straight Run Gasoline	Crude Pressure Still Gasoline
Gravity, Bé. degrees (mod. 140)	57.7	54.3
Refractive index (60 deg. F.)	1.4142	1.4252
Heat of reaction with sulphuric acid (1.84 sp.-gr.), deg. F.	2.5	11
Loss to sulphuric acid at room temp., per cent.	9	16
Loss to sulphuric acid at 32 deg., per cent.	5	8

The writer is indebted to W. A. Hamor and W. F. Faragher for many valuable suggestions and assistance in preparing the foregoing article as well as one describing the several processes in commercial use, which is to appear in this journal at an early date.

[33] In the presence of steam it is claimed that a sweeter product is secured. See, however, Brooks, *J. Frank. Inst.*, December, 1915, p. 659, and Davies, *J. Ind. Eng. Chem.*, vol. 8 (1916), p. 114.

[34] See Ellis and Wells, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 1029.

[35] Brooks and Humphrey, *J. Am. Chem. Soc.*, vol. 40 (1918), p. 822.

[36] *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 1029.

[37] *J. Am. Chem. Soc.*, vol. 40 (1918), p. 822.

[38] The loss under these conditions should be about half that at average atmospheric temperature.

The Finnish Tar Industry

For the year 1919 the Finnish tar production has been roughly estimated at not more than 50,000 hectoliters, with a value of approximately 8,000,000 marks. Import and export statistics are given below for the whole of 1919 and for the first three months of 1920:

Tar Products	1919 Amount	1919 Value Marks(a)	1920 (January-March) Amount	1920 (January-March) Value Marks(a)
Exports				
Tar, hectoliters	11,638	2,604,031	(b)352,789	734,749
Rosin and resin, pounds	789,000	1,459,629	54,800	100,858
Turpentine, pounds	94,600	312,396	....	....
Imports				
Tar, hectoliters	25,794	3,041,709	....	....
Rosin and resin, pounds	3,124,000	5,135,862	1,892,700	5,421,485
Turpentine, pounds	39,600	143,772	....	....

(a) The par value of the Finnish mark is 19.3 cents. (b) Kilos.

Practically all tar exported from Finland is wood tar, while the imports consist of coal and asphalt tar. The great decrease in the tar production of 1919 is attributed to export restrictions and uncertain prices. Such restrictions did not exist in 1918, and as a result production was very high that year. It is said that America is the only country at present in which there is a great demand for tar, but the high cost of transportation prohibits its shipment there, the freight rates being almost as much as the price of the tar itself. Practically all the tar produced now is for domestic use. The high cost of production and the depreciation of the Finnish mark are great handicaps to the industry, and the outlook for 1920 is very discouraging. Until prices stabilize and export restrictions are removed production will continue to be low.

Drop in Chemical Trade at Hongkong During 1919

There was little life in the trade in chemicals at Hongkong during 1919, and the United States played a minor part in what trade there was, though efforts were made during the year to secure supplies in some important lines from American manufacturers. The value of the trade increased from $2,264,149 in 1918 to $2,572,755 in 1919. Imports of saltpeter, which is the heaviest item in the list, were valued at $459,659 and came from India. There were practically no imports of saltpeter in 1918, the export from India being prohibited. Imports of soda ash were valued at $228,342, compared with a value of $120,014 in 1918, and came almost entirely from Great Britain. Caustic soda reached a value of $194,696, compared with a value of $210,411 the previous year. Two-thirds of it came from the United States and the rest from Great Britain. There was a decrease in the import of acids, most of which came from Japan. Bleaching powder, calcium carbide, phosphorus and glycerine showed decreases, while imports of alum, borax, quinine, chlorate of potash and sulphur were increased.

Data on Operation of Continuous Type Lime-Soda Ash Water Softener

By R. F. Catherman and H. C. Fisher

A NUMBER of articles have been published from time to time, giving the theory and practice of water softening, using the intermittent system. The following remarks are of different nature and discuss the problems encountered in the operation of a continuous water softener using lime and soda ash as the precipitating agents. The information given here was gained during the operation of a Booth Continuous Water Softener during a period of six months, sixteen hours per day. Before the operation of the new West End power station of the Union Gas & Electric Co., Cincinnati, Ohio, power was generated at the old Plum St. station, which was situated on the Miami and Erie Canal, the waters of which were used for boiler feed and condensing purposes. The apparatus mentioned was used to prepare

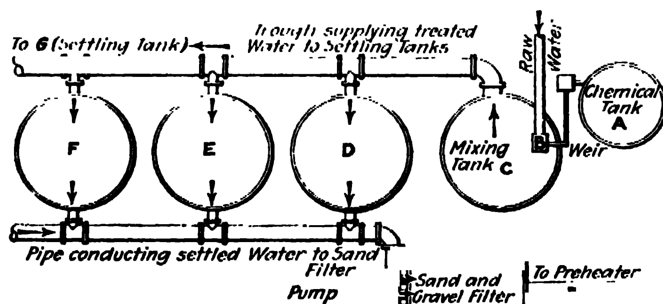


FIG. 1. CONTINUOUS TYPE WATER SOFTENER

water for the boilers, a task that was difficult because of the many variable factors entering into it.

The general layout of the plant is shown in Fig. 1. Water from the canal entered the mixing tank *C* from the automatic weir *B*, where chemical solution from tank *A* was pumped through *B* into tank *C*. The treated water then passed along a trough to settling tanks *D*, *E*, *F* and *G*, after which it was forced through

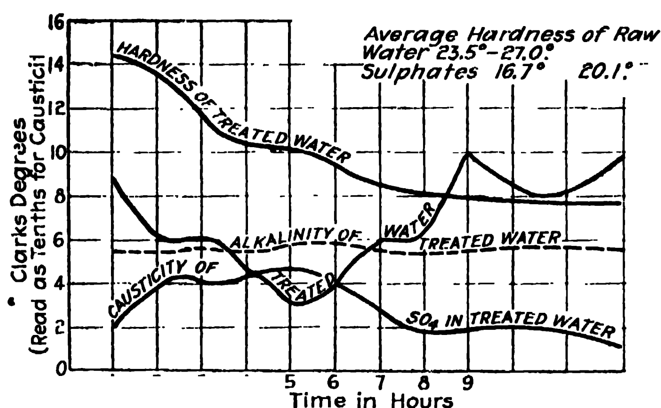


FIG. 2. SYSTEM BEING BROUGHT TO EQUILIBRIUM

a sand filter and up into a preheater. Specific dimensions have no particular bearing on the discussion and will, therefore, be omitted. (Capacity of softener—14,000 gal. per hr.)

Water Supply Variable

The fundamental part of the whole system was the weir, which was so arranged as at all times to admit 650 parts raw water to 1 of chemical solution, by volume. Theoretically, knowing this relation and the constitution of the raw water, the necessary charge can be calculated. However, this was not practical, considering the raw water from the canal. This stream was used as a means of sewage disposal by a large number of industrial firms in the Mill Creek Valley, such as tanneries, dye works, soap factories, distilleries, etc. Using

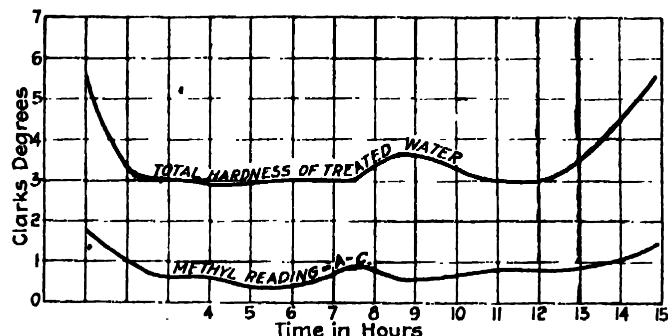


FIG. 3. VARIATIONS IN TOTAL HARDNESS WITH CHANGES IN METHYL READING

Clark's soap solution, which was considered sufficiently accurate for the purpose in hand, the hardness of the raw water was found to vary widely between 15 and 40 deg., a constant condition never being maintained. Sulphates usually constituted 50 per cent of this total hardness. Analysis showed calcium, magnesium, barium and iron to be present in amounts decreasing in the above order. Besides these minerals, large amounts of organic matter were present, sometimes to such an extent that the quantitative analysis was rendered very difficult. As will readily be seen, the above conditions, combined with extremely variable loads on the system, presented a difficult problem in softening the water.

Analytical Data Determinations

Assuming that the reader is acquainted with the chemistry of water softening, using the lime and soda ash method, the quantitative reagents will be discussed. The total hardness of the treated water was found, using Clark's soap solution so standardized that 1 c.c. was equivalent to 14.3 parts of hardness per million parts of water, expressed as $CaCO_3$. Titration of a sample of 100 c.c., using hydrochloric acid of Clark's degree strength and phenolphthalein as an indicator, gave the causticity or *C* reading. Further addition of methyl orange and continued titration gave the alkalinity or *A* reading. The difference between them, *A* — *C*, was termed the *M* or methyl reading. Since the water was acid in character, these readings were obtained on the raw water with the exception of *C*.

Interpretation of Data

As before stated, the variable factors in the system made it impossible to calculate the chemical charges. Upon assuming control of the plant, therefore, experiments were performed to obtain relationships between the *H*, *C* and *M* and the *A* readings. Fig. 2 shows the relations during a period when the system was being brought to equilibrium. It shows that as the hardness decreases, the *M* reading approaches a value that is constant for any given raw water. Considering another typical period as shown by Fig. 3, it is seen that as *M* deviates markedly from the equilibrium value of that particular water, *H* rises. Explanation of these facts may be as follows: Hydroxyl ion must be present in amount sufficient to precipitate all bicarbonates and still provide a slight excess over this amount. By the law

of mass action, this excess increases the precipitation and also provides for any sudden increases in the temporary hardness of the raw water. During the above period, Na_2CO_3 is removing the sulphates, and is also provided in slight excess. Consider a case when the hardness of the raw water is decreased, both temporarily and permanently in approximate proportion. Such a case indicates that the excess chemicals cause the production of hardness, the $CaCO_3$ forming a gelatinous precipitate



$$Ca(OH)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaOH$$

Too large an accumulation of carbonate precipitate in the settling tanks was always accompanied by an increase in hardness despite the condition of the causticity and alkalinity, hence the justice of the above statement

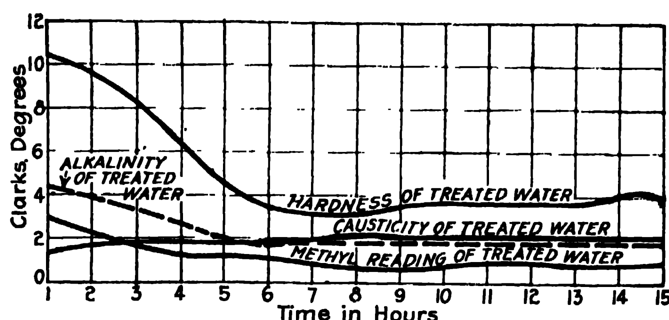


FIG. 4. SYSTEM APPROACHING EQUILIBRIUM

seems established. The excess NaOH gives rise to a high C reading, which, when combined with the high H and A, instantly showed that a too large excess existed, and steps were always taken to remedy the condition. Partial drainage of settling tanks always facilitated matters, at the same time preventing a high alkalinity.

Calculation of Lime and Soda Ash Charges

Formulæ for the calculation of charges, as given by the designers of the plant, were based upon the findings of the American Public Health Association. These principles are sound, but must be interpreted with great care in all cases. The specific directions given were somewhat fallacious, as proved by long periods of inefficient operation experienced in their use. As mentioned before, there was an equilibrium point which marked the lowest attainable hardness. This point was defined by the titrations, the methyl reading being the most significant. Efforts were always bent toward keeping the hardness between 3 and 4 deg. Clark. In this range of hardness, as shown in Fig. 2, the typical readings were identified by methyl readings averaging from 0.6 to 0.8 deg. Of course, it must be understood that the constant changes in the constitution of the raw water made actual calculations and results variable, but examination of typical report sheets shows the truth of the statement. Since direct calculations were not feasible, resort was made to the data for a solution of a different type. Taking a problem for explanation, let the following be the conditions:

Treated Water					Charge					
Time	H	C	M	A	Time	H_2O, In.	Lime, Lb.	Soda, Lb.	Lime, Lb.-Ft.	Soda Lb.-Ft.
7.40 a.m.	8.7	0.9	1.6	2.5	8.15 a.m.	12	165	32.0	165	32.0
9.20 a.m.	8.9	1.5	1.1	2.6	9.40 a.m.	6	92.5	27.5	185	55.0
10.50 a.m.	7.5	1.2	0.8	2.0	11.10 a.m.	6	100.0	30.0	200	60.0
1.00 p.m.	4.7	1.0	0.8	1.8	1.15 p.m.	6	108.5	30.0	217	60.0

(and so on through the day)

Calculations were found to obey the following proportions, in which the only factors that entered were those concerning the condition of the treated water, an obvious fact since the condition of the raw water is reflected in that of the treated water. In fact, the hardness of the raw water was only used as a comparative basis for the approximation of the charges needed when starting the operation of the plant after having, for some reason or other, had it out of service. As found, $C = 0.9$ deg., $M = 1.6$ deg., and $A = 2.5$ deg.; therefore knowing that that value of C is too low and that the value needed is probably 1.5 or a similar one, the ratio of these values is equated to the ratio of the last charge of lime to the unknown one. (All charges based on foot depth of chemical tank.)

$$\frac{\textit{Existing } C}{C \textit{ necessary for equilibrium}} = \frac{\textit{Last charge of lime}}{\textit{New charge of lime}} \quad (1)$$

Knowing also that the equilibrium value of M is a fixed quantity, the next step is to form a ratio between values of M in a similar manner.

$$\frac{\textit{Existing } M}{C \textit{ necessary for equilibrium} + \textit{correct } M} = \frac{\textit{Last charge of soda}}{\textit{New charge of soda}} \quad (2)$$

ing the above:

$$\frac{0.9}{1.5} = \frac{100.0}{x} \qquad x = 166 \textit{ lb. lime} \quad (1)$$

$$\frac{2.5}{2.3} = \frac{35.0}{x} \qquad x = 32 \textit{ lb. soda ash} \quad (2)$$

The variations from the actual calculated results, as seen in parts of the given tables, emphasize the personal equation which enters the operation of a continuous type water softener.

Experiments With NaOH

During a period of three days experiments were tried with the use of sodium hydroxide as the softening agent. The theory leading to the use of caustic soda was based

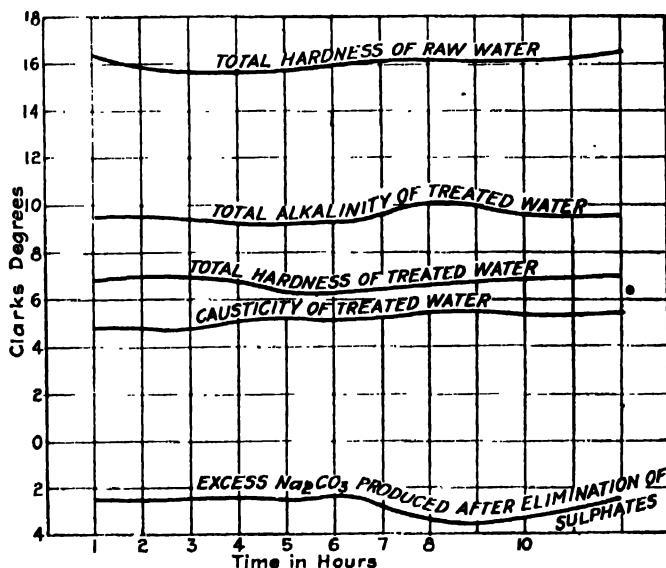


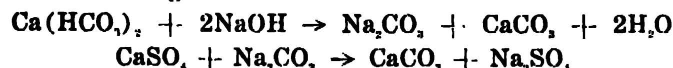
FIG. SYSTEM AT MAXIMUM EFFICIENCY

on the consideration that the bicarbonates would be precipitated by the hydroxyl ions, as happens with the use of caustic lime, producing simultaneously sodium car-

DAY OF BEST EFFICIENCY (USING NaOH)

Raw Water				Treated Water								Charge			Filter Temp.	
Time	H	M	SO_4	Time	H	C	M	A	HCO_3	OH	CO_3	Time	H_2O, In.	Soda, Lb./Ft.	Time	Deg. F.
7 30 a.m.	16 4	7 8	8 6	7 40 a m	6 8	4 8	4 6	9.4	0 0	0 2	9 2	8 15 a.m.	24	110	8.00 a.m.	84
				9 15 a.m.	6 8	4.6	4 8	9 4	0 0		9 2	No charge			10.00 a.m.	85
				10 30 a.m.	6 7	4 8	4.4	9 2	0 0	0 4	8 8	No charge			12.00 m.	84
10.40 a.m.	15 6	8 0	7 5	11 15 a.m.	6.6	5 0	4 2	9 2	0 0	0 8	8 4	No charge			2.00 p.m.	86
				11 50 a.m.	6 6	5 0	4 0	9 0	0 0	1 0	8 0	No charge			4 00 p.m.	89
				1 15 p.m.	6 3	5 0	4 6	9 6	0 0	0 8	9 2	No charge			6 00 p.m.	78
1 20 p m	16 0	8 6	7 4	2 30 p m	6 4	5 3	4 8	10 0		0 4	9.6	3 50 p.m.	18	105	8 00 p.m.	80
				5 00 p m	6 5	5 2	4 4	9 6	0 0	0 8	8 8	No charge			10 00 p m.	79
				7 00 p.m	6 9	4 4	5 0	9 4	0 0		10 0	No charge				
				8 30 p.m.	6 8	5 0	4 8	9 8	0 0	0 4	9 6	9 45 p.m.	18	105		

bonate, which would react with the sulphates present, thus removing them.



$$Ca(HCO_3)_2 + 2NaOH \rightarrow Na_2CO_3 + CaCO_3 + 2H_2O$$

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

The comparative success of the experiment suggested a few questions:

At what period during the experiment was precipitation of sulphates initiated?

What was the behavior of the causticity? The alkalinity?

What factor controlled the lowest attainable hardness?

Examination of Fig. 4 shows that the permanent hardness was precipitated from the beginning of operations, that no hydroxyl was present at that time, and that as the causticity increased the total hardness diminished and the alkalinity remained constant. Applying the correct formula, it is seen that for the system approaching equilibrium the HCO_3 averaged 5 deg. as the SO_4 decreased from 8.9 to 1.4 deg. The day of best efficiency is shown in Fig. 5. Since that day is typical, the calculations are given in the accompanying table.

The large carbonate readings are attributed to the total elimination of sulphates and the consequent production of excess Na_2CO_3. Owing to the many factors entering the system, nothing specifically numerical can be stated concerning this. One outstanding fact is presented by the data—namely, that if a constant charge can be used after reaching the equilibrium point, the total alkalinity will not increase. An increase in the concentration of the charge, after reaching that point, is accompanied by a rapid increase in the alkalinity.

Union Gas & Electric Co.
Cincinnati, Ohio.

Gas Appliance Investigations by the Bureau of Standards

The investigation of gas-burner design and operation, begun last year in co-operation with the industrial fuel committee of the American Gas Association, has been continued actively throughout the year. This work is an essential preliminary to investigations which have been in mind for several years looking toward increased efficiency in the use of gas. The proper design of air shutter, gas orifice and burner throat to give the maximum injection of air under ordinary conditions was the part of the problem particularly assigned to the bureau. Some months were spent in designing and developing suitable apparatus for making the necessary measurements of the air and gas, but the time thus spent was well worth while, as the equipment developed proved so satisfactory that results have been obtained with unusual rapidity. This work has been done on experimental burners representing a wide variation in dimensions.

Discontinuance of Crude Camphor Export Allotments by Japan

The Japanese authorities have decided to discontinue the allotment of crude camphor to camphor refiners in the United States and other countries foreign to Japan. This step has been taken as a measure of relief to the Japanese camphor refiners, who are in serious straits, owing to the depression in the celluloid industry. Japanese camphor refiners are concerned with nothing but camphor, while it is understood American camphor refiners are concerned with that product only as one of a number of others with which they can keep their plants busy. It is therefore believed that American camphor refiners will not be especially inconvenienced.

In order to offset any possible loss, the authorities have decided to allot to refiners in the United States, at a special discount, 15,000 lb. of refined camphor a month. During the year ended March 31, 1920, only about 64,000 lb. of crude camphor was allotted to camphor refiners in the United States. A much greater quantity of the refined, however, is allotted, so that American refiners may, with the special discount and the greater quantity, obtain at least their usual profit for handling camphor. The price for refined camphor is 290 yen ($144.56) per 100 lb.

This action does not alter in any way the allotments of "B" and "BB" grade camphor to celluloid manufacturers. In fact, the authorities are hopeful of being able to increase production during the fall and winter of this year so that allotments to celluloid manufacturers may approach nearer the maximum figures than has hitherto been the case.

New Electric Power Plants in Italy

In the territory of Treviso the Società Adriatica di Elettricità, together with the Società del Cellina, is running two hydro-electric power plants, which are situated at Fadalto and Nove, on the lakes of Santa Croce and Morto, capable of producing, respectively, 20,000 and 8,000 hp.

On account of the unusual demand for electric energy for illumination, industries, drainage installations and agriculture, due largely to the prohibitive price and scarcity of coal, these two societies have decided to immediately execute a program for augmenting their production, and both are working at present in order to transform their plants and increase their production to approximately 280,000 hp.

Once the work is accomplished, they will dispose of 700,000,000 kw. of energy, in comparison with 32,000,000 kw. at present, which would mean a saving for Italy of about 1,000,000 metric tons of coal per year.

To carry out the program the societies will have to spend about 220,000,000 lire in five or six years.

Practical Notes on the Design and Treatment of Steel Castings*

A Discussion of Foundry Practices Necessary to Avoid Cracks, Draws, Honeycombing, Cavities and Such Defects—The Importance of Heat Treatment Is Emphasized, It Being Noted That Correct Methods Give Castings Equal to Forgings in Physical Properties

BY GEORGE F. PRESTON

IT IS much to be regretted that, between engineers and steel-founders, there is so little interchange of the knowledge gained by experience on the subject of the production and treatment of steel castings, a subject of very considerable importance, as greater reliability in steel casting would result from a better understanding of requirements and difficulties by users and suppliers.

Steel castings are used extensively for very diverse purposes. Some difficulties which have arisen in the foundry have been due to the non-appreciation of the fact that, at the recalescence point Ar_3 in the cooling curve of steel contraction is arrested and an actual expansion takes place. In an ordinary 0.3 per cent carbon

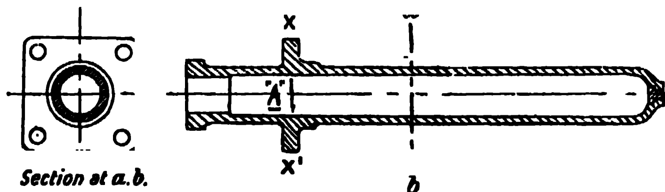


FIG. 1. CYLINDER WITH DIFFICULT BED PLATE

steel the expansion between 690 and 650 deg. C. is approximately equal to the amount of contraction between 790 and 710 deg. C.; therefore in some castings of intricate design reversals of stress do not occur simultaneously in all parts. If such castings are left in the sand or on the floor, cooling at unequal rates in various parts, contraction will be taking place in some portions, while in others expansion will occur, when adjacent members are in a plastic or weak condition, resulting in pulls or cracks. When such difficulties due to reversals of stress occur, modification in design, so as more nearly to equalize the thickness in critical parts, affords one means of remedy. Another is by chilling or using one of the various methods, not altogether looked on with favor by the engineer, for making the thicker sections cool more rapidly where feasible, or, for any other reason, not undesirable.

USE OF CHILLS

Most steel-founders have probably experienced cases where the use of chills has been followed by cracks in the casting, through the effect of using such chills not having been fully considered. An alternative method which might be adopted for some castings is to arrange for the cooling from a temperature above 770 deg. C. to take place in a preheated furnace, care being taken to strip the casting at a temperature sufficiently above this to enable it to be sealed up in the furnace before the temperature has fallen to the danger point. This method was adopted with success in the case of a casting for a ship of world-wide repute, having a heavy flange, or seat, about the middle of its length, after several unsuccessful attempts had been made to obtain a satisfactory casting by other means.

Cases occur where the engineer would be put to increased cost, or experience a difficulty, by omitting some portion objected to from the founder's standpoint, as, for example, in a cylinder or tube such as that shown in Fig. 1, having a heavy flange, *XX'*, 2 to 4 ft. from the mouth, and used only for bolting the cylinder on to its bed plate, which present two difficulties to makers. One is to feed the square flange to insure soundness; the other, which is possibly of more consequence, is to prevent pulling in the bore of the cylinder about the center of the width of the flange at *A*. In such cases probably no really serious objection could be raised to introducing in this heavy flange a frame (Fig. 2), previously cast in steel, to act as a chill, thus equalizing the rate of cooling and also insuring an absence of cavities in the surrounding metal. There would be little theoretical and probably no practical loss of strength, as unless the chill was of excessive thickness it would to a large degree be fused by the fluid steel.

FEEDING HEADS

In the case of important castings subjected to severe stresses, such as large gun mountings, etc., the fullest and most careful consideration should be given by the designer to the placing of heavy masses or sections of

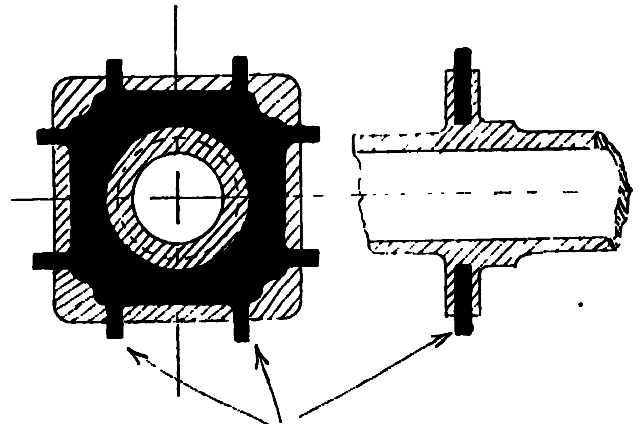


FIG. 2. SUGGESTED CHILL FOR FIG. 1; TO BE PREHEATED

metal where adequate arrangements can be made for feeding, as, in the absence of feeding heads, the thinner surrounding sections will draw on such reservoirs of molten steel and result in unsoundness or piping in

*A paper read before the annual meeting of the British Iron and Steel Institute, May 6, 1920.

parts where it is of the utmost importance that a large factor of safety should be provided.

The making of a ship's stem free from defects might be instanced as an illustration of this important point as to the position and size of necessary feeding heads, to insure soundness, or, on the the other hand, of alteration in design to obviate them—a problem which, owing to the great divergence in the types of castings required by users, is relatively more difficult of general solution (even if not of the same importance) than the recently much discussed question of producing sound ingots.

Such a casting usually has heavy brackets cast between the webs at the deck positions, large radii, advisedly, being usually formed, thus further increasing the relative mass at these places. There is little doubt that a more satisfactory casting would result (even if, superficially considered, such does not appear to be the case owing to unsoundness of piping not being apparent on the surface) by breaking the continuity of the junction of the bracket with the section of the webs, particularly at the extreme forward point, as such recesses in the deck brackets can safely be filled in later by electric welding and calked to make perfectly water-tight. If feeding heads are placed over these brackets, the steel will remain fluid at these places after the general contour of the stem casting has solidified, thus tending to unsoundness, distortion and troubles through contraction. Another point which should be borne in mind in connection with castings of this type is that during the period of cooling after casting the curved contour will tend to approximate to a straight line. Allowance should therefore be made by the pattern-maker for this tendency, particularly toward the two ends. When the annealing, or heat treatment, is carried out the contortion which would probably result if flames are allowed to impinge on the casting must be guarded against before the furnace is closed.

Modifications in design would be the more satisfactory expedient in some cases which come before the steel-

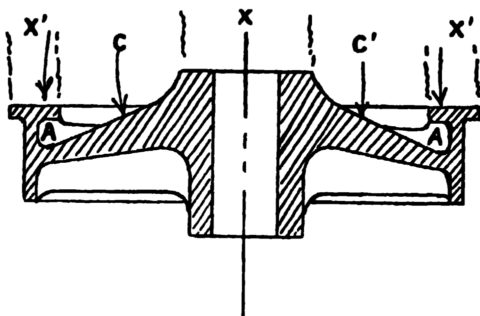


FIG. 3. WHEELS WITH RIBS UNDER INTERNAL FLANGE AND HEAVY CONE CENTER

founder, parts being made separately where possible. This has sometimes the objection of increase in cost of machining, etc., but cheapness should not be the sole consideration in making such castings.

Castings of the type shown in Fig. 3 are sometimes asked for, with light ribs, *AA*, tied under internal flanges and also to a heavy plate or cone center, *CC'*. Such ribs naturally cool at a much quicker rate than the heavy disk portion and feeding heads, *XX'*, and are therefore in considerable tension, where the members join the periphery, when the plate portion and the center boss have reached their maximum contraction.

It is likewise a difficult matter to insure perfectly satisfactory casting of such design as shown in Fig. 4. This shows a disk, or wheel, having spokes of heavy rectangular section on which are superimposed a plate of lighter section. Drawing or other defects will probably appear in the plate over the center of the spoke or rib (see *X* on section *ab*).

It must be admitted that a careful consideration by the management (and especially a joint discussion with all foremen responsible for seeing work through the different shops) of the problems to be faced in these and similar instances would conduce to the production of better castings; as it is sometimes seen, after a pattern is completed, that if it had been made differently in some respect, to allow of a modification in the method of making the mold, provision could have been more efficiently made for feeding, and also for guarding against contraction and other troubles.

Such expedients as the insertion of tubing of small diameter and of considerable length rammed with sand,

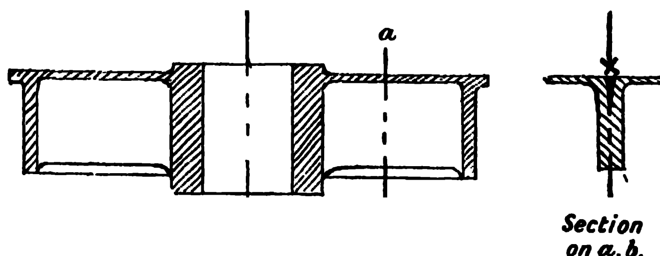


FIG. 4. "DRAWING" OVER DEEP RIBS

in lieu of cores where they are surrounded by large masses of steel—which cores would necessarily have to be made hard to stand and would become much more so through the contraction of the steel—would probably then be arranged for and much expense be saved in fettling and in the machine shop. It is well known that bent or broken cores cause endless trouble when the casting reaches the drilling machine; in fact, in many instances it would be far cheaper to omit small bolt-hole cores altogether.

There is also a danger of small cores in one plane (say for a number of bolt-holes) causing vital cracks in large castings of heavy section, owing to contraction, the cores becoming very hard and offering great resistance while the steel is semi-plastic.

Honeycombing

Steel-founders of repute have overcome the trouble of honeycombing and blowholes in castings. These in earlier days were considered almost unavoidable, in fact it has been stated in the past that the presence of blowholes might be taken as a "guarantee of quality in other respects"!

Given steel properly melted and with suitable percentages of silicon and manganese, and care in making and drying molds, little trouble is experienced in this respect; piping, sand defects, etc., being far more frequently the cause of discards.

The elimination of honeycombing has resulted in very largely increased productions of cast steel blanks for machine-cut gearing and similar castings, on which a large amount of machining is done; but, owing to the serious loss which would be incurred if defects developed, particularly at a late stage in the machining operation, it is very necessary that everything which can possibly be done to insure perfection should be given earnest consideration. Arrangements should be made

for the fluid steel to enter the mold at the bottom, and whenever possible a centripetal action, commonly termed "spinning," should be secured. Suitable risers and feeders should be provided where necessary, to insure any dirt being brought up into the heads. It is usually advisable to cast such articles quickly.

Castings of this kind are frequently produced without the slightest defect, provided the design be favorable. One cause of trouble has been due to the founder being asked to supply blanks of fairly large diameter with solid disk, or plate, centers, which have a pronounced tendency, in large diameters, to result in cavities being formed in the rim, practically in the position where the roots of the teeth are when these are "milled" out. (Fig. 5). This is due to the rim being of heavier section than the disk and therefore remaining fluid longer, and also, in cases where the change in section is not so great, to difficulty in arranging for adequate feeding at this place.

It is preferable to adopt H-section arms, but it is then found expedient to break the continuity of the metal at the junction with the rim by placing a narrow

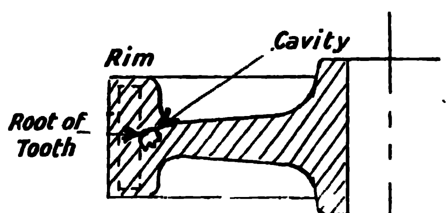


FIG. 5. HONEYCOMBING AT JUNCTION OF RIM AND ARM

core through the webs of the arms. If objection be made to such a method resulting in any weakening of the casting, this can easily be obviated by increasing the strength of the faces, or top and bottom flanges, of the arms by having larger radii between them and the rim (see *XX'* Fig. 6), which is preferable from the founder's standpoint as well.

The same problems are encountered in the production of smaller castings, weighing from a few ounces upward, as supplied to motor and general engineering firms.

The difficulties might be overcome in many instances if it were possible to arrange to submit suggested designs to some steel-founder of good standing beforehand.

It is not intended, however, to convey the impression that all faults lie with the drawing-room, as by careful attention and thought on the part of the foundry staff better articles could be produced by judicious use of chills, feeders, etc. Further interchange of opinion would, however, undoubtedly lead to increased efficiency and obviate some of the troubles experienced by the engineer.

To give one example only: Axle-box guides for locomotives are still made as shown in Fig. 7A, which any user will understand generally results in "drawing" at *X* and *X'*, in addition to causing extra work in the machine shop owing to the absence of tool clearances, instead of a more gradual change in section and also of radii at the corners, as illustrated by Fig. 7B, the more usual present design.

Innumerable examples might be adduced[1] affecting practically every type of steel casting made, but the desire at the moment is to persuade the engineer that exchange of views is of importance not only in respect of the production of castings without inherent weaknesses, but also in regard to the use of differing qualities of steel, or of special alloy steels, for various purposes.

[1]Hydraulic cylinders having square instead of rounded or spherical ends, for instance.

The provision of suitable test-coupons, in the case of some forms of castings, is an important matter if sound pieces for tensile and bend tests are to be insured. This should not be left to the discretion of the molder, who is usually, in deciding where to place these, governed by considerations of convenience in respect to the molding-box used for the job. The question is well worth consideration by the management, owing to the loss incurred if a satisfactory casting be rejected solely through inability to obtain test-pieces free from defects. In some cases, on cutting up a casting for test to represent others produced from the same cast of steel, or on breaking it under the tup for remelting, it has been found that the casting was perfectly sound, defects appearing in the test-pieces only.

It is also highly advisable to provide for spare test-pieces, as cutting pieces from rising heads often results in disappointment from causes such as segregation.

Consideration should be given to such points as feeding the test-bars, and whether the steel is able to flow freely through the part provided for tests; whether any dirt carried off the face of the mold, etc., may be trapped, and whether the test-bar will be sound at the expense of unsoundness in the casting itself or *vice versa.*

For small castings it is advisable to treat the test-bar as a separate casting but connected by a "spray" of sufficiently large sectional area to insure that the test-piece is securely attached to the group of castings, or to the single casting, as the case may be, and also to give an adequate flow of steel into the test-bar, on which a separate feeding head should be superimposed. A suitable design of test-piece for this purpose is shown in Fig. 8.

The provision of test-pieces from small castings may add very considerably to the cost of production, especially in cases where only a few are required from a pattern. This should be borne in mind when quoting, and the most favorable arrangements made with the inspecting engineer as to including a quantity from one cast of steel as well as from a single molding box.

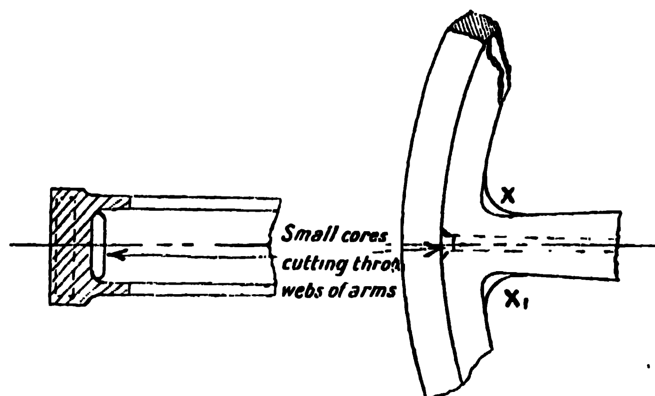


FIG. 6. CORE AT JUNCTION OF H-SECTION ARMS

When molds are made by machines, it will be found convenient to arrange the patterns on the plate, whenever possible, so that one or more patterns can easily be removed and a test-bar included in place in several of the molds for each cast. Special attention must neces-

sarily be given to the method of fastening patterns to the plate to prevent any possible chance of displacement through the more frequent changing.

Heat Treatment

To insure satisfactory test result it is necessary that the annealing or rather heat treatment (as the great majority of castings are now cast in mild steel and annealing—i.e., softening—to permit of the castings being readily machined was principally required for crucible steel castings) should be carefully carried out. It is very advisable to have some means of recording temperatures, reading being taken in various positions in larger furnaces; at any rate until it is ascertained that something approaching a uniform heat is obtained in the particular type of furnace in use. The furnace attendant, if left to himself, often appears specially interested in recording flame temperatures rather than those of the castings under treatment. If personal attention is given, by some one holding a responsible position, to this matter of heat treatment, economies in working, as well as higher quality material, etc., may result, as small modifications in furnace design—for instance, slight alterations in the sizes and positions of admission ports—may be found advantageous.

There is no doubt that an experienced workman can judge temperatures to within a reasonable variation, at any rate under the atmospheric conditions he is accustomed to, but it will usually be found that the tendency is to estimate the temperature higher at night than in daylight, and the cost of a pyrometer is money well spent.

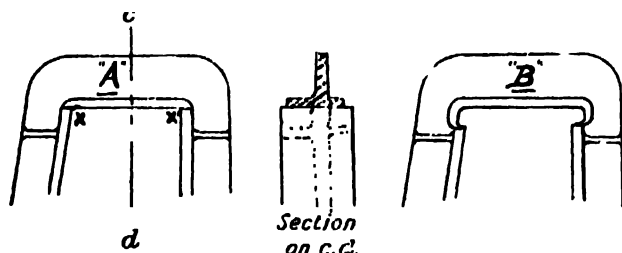


FIG. TROUBLESOME AND APPROVED DESIGN FOR AXLE-BOX GUIDES

The most satisfactory furnace is one in which the rate of cooling down at the critical temperature can be varied to some extent, as it is then possible to obtain small variations in the maximum stress where castings are made to stringent specifications.

Owing to the difficulty sometimes experienced in obtaining permission for material, which has given results, say, 4,000 to 6,000 lb. over or under the tensile strength specified, to be re-treated, it would appear that some engineers have not yet realized that the rate of cooling through the recalescence point of the steel governs the tensile strength, and that a substantial increase or decrease can be made by accelerating or lengthening the period of cooling through this range.

It is found in practice that heating to a temperature of about 950 deg. C. is advisable to insure the breaking down of the cast crystalline structure, the final structure of the ferrite and cementite being, of course, coarser or finer according as the rate of cooling through the critical range is slow or rapid. This temperature is much higher than is theoretically necessary, but experiments over a considerable period show the necessity for the higher temperature. The original crystallization of a casting will, of course, be governed by the mass of metal, and the rate of cooling after casting either in the mold or, if knocked out, early after casting, on the foundry floor.

The length of time necessary throughly to soak castings and complete the breaking down throughout is a variable matter depending on size, thickness of metal, position the castings are loaded in the furnace, and probably several other considerations.

When dealing with large castings of heavy section it is advisable to pack them well up from the floor of the furnace. If this can possibly be done, pieces having heavy cores should be rough fettled before being placed in the furnace. The annealing will then be more efficiently and expeditiously carried out.

Generally, if arrangements are made which will admit of castings being cooled off quickly through the critical range without risk of distortion, setting up of stresses, etc., through currents of cold air impinging on one part of a casting, or other causes, an increase in the tensile strength without decrease in the elongation can be looked for and, owing to the closer structure, better results from bend and shock tests obtained.

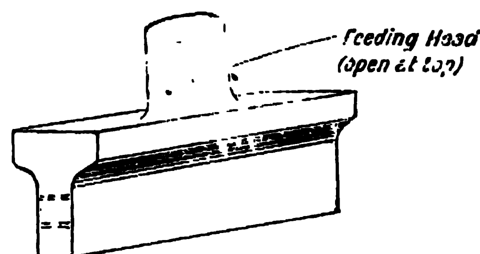


FIG. 8. SUITABLE DESIGN FOR TEST PIECE

Many cases have been noted where mild qualities of steel, as cast, have given practically the same tensile strength and elongation as after annealing—for instance, a breaking strain of about 60,000 lb. per sq.in. with 28 to 30 per cent elongation in 2 in. Untreated samples fail, however, to give anything approaching satisfactory bend tests.

Shock Test

It is possible that manufacturers of high-quality castings may soon consider that some form of shock test might by no means be against their interests if lower grade material, less suitable for the purpose required and supplied at a cheaper rate, be in this way eliminated from competition. The importance of the annealing or heat treatment of steel castings has been specially mentioned in papers read at various times, and a study of these is well worth the time so spent by anyone responsible for the production of steel castings, as are also papers which have recently been read on steel ingots, the problems requiring solution being closely allied.

The aim of every maker should be to produce castings absolutely, not commercially, free from defects, and the engineer should be willing to give earnest consideration to any reasonable modifications which may be suggested by men of experience. By close co-operation, steel castings might be produced which could be used with the same confidence as is extended to forgings when it is borne in mind that practically the same structure in the steel can be obtained by correct heat treatment as by work done on the steel during the process of manufacture.



ROLLING OF CELLULOSE-ACETATE-BASE CELLULOIDS

Manufacture of Cellulose Acetate*

Generalities on Cellulose Acetates—Esterification—Operating Conditions—Industrial Manufacture by the Acetylation of a Modified or Natural Cellulose With or Without Solution of the Cellulose in the Esterifying Bath

BY MAURICE DESCHIENS

THE chemistry of cellulose acetate has been greatly developed during the last few years. This product finds now extensive use in a great number of industries, especially in aëronautics, films, non-flammable celluloids, imitation coral, amber, shells, ivory, artificial flowers, non-breakable and flexible window glass, transparent sacks, electric insulators, artificial silk, etc.

GENERALTIES ON CELLULOSE ACETATE

The composition of cellulose might be given as $(C_6H_{10}O_5)_x$ or, if x is assumed to be 12, $C_{72}H_{120}O_{60}$. The simplified formula may be written as $C_6H_{10}O_5$.

The three best-known acetylated derivatives of cellulose by acetic acid and anhydride in the presence of appropriate catalysts are

$C_6H_9O_4(OCOCH_3)$ = mono-acetate

$C_6H_8O_3(OCOCH_3)_2$ = di-acetate

$C_6H_7O_2(OCOCH_3)_3$ = tri-acetate or normal acetate

The cellulose acetylation reaction does not consist in a simple substitution of the alcohol radical OH by an acid radical, but is in reality very complex due to the fact that partial hydration of the cellulose may take place during the normal acetylation process, or coincident with or following the acetylation, with the result that there is an undetermined number of intermediate products of hydrocellulose acetates as proved in the determination of viscosities, solubilities and saponification indices.

From the technical and industrial point of view the tri-acetate is the only one of interest and the acetylation methods are for the production of this acetate. Industrially it is difficult to obtain the tri-acetate as the final product, as this is mixed with lower acetates, especially the di-acetate $C_6H_8O_3(OCOCH_3)_2$ and compounds of partial hydrolysis (hydrocellulose acetate and hydrocellulose). This is due to the complexity of the esterifying bath, which contains sometimes cellulose, oxycellulose (action of oxidizing agents on the cellulose), hydro-cellulose (hydrolysis of cellulose) and acetic esters of cellulose. When sulphuric acid or sulphates are used as catalysts, sulphuric esters are also present (action of sulphuric acid) and acetosulphuric compounds (combined action of acetic and sulphuric acids), all in the normal and partially hydrated forms. Besides, there may also be present one or more series of cellulose decomposition products in different states of hydrolysis and esterification.

From the examination of industrial acetates of different origins it is possible to conclude that even the acetates prepared in the same plants by the same processes have variable solubilities and viscosities and no relation can be established between the contents in acetyl of these acetates and their physical and

*Abstracted and translated from *Chimie et Industrie*, May, 1920, pp. 591-607.

chemical properties. It can be said, though, that the presence of sulphuric acid or sulphates in the cellulose acetates produces instability and exerts an appreciable influence on the solubility.

It often occurs that cellulose acetates which analytically are identical have very different physical properties.

A series of analyses has shown that: The percentage of the cellulose acetate which is insoluble in acetone varied from 3 to 0.2 per cent. The viscosity of a 6 per cent solution of cellulose acetate in acetone at 15 deg. C. gave figures varying from 90 to 5, the viscosity of 30 deg. Bé. glycerine being 100. The free acidity expressed as per cent CH_3COOH varied between 0.01 and 1; ash between 0.8 and 0.13 per cent.

The acetates containing the higher acidity, the greater quantity of ash and of insolubles are the most unstable to heat, decomposition starting at 176 deg. C., whereas for normal acetates decomposition starts at 210 to 215 deg. C., which shows that the industrial product is a mixture of di- and tri-acetate. That this is so can be proved by determining the acetyl percentage by the Barthelemy method of saponification.

The theoretical percentages of CH_3CO are: for di-acetate 34.96 and for tri-acetate 44.79.

A commercial acetate from the Usines du Rhône having the following properties was found to contain 43.08 per cent CH_3CO:

Viscosity at 15 deg. C. (30 deg. Bé. glycerine = 100)	16.5
Insolubles in acetone at 15 deg. C.	0.2 per cent
Free acetic acid	0.005 per cent
Ash	0.18 per cent
Moisture	5.3 per cent
Decomposition starting at	218 deg. C.
Total decomposition at	224 deg. C.

Industrially it is practically impossible to avoid the mixture, because usually only minimum amounts of acetic anhydride are used in the reaction with cellulose.

There is no acetate perfectly pure. The acetic esters being non-crystallizable, the law of mass action (the reciprocal reactions of two substances depend not only on their affinity constants but also on their relative concentration) cannot be applied to the system of the mixture of acid and cellulose acetate due to the total absence of homogeneity. This law applies only when all of the cellulose acetate is in solution.

Cellulose acetates decompose when submitted to vaporization or distillation.

Commercial tri-acetates when heated change aspect slowly between 175 and 220 deg. C. and carbonize between 188 and 270 deg. C.

Esterification

Cellulose tri-acetate is obtained by direct acetylation of dry cellulose with acetic anhydride and acid, but as these organic acids, although strong, do not have hydrolyzing power, the hydrolysis is started by introducing in the mixture traces of inorganic acids (H_2SO_4 or H_3PO_4) or compounds giving inorganic acids (zinc chloride, ammonium persulphate, acid potassium sulphate, methylamine sulphate, copper sulphate). It is advisable that the formation of the esters shall be slow, because an energetic hydrolysis has a strong influence on the molecule of cellulose to be esterified.

The acetylation is a bimolecular reaction, expressed by the following equilibrium:



$$C_6H_{10}O_5 + CH_3COOH \leftrightarrows C_6H_7O_2(OCOCH_3)_3 + 3H_2O$$

The acetylation is improved by raising the temperature carefully to a degree which is determined according to the catalyzer used. Thus, for $ZnCl_2$, $KHSO_4$ and ammonium persulphate 80 deg. C. is the most favorable temperature. To absorb the water formed during the reaction and to eliminate it from the esterification it is necessary to use energetic dehydrating agents such as H_2SO_4, H_3PO_4 or $ZnCl_2$.

Equilibrium is reached when the acetylated cellulose is dissolved or nearly dissolved. The mixture is heterogeneous when the cotton fibers are not appreciably changed in appearance; it is homogeneous when the cellulose passes into solution in the acetylating mixture.

In the manufacture of nitrocellulose the esterification is energetic and perfect because nitric acid is a vigorous esterification agent; in the case of cellulose acetates the esterification is slower and the destructive action of the acids on the ester during the acetylation is more profound. In the case of the nitrates, these are insoluble in the nitrating mixture and hence no destructive action takes place, whereas the acetates pass in solution, the acetic esters being soluble in the acetic acid and anhydride. Any process by which this solution could be stopped would be of great technical and economic importance, because it would permit a reduction of the quantity of acetic anhydride necessary for the production of a unit of acetylated cellulose and would give a more regular acetylation, without secondary reactions.

L. Ledebur and many other authors propose to add to the acetylating bath a sufficient quantity of carbon tetrachloride, cellulose acetate not being soluble in a mixture of acetic anhydride, acetic acid and carbon tetrachloride. This process is interesting in that the boiling point of carbon tetrachloride (83 to 84 deg. C.) is lower than that of the acetic anhydride (138 deg. C.) and acetic acid (119 deg. C.) and by fractional distillation the carbon tetrachloride can be recovered.

In an industrial acetylation the carbon tetrachloride is added at the end of the esterification operation to precipitate the cellulose acetate. The precipitate is separated by filtration, centrifuging and drying.

Operating Conditions

The main points to be considered in the manufacture of cellulose acetates are:

(1) A careful selection of the materials used. The cellulose, acetic acid and acetic anhydride are to be analyzed before used, so that when needed their proportions may be logically modified to give as uniform as possible final commercial products.

(2) Slow and regular acetylation with a thorough temperature control. It has been proved that the variations in viscosity are a function of the acetylation temperature. For a given process an increase in temperature results in cellulose compounds of lower molecular weight, greater viscosity and lower solubility.

(3) Hydrolysis and ripening should be as uniform as possible and under constant supervision with frequent sampling. The samples should be analyzed for solubility (the solubility in acetone being the measure of acetylation for the tri-acetate), plasticity (the plasticity in warm chloroform being also the measure of acetylation for the tri-acetate). It is also a good plan to make microscopic examinations.

It has been stated previously that cellulose acetates even when manufactured by the same process and similar analytically may possess very different qualities.

These variations may be due to the status of hydrolysis during the treatment of the cellulose, to not sufficiently well-controlled esterification, hydrolysis or ripening, or to defective precipitation and washing.

Samples of cellulose tri-acetate to be considered good have to be very soluble, have a very low percentage of H_2SO_4 and resist the heat test. The following table gives the analysis of the most commonly used tri-acetates:

	Moisture	Ash	Viscosity*	% Free Acetic Acid	% H_2SO_4	Temp. of Decomposition
Acetate H. Dreyfus of Basel	5.97	0.32	18 9	0.005	0 34	178
Acetate H. Dreyfus of Basel	3.95	0.45	27	0 006	0 53	173
English acetate............	4.94	0.42	30 6	0.006	0 90	170
British Cellulose Co.......	5.22	0.41	38.2	0 068	0 24	164
Usines du Rhone..........	4 40	0 40	11.3	0 004	0 21	218
Usines du Rhone..........	4.96	0.16	10.0	0 01	0 12	226

* Viscosity at 15 deg. C. of 6 g. in 100 g. acetone. (Viscosity of 30 deg. Bé. glycerine = 100.)

The presence of sulphuric acid in the tri-acetates is very harmful; it diminishes their solubility because it tends to transform them into di- and mono-acetylated derivatives which are insoluble in the usual tri-acetate solvents. This transformation takes place with the production of free acetic acid, so that the presence of too great a quantity of free acetic acid indicates unfavorable conditions.

Methods Used for the Acetylation of Cellulose by Acetic Acid and Anhydride

The method of direct acetylation of cellulose by acetic acid and anhydride in the presence of acetyl chloride is no longer used. The two methods now used are:

I. Acetylation of a modified cellulose (hydrocellulose, oxycellulose, viscose).

II. Acetylation of natural cellulose (cotton, paper, etc.).

In these two methods the two distinctive cases to be considered are whether the cellulose is or is not dissolved in the esterifying bath.

Acetylation of a Modified Cellulose

The Badische Anilin und Soda Fabrik has taken out a series of patents on the hydrolysis of the cellulose by saturation with dilute sulphuric acid (catalyzer) and the acetylation of the hydrolyzed mass separated from the acidulated water. The two cases to be considered are:

(A) Acetylation With Solution in the Esterifying Bath.—100 parts cotton to be acetylated are saturated with a 4 to 5 per cent solution of sulphuric acid for sufficient time, then the cellulose is pressed until it contains twenty parts of the diluted acid. The hydrolyzed cotton is loosened and introduced in a mixture of 400 parts acetic anhydride and 400 parts of acetic acid. The reaction is exothermic and the temperature is to be kept around 40 deg. C. The acetylation is complete when the cellulose is entirely dissolved; the cellulosic ester is then precipitated by water, washed and dried.

(B) Acetylation Without Solution in the Esterifying Bath.—100 parts are saturated with a 60 per cent solution of sulphuric acid and pressed until the cotton retains only 10 parts of the acid solution. The resulting hydrolyzed cellulose is placed in contact with 300 parts of acetic anhydride and 1,100 parts benzene (precipitant for cellulose acetate). The acetylation lasts twelve hours, then the temperature is raised and maintained at 60 to 65 deg. C. on a water bath until a sample indicates an acetate soluble in warm chloroform. The cellulose acetate which has not been dissolved is pressed, neutralized with Na_2CO_3 solution, washed and dried. By this method the cellulose retains the texture and form of the initial fiber.

A French patent (316,500) proposes the use of ortho-, pyro- or meta-phosphoric acids or P_2O_5 as catalyzers for the acetylation of a hydrocellulose or oxycellulose (100 parts) with 400 parts of acetic anhydride containing 1 per cent of the catalyzers mentioned, the temperature being maintained at 50 to 60 deg. C.

The acetates obtained by this process are not very resistant, and it is to be remarked that the less the initial cellulose material has been hydrolized the better the cellulose acetate produced.

Acetylation of Natural Cellulose

The modern method for the preparation of the cellulose acetate is by the acetylation of natural cellulose based on the treatment of cleaned and dried cellulose by acetic acid and anhydride in the presence of a catalyzer. The catalyzers used are H_2SO_4, $KHSO_4$, $CuSO_4$, methylamine sulphate, ammonium persulphate, $ZnCl_2$, etc., the most commonly used being sulphuric acid. Here also, as in the case of the treatment of a modified cellulose, the acetylation is made with or without solution of the cellulose in the esterifying bath.

(A) Acetylation With Solution in the Esterifying Bath.—This method is best outlined by giving the description of the reactions taking place according to

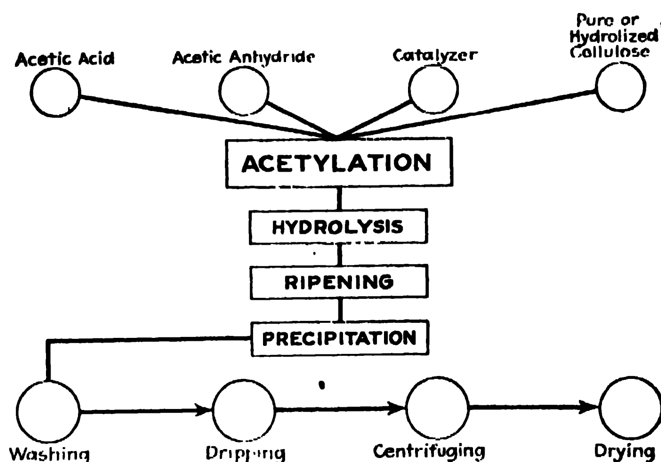


FIG. 1. FLOW SHEET OF THE MANUFACTURE OF CELLULOSE ACETATE

the principles forming the basis of G. W. Miles' American patent 838,350 (1906). The entire operation consists of five phases, the temperature varying with the catalyzer used.

First Phase: Acetylation. Dried cellulose (100 g.) is introduced in a mixture of pure acetic anhydride (270 to 310 g.) and glacial acetic acid (390 to 410 g.), to which is added the catalyzer consisting of 66 deg. Bé. sulphuric acid (3 to 5 c.c.). The whole is well mixed and triturated in rocking mixers having two helicoidal blades. The mixer is jacketed so as to permit of temperature control of its contents; the inner wall is of bronze, aluminum or enamel. Capacity of mixer 300 to 600 l. The reaction is exothermic. The temperature is to be maintained at 40 deg. C. until the

mass becomes of homogeneous appearance, when the temperature may be allowed to reach 50 to 65 deg. C. When the temperature starts to drop the mass is heated on a water bath and kept at about 50 deg. until the cellulose is entirely dissolved. This requires from thirty-six to forty-eight hours and even longer. The end of this phase is reached when a sample precipitated by water is soluble in cold cholorform and insoluble in acetone.

Second Phase: Hydrolysis. A mixture of 60 to 65 c.c. water and 60 c.c. acetic acid per 100 g. cellulose is added slowly to the esterifying bath by continuous agitation. During this phase of the operation there must not be any precipitation of cellulose acetate.

Third Phase: Ripening. The mass from the mixer is transferred to similar mixers but of greater capacity and allowed to ripen at 40 to 50 deg. C. for twelve to sixteen hours. During this time hydrolysis takes place uniformly and slowly and the cellulose acetate which was insoluble in acetone becomes gradually soluble while the solubility in cold chloroform diminishes. This ripening results in a greater and more complete division of the cellulose acetate molecule, as can be seen by examining samples at different stages, the product becoming more and more a tri-acetate soluble in acetone, more divided and less granular.

Frequent samples for the determination of viscosity and solubility will indicate the point when the cellulose acetate is of the required quality. The ripening phase is to be guided by the following characteristics:

A product soluble in cold chloroform and insoluble in acetone indicates that the ripening is not complete.

A product insoluble in cold chloroform, plastic in warm chloroform and soluble in acetone indicates that the ripening is complete and the tri-acetate of cellulose is of the desired quality.

If this stage of ripening is passed the product becomes a complex mixture of hydrocellulose acetates which after precipitation is in the form of powder whose solubility and qualities are very variable. If the ripening is carried still further the product obtained is a biose (cellobiose, $C_{12}H_{22}O_{11}$).

Fourth Phase: Precipitation. The acetylated mass is transferred to precipitation vats and precipitated with an excess of cold water to which is added an alkaline carbonate sufficient to neutralize the sulphuric acid used. The whole is stirred mechanically. The acetate is precipitated as a white flocculent mass which is to be washed and neutralized as perfectly and as fast as possible so as to avoid the hydrolyzing action of the sulphuric acid which would give acetates of lower molecular weights, less resistant and susceptible to decomposition during storing.

Fifth Phase: Drying. The neutralized and washed cellulose acetate is placed in drying chambers and maintained at a temperature of 20 to 25 deg. C.

The theoretical efficiency is seldom realized, but with carefully controlled acetylation, hydrolysis and ripening stages, the industrial efficiency of the reaction

$$C_6H_{10}O_5 + 3CH_3COOH \leftrightharpoons C_6H_7O_2(OCOCH_3)_3 + 3H_2O$$

reaches 83 per cent.

In all the acetylation methods these five phases of the entire operation are to be considered. The temperature and duration of each phase vary with the catalyzer used. Thus: With $ZnCl_2$ the acetylation, hydrolysis and ripening are performed at 65 to 70 deg. C., with nitrosyl sulphate at 70 deg. C., with ammonium bisulphate at 50 deg. C., with methylamine sulphate or aniline sulphate at 30 to 60 deg. C. and with potassium bisulphate at 80 deg. C.

The Naamlooze Vennootschap Co.'s Process for the Preparation of Cellulose Tri-Acetate

A new method for the preparation of cellulose triacetate is that of the Naamlooze Vennootschap Fabriek van Chemische Producten Co. of Holland (French patent 494,832 of June 10, 1919). The principle is to submit the cellulose to a preliminary treatment by which the penetration of the catalyzer into the cellulose fibers is greatly facilitated.

This method can be realized in the following two ways:

1. By the use of glacial acetic acid.
2. By the use of weak acetic anhydride.

(1) *Use of glacial acetic acid.* (*a*) *Preparatory treatment.* 100 g. cellulose is impregnated with 500 c.c. of glacial acetic acid and 5 g. of 62 to 66 deg. Bé. sulphuric acid. Let stand for twenty hours at 15 to 20 deg. C. (*b*) *Acetylation.* Add 500 g. of 80 per cent acetic anhydride, cool to maintain the temperature at 40 deg. C. until a clear solution is obtained. (*c*) *Hydrolysis and ripening.* After a few hours add 40 to 60 c.c. of 10 per cent sulphuric acid and let ripen for twenty-four hours at 35 deg. C. (*d*) *Precipitation and drying.* The precipitation is realized by the use of an excess of cold water and the precipitate washed and dried.

(2) *Use of weak acetic anhydride.* When it is desired to use weaker acetic anhydride the operations are as follows:

(*a*) *Preparatory treatment.* 30 g. of cellulose is impregnated with 300 g. of a mixture of 40 per cent acetic anhydride and 60 per cent acetic acid for sixteen hours at 16 deg. C. (*b*) *Acetylation.* Raise the temperature to 35 deg. C. with constant stirring until a clear homogeneous mass is obtained. (*c*) *Hydrolysis and ripening.* Add 18 to 20 c.c. of 10 per cent sulphuric acid solution and let digest for twenty-four hours at 35 deg. C. (*d*) *Precipitation, washing, drying as in the previous methods.*

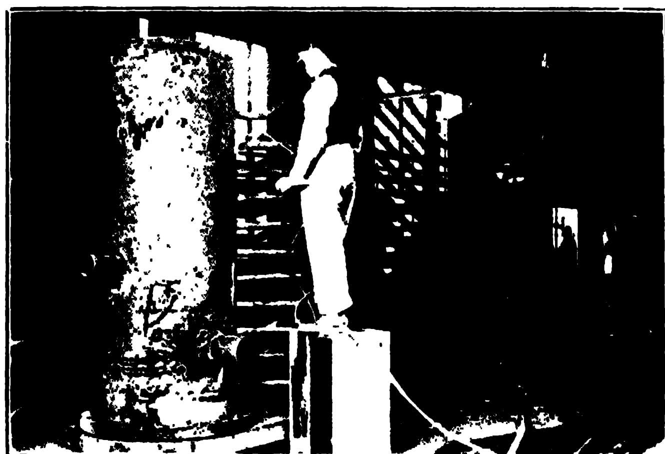
(*B*) *Acetylation Without Solution in the Esterifying Bath.*—A typical example of this method is that forming the subject of Harry S. Mork's American patent 854,374 (1907). The operation is as follows: (*a*) *Preparatory treatment.* Treat 100 g. of cotton with a mixture of 400 g. of pure acetic acid and 20 g. benzene sulphonic acid for a few hours; the mass is pressed until it contains half of the original liquid and ripened for twelve hours at 15 to 20 deg. C. (*b*) *Acetylation.* The wet cellulose is esterified by immersion in a bath containing 300 g. of acetic anhydride and 1,200 g. benzol. (*c*). *Ripening.* The mass is maintained for about eighteen hours at 15 to 20 deg. C. until a sample indicates a product of the desired solubility. (*d*) *Precipitation, washing and drying as in the previous methods.* The Société Debauge et Cie. (French patent 450,886—1915) uses a similar process with benzene, toluene or carbon tetrachloride as precipitants for the cellulose acetate.

(An article on the Properties and Industrial Uses of Cellulose Acetate will be published in a subsequent issue.)

Failures From Contraction of Welded Straight Piping Solved by Using Welded Bent Piping

An unusual contraction problem arose recently in connection with the pipe welding on fifty-four large gasoline condensers for the Texas Oil Co. Each condenser consists of four large forge-welded drums and seventy lengths of extra heavy 2-in. pipe. The drums are open at one end and flanged so that they may be bolted or riveted together after the pipes are welded in.

The pipe welding is being done by the Oxweld Acetylene Co. at the welding shop of that company's Newark plant. The original plan called for straight piping in line of center between each lateral pair of drums and bent or bowed piping to connect the sides. As the distance between the drums had to be exact to meet the foundation specifications and to insure coincidence of the flanges and bolt or rivet holes of one set



APPLICATION OF WELDED BENT PIPING

of drums with the corresponding points in its mates, the importance of properly handling the contraction problem is at once apparent.

Oxweld engineers recommended the substitution of bent piping for the straight piping noted. The theory as to contraction control was tested on both the straight and the bent pipe. Accordingly a heavy cast-iron jig was made, to which the drums were made fast in the proper position with heavy bolts. The contraction when the straight pipe was used was so powerful that the bolts were sheared off by the pull on the drum, the contractions amounting to several inches. When the bent pipe was used instead of the straight pipe this did not occur, the bent pipe accommodating itself to the contraction so completely that when the drums were removed from the jig they were found to be in correct position, fitting perfectly with the mating pairs.

The application of the bent piping is clearly shown in the accompanying photograph. After the welding, the condensers are tested to a hydraulic pressure of 500 lb. per sq.in. In one of these tests a 3-in. cast-iron cap bolted to one of the drums gave way, but the pipe welds in every instance stood the test without a break or a leak appearing, clearly demonstrating the remarkable strength of the oxy-acetylene welds to resist unusual pressure strains. There are thirty-five pipe welds in each drum and 140 in each complete condenser, a total of 7,560 welds in the fifty-four condensers.

The fifty-four condensers will be used in the distillation plant of the Texas Oil Co. for recovering gasoline from natural gas and crude oil.

Synopsis of Recent Chemical & Metallurgical Literature

The Sugar Situation in France.—The sugar situation in Europe has suffered very much during the war, as can be seen from the following data taken from a study by P. NOTTIN on the French sugar industry before and after the war. (*Bulletin* de la Société d'Encouragement pour l'Industrie Nationale, vol. 132, 1920, pp. 103-108). Thus the European production of 8,179,013 tons of sugar for the fiscal year 1913-14 was reduced to 3,642,-664 tons for the fiscal year 1918-19. This decrease in production was more accentuated in France and Belgium and the present conditions in these two countries are far worse than in the other sugar-producing countries, because the greater part of the French and Belgian sugar refineries have been wantonly destroyed.

The following table shows the status of the French sugar industry during the war:

Fiscal Year	Sugar Beet Acreage Cultivated	Number of Sugar Plants In Operation	Amount of Sugar Produced, Tons
1913-14	515,000	206	717,400
1914-15	331,000	69	302,960
1915-16	186,800	64	135,899
1916-17	201,000	65	185,435
1917-18	187,000	61	200,265
1918-19	169,200	51	110,096

Of the 206 sugar refineries in operation in 1913-14, 145 have been wrecked. Only fifteen of these plants can be repaired; the remaining 130 have had all the machinery and apparatus completely destroyed beyond repair and in ninety plants even the buildings have been demolished. In the four main French sugar-producing departments—Aisne, Nord, Somme and Pas-de-Calais—the number of refineries and their power during 1914 and 1919-1920 were:

Department	1914 Number of Plants in Operation	1914 Power	1919-1920 Number of Plants in Operation	1919-1920 Power
Aisne	47	19,920	1	200
Nord	38	19,135	1	325
	34	17,250	3	4,400
	25	12,260	6	5,430

Of the 700,000 tons of sugar constituting the average French yearly consumption, the maximum which can now be produced is about 275,000 tons, to which may be added a maximum of 110,000 tons of cane sugar from the French colonies (Guadelupe and Martinique). Although a sugar-exporting country in 1913, France has now to import about half of its needed sugar. It will take years before the French sugar industry will be able to resume its former status.

In spite of European conditions, however, the world's cane sugar industry has flourished during the war. Thus the cane sugar production has increased from 9,821,413 tons in 1913-14 to 12,009,866 tons during 1918-19. Before the war cane sugar constituted 52.6 per cent of the total world production; in 1918-19 this figure was increased to 73.4 per cent.

The beet sugar industry has grown during the last few years in America; the same can be said of Cuba for the same sugar.

The following table summarizes the status of the sugar industry in the main sugar-producing countries:

	Period 1911-1914		Period 1918-1919	
	Production, Tons	Percentage of the World's Production	Production, Tons	Percentage of the World's Production
United States and dependencies	4,435,000	24.3	6,020,300	36.8
Great Britain and colonies	3,280,000	18.0	3,263,300	19.9
Holland and colonies	1,582,000	8.6	1,846,600	11.2
Germany	2,365,000	13.0	1,412,000	8.6
Russia	1,812,000	9.8	700,000	4.2
Austria-Hungary (Czechoslovakia)	1,579,000	8.6	700,000	4.2
Japan	229,000	1.2	375,000	2.2
Brazil	215,000	1.1	260,000	1.5
Peru	168,000	0.9	250,000	1.5
Argentina	219,000	1.2	240,000	1.4
France and colonies	863,000	4.7	219,800	1.3

It can be seen that the United States and its dependencies produce more than a third of the total world production, Great Britain with its colonies more than one-fifth, whereas France with its colonies has fallen from the seventh to the eleventh rank.

Catalytic Action of Copper Salts on the Oxidation of Ferrous Compounds.—Iron salts act as reducing or oxidizing agents according to whether the reaction takes place in an alkaline or acid medium. Thus ferrous salts precipitate cuprous oxide from alkaline solutions of copper, whereas ferric salts in acid solutions dissolve the cuprous oxide and become ferrous. L. MAQUENNE and E. DEMOUSSY have conducted a series of experiments to determine the action of copper salts on the oxidation of ferrous salts and presented the results of their work before the French Academy of Sciences (*Comptes rendus*, July 12, 1920, pp. 65-69).

Working on a solution containing 1 g. crystallized ferrous sulphate per liter and varying amounts of sodium acetate with or without the addition of 2 mg. anhydrous copper sulphate per liter, the quantities of superoxidized iron in one dl. of the solution after one and two days standing are given in the following table:

Sodium acetate mg. per dl. of solution		100	200	500
Superoxidized iron mg. per 24 hr.	without copper	2.4	3.9	6.3
	with copper	5.0	6.5	7.9
Superoxidized iron mg. per 48 hr.	without copper	3.1	5.3	7.7
	with copper	5.9	7.9	8.9

It is seen that in each case copper favors the oxidation of the iron, the more so the less the acetate content of the solution. Ferrous acetate is much more alterable than the sulphate. An addition of a single drop of acetic acid retards notably the reaction, due to the fact that the hydrolysis coefficient of the ferrous acetate is lowered. With a stronger acid the effect is the same but much more intensified.

The action of an alkali phosphate is similar to that of the alkali acetate and with even better results. Thus in a solution containing 32 mg. of ferrous sulphate with 80 and 320 mg. of acid potassium phosphate (KH_2PO_4) per 100 c.c. of solution without or with 0.4 mg. copper sulphate, the quantities of oxidized iron after one, two and three days' exposure in the air are given in the following table:

Acid potassium phosphate mg. per 100 c.c.		80	320
Superoxidized iron mg. per 24 hr.	without copper	0.5	1.2
	with copper	1.2	4.3
Superoxidized iron mg. per 48 hr.	without copper	0.8	1.5
	with copper	2.7	5.0
Superoxidized iron mg. per 72 hr.	without copper	0.8	1.5
	with copper	3.3	5.5

An excess of phosphate up to twenty-five times the weight of the ferrous sulphate used gives similar results. The addition of 0.2 mg. copper sulphate per 100 c.c. of a solution containing 40 mg. iron sulphate and 1 g. monopotassium phosphate is sufficient to double the quantity of the iron oxidized per 24 hr. An excess of acid even when small hinders the reaction as shown by the following results with a solution containing 40 mg. iron sulphate, 200 mg. monopotassium phosphate and 0.2 mg. copper sulphate per 100 c.c. to which is added varying amounts of sulphuric acid:

	Iron Oxidized in 24 Hr.
Without excess of acid	3.6 mg.
With 1 mg. H_2SO_4	3.3
With 2 mg. H_2SO_4	2.1
With 5 mg. H_2SO_4	1.4

It is seen that the retarding action of sulphuric acid is already appreciable with 1:100,000 dilution.

Under normal conditions—i.e., without an excess of acid—the rapidity of the reaction depends on the quantity of phosphate and copper sulphate used. Thus in a solution containing per liter 400 mg. iron sulphate (exactly 79.1 mg. Fe) 2 g. phosphate and 0.2 or 0.8 mg. of copper sulphate the following results were obtained:

	Iron Oxidized Mg. After						
	1 Day	2 Days	3 Days	5 Days	7 Days	16 Days	25 Days
Without copper	8.6	12.0	15.5	17.2	18.9	25.8	29.2
With 0.2 mg. $CuSO_4$	20.6	25.8	31.0	32.7	36.1	49.9	56.8
With 0.8 mg. $CuSO_4$	36.1	44.7	49.9	55.0	60.0	68.0	74.0

After more than twenty-five days with greater amounts of copper sulphate the efficiency of the oxidation may reach 0.93 per cent of the initial iron, whereas when no copper sulphate is used the maximum oxidation efficiency is only 37 per cent of the initial iron.

The action of the copper is manifested even with a 1:100,000,000 dilution, which is of the same order as that for diastases and coenzymes producing similar actions. The action of the copper is also influenced by the temperature.

There exists thus a profound analogy in the action of copper and the diastatic action, and this might lead to a better understanding of the action of copper on living organisms.

Manganese under similar conditions does not react. In vacuum, with copper, the same as with the oxydases, no reaction takes place.

Their conclusions are:

1. Copper salts exert on ferrous compounds a catalytic action the effect of which is to facilitate their oxidation in the air.

2. This activating action which is already appreciable with extremely diluted solutions and sensitive to the slightest changes in the composition of the reacting medium is somewhat specific and consequently can be compared to that of the diastases from which it differs only in that the reactions take place in the absence of any organic matter. (Solutions of alkaline sulphates are also oxidized rapidly in the air when even traces of copper are present. This is one of the causes of alteration of the developing baths in photography.)

3. The effect is manifested in sufficiently diluted solution to warrant the statement that the electrolytic dissociation of the ferrous and cupric salts which takes place is complete and in a direct ratio with their hydrolytic dissociation.

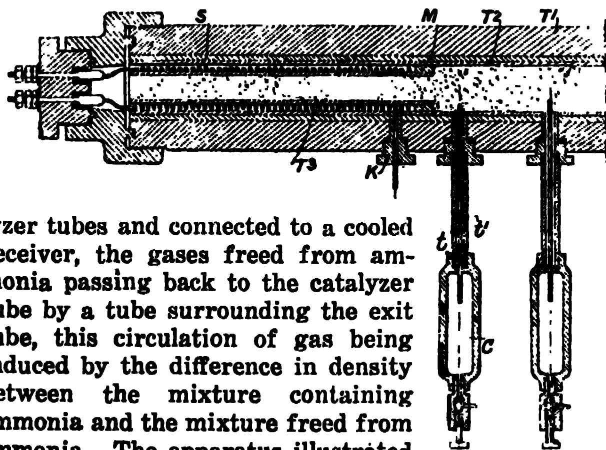
Recent Chemical & Metallurgical Patents

British Patents

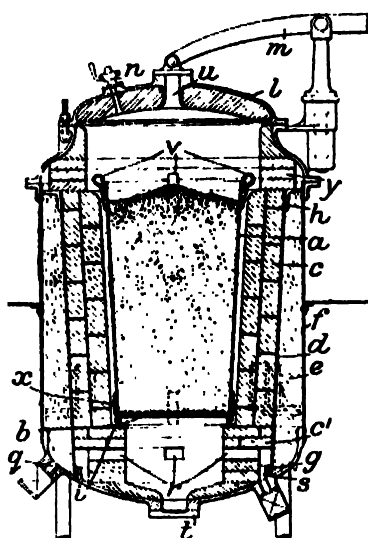
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Process for Sterilizing Food.—A process for sterilizing food, such as fruit and vegetables and other organic substances, such as starch and gelatine, but especially applicable to milk, consists in heating the substance to be treated while it is exposed to a pressure of one atmosphere or over of some appropriate gas. For milk, air or nitrogen may be used, but pure oxygen is not suitable. It is stated that milk treated by this method at temperatures between 70 and 98 deg. C. lasts less well than milk that has been treated at temperatures either just below 70 or above 98 deg. C., the process last described giving the greatest durability. To cause the milk to retain its odor and taste, rapid oscillations of temperature are produced during the process, either by forcing comparatively cold gas through the highly heated milk, or highly heated gas through comparatively cold milk, the pressure being maintained constant throughout the process by a loaded relief valve. (Br. Pat. 142,169—1919. R. PAPE, Busum, Holland, June 30, 1920.)

Apparatus for Catalytic Synthesis of Ammonia.—In an apparatus for the catalytic synthesis of ammonia at pressures exceeding 500 atmospheres the removal of the ammonia from the product of the reaction is effected by means of a series of tubes each entering the catalyzer tubes and connected to a cooled receiver, the gases freed from ammonia passing back to the catalyzer tube by a tube surrounding the exit tube, this circulation of gas being induced by the difference in density between the mixture containing ammonia and the mixture freed from ammonia. The apparatus illustrated consists of an outer steel tube T^1 and an inner metal tube T^2 separated by a layer of heat-insulating material; a shorter inner tube T^3 surrounded by an electric heating-spiral S extends as far as the plug M, this tube T^3 and the portion of tube T^2 beyond the plug M being filled with the catalyst. The reacting gases enter by the pipe K and pass first through the annular space surrounding the tube T^3, thereby being heated to the reaction temperature (500-700 deg. C.) and then enter the mass of catalyst. The reaction gases are withdrawn by means of a series of pipes t^1, each of which penetrates into the catalyst and is connected to a cooled receiver C in which the ammonia condenses, the residual gas returning to the catalyst tube by pipes t surrounding the pipes t^1; the pipes t are lagged with heat-insulating material. In a modified construction, the gases enter the catalytic apparatus through a central tube passing through the whole mass of catalyst, the arrangement for withdrawing the ammonia being the same as that described above. (Br. Pat. 142,150—1919. L'AIR LIQUIDE, SOC. ANON, POUR L'EXPLOITATION DES PROCÉDÉS G. CLAUDE, Paris, June 30, 1920.)



Calcium Cyanamide.—In the production of cyanamide from calcium carbide and nitrogen the nitrogen is forced under pressure upward through a furnace jacket packed with fibrous material such as asbestos, and then downward through the carbide in the furnace. The reaction is started by a heat-absorbing lining to the furnace which has been heated by a previous operation, or by electric resistances in the furnace lining, or by an aluminothermic or similar mixture introduced in a cartridge or container. The apparatus described consists of an outer shell f, an inner airtight shell d, asbestos or like packing e, between them, brickwork such as magnesia bricks c, c', and a crucible a. The shell d is secured at the top to an angle-iron h and at the bottom by an asbestos joint g. The crucible has a perforated bottom b upon which is placed a layer of asbestos and/or stout paper, which becomes carbonized; it is provided with lifting hooks v and centeringpieces x, and rests upon an annular asbestos packing i. The cover l is lifted by means of a lever m, a valve n being provided for releasing the pressure before lifting the lid. The reaction may be started in the first instance by burning straw inserted through opening u. Nitrogen is supplied by a pipe q, passes through the packing e between the shells d, f, thence through openings y in the brickwork and downwardly through the carbide in the crucible a, and passes through the bottom of the crucible and by passages r in the brickwork to an exit s. Dust is removed by an opening t. The separate crucible a may be dispensed with. Several such furnaces may be connected in series. (Br. Pat. 142,354—1919. A. DUCHEMIN, Paris, June 30, 1920.)



Treating Paraffine Wax to Obtain Fatty Acid.—Paraffine wax, while melted and at a temperature of 100-120 deg. C., is submitted to the action of a blast of air or oxygen over a long period, resulting in the formation of oleic and other fatty acids, resin acids, ceresin, spirits of resin and small quantities of alcohols and aldehydes. To prevent decomposition of the products, the process is stopped when a deep yellow color is produced, corresponding to a 70 per cent conversion of the paraffine wax. A catalyst, such as mercuric oxide, or paraffine wax, which has previously been subjected to the foregoing treatment, may be added. (Br. Pat. 142,507—1919. A. SCHMIDT, Troisdorf, near Cologne, Germany. July 7, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Treating Distiller's Slop.—Slops resulting from the production and separation of alcohol from black strap molasses contain certain carbohydrates which interfere with the satisfactory recovery of glycerine. HARRY P. BASSETT, of Cynthiana, Ky., has found that boiling with lime converts these carbohydrates into salts of the hydroxy-acids of the lactic acid series. Upon acidifying, the latter are decomposed with the formation of aldehydes and acids of the volatile fatty acid series. Of these, formic and acetic acids are present in substantial quantities and may be recovered by distillation. The solution is then treated with a mixture of ferrous and ferric sulphate and made alkaline, thus precipitating the basic iron salts of the fatty acids. The mixture is filtered and the filtrate evaporated until about two-thirds of the potassium salts present have separated out. The decanted liquid contains about 50 per cent glycerine, which may be recovered by steam distillation. (1,344,850 and 1,344,851; June 29, 1920.)

Vanillin.—Guaiacol and formaldehyde are mixed together in molecular proportions and diluted with methanol or ethyl alcohol, and an alcoholic solution of hydrochloric acid and of p-nitrosodimethylaniline in half molecular proportion is added. The mixture is heated for several hours on a water bath, gaseous hydrochloric acid being bubbled through continuously meanwhile.

The resulting products give an excellent yield of vanillin with p-amidodimethylaniline as a byproduct. The formed vanillin may be extracted by treating the product of the reaction after cooling with a dilute caustic soda solution, the alcohol is separated by distillation, and the p-amidodimethylaniline is then extracted with benzene or ether.

The remaining alkaline solution of vanillin is then acidified and extracted with benzene or ether, after which the solvent is distilled, the remaining crude vanillin being then distilled in vacuum and the vanillin, recrystallized in water, separates in crystals having a melting point of 81 deg. C.

The reaction gives a yield of 100 per cent of crude product with respect to the guaiacol used. (1,345,649; ANDRÉ WEISS, of Lyons, France, assignor to Société Chimique des Usines du Phone; July 6, 1920.)

Crystal Production.—A method for the production of large regular crystals, such as Rochelle salt, for use in scientific apparatus utilizing the piezo-electric effect is described by ROY W. MOORE, of Schenectady, N. Y. (1,347,350; assigned to General Electric Co.; July 20, 1920.)

Oxidizing Isoborneol to Camphor.—A process for oxidizing iso-bormeol to camphor which does not require the presence of a starter or catalyzer is outlined as follows by ROLAND L. ANDREAU, of Wilmington, Del.: A quantity of mixed nitric and sulphuric acids is made, containing the following proportions: 339 kg. of sulphuric acid, 66 deg. Bé., and 253 kg. of nitric acid, 26 deg. Bé., specific gravity 1.22. The mixed acid is introduced into a container, which may be provided with any desired type of stirring device. Thereupon about 1 kg. of isoborneol is added to the mixed acid. Only a small amount of the isoborneol is added in order to avoid having the reaction proceed too violently. If the reaction proceeds too violently the undesirable products, such as resinous compounds and camphoric acid, will be formed, and the compounds will become subjected to such violent ebullition that they cannot be retained in the vessel. When the temperature has risen to above 40 deg. C., indicating that the reaction has begun, which will usually be after about 15 minutes, additional isoborneol is added gradually and with caution; taking care that the temperature of the mass remains between 35 deg. C. and 40 deg. C. during the reaction, continuing the addition until the entire amount of isoborneol added equals 154 kg. The supernatant liquid, which contains the camphor in the form of a loose addition compound with N_2O_3, is then decanted and run into water, where the camphor precipitates as a solid, and is then washed, centrifuged, dried and purified. In this way a substantially theoretical yield is obtained. (1,347,071; assigned to E. I. du Pont de Nemours & Co.; July 20, 1920.)

Cellulose Acetate.—Many attempts have been made to substitute the sulphuric acid used as contact, or condensing agent, in conjunction with glacial acetic acid and acetic anhydride in the manufacture of cellulose esters, on account of its high splitting action on cellulose. The halogen acetic acids have been suggested, but their action is very slow, even when employed in very large quantity. JOE O. ZDANOWICH, of London, England, has found that when these acids are formed in the acetylating mixture in the presence of cellulose their action is more energetic. Thus 20 g. of cellulose is added to a mixture of 60 c.c. of acetic anhydride and 110 c.c. of glacial acetic acid. While stirring, a current of chlorine gas is introduced, either at ordinary temperature or at 60 to 70 deg. C. After about two hours' time, either at this temperature or at the ordinary temperature, ten or twelve drops of sulphuric acid is introduced and the mixture is stirred until it changes into a clear, colorless, very viscous solution, which can be used for films, artificial silk, varnishes and the like, or can be precipitated, and treated and used in the usual way. (1,347,801; July 27, 1920.)

Electrolytic Pickling Process for Copper.—In order to avoid loss of ductility, copper is often worked while hot and in this state it oxidizes very readily. The removal of the oxide scale by pickling in sulphuric acid produces a solution of copper sulphate, the economical recovery of which presents a problem due to losses by leakage and accidents during operation. JOHN COULSON, of Wilkinsburg, Pa., proposes to make the copper body to be pickled the cathode in an electrolyte of dilute sulphuric acid, a lead-containing tank serving as the anode. The arrangement of the apparatus is such as to permit the articles being treated to be attached to the negative pole of the source of electric current before entering the electrolyte in order to prevent, from the outset, electrolytic action of the current upon the metallic copper. The copper oxide is, however, reduced to metallic copper by nascent hydrogen evolved from the electrolyte at the cathode. This process reduces the oxide very rapidly. In order to recover, from the electrolyte, the copper which is present in the form of copper sulphate, he provides a third or auxiliary electrode which may also be electrically connected to the negative terminal of the source of electrical energy. Copper from the electrolyte is deposited upon this auxiliary electrode and is thus recovered. (1,347,897; assigned to Westinghouse Electric & Mfg. Co.; July 27, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Association of Iron and Steel Electrical Engineers

Following is the program for the fourteenth annual convention of the Association of Iron and Steel Electrical Engineers, to be held at the Hotel Pennsylvania, New York, Sept. 20 to 24:

MONDAY, SEPT. 20

9 a.m.—Registration.

10:30 a.m.—Business session (for members only). Reports of committees. Election of officers.

2 p.m.—Papers: "Practical Education of Steel Mill Electricians," W. A. Cornwell; "Relation of Standardization in Electrical Equipment to Safety," Walter Greenwood.

TUESDAY, SEPT. 21

10 a.m.—Papers: "Power Transmission for Industrial Plants," D. M. Petty; "Underground Transmission," A. L. Freret.

2 p.m.—Excursion.

WEDNESDAY, SEPT. 22

10 a.m.—Papers: "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "Report of Electrical Development Committee for 1920, E. S. Jefferies, chairman.

2 p.m.—Papers: "The Reversing Electric Mill Considered From the Standpoint of Tonnage," K. A. Pauly.

7 p.m.—Annual Banquet. Arrangements have been made to accommodate 1,000 guests. Ladies are especially invited.

THURSDAY, SEPT. 23

10 a.m.—Papers: "Centralized Turbine Generating Stations for Steel Mills," T. E. Keating; "Current Limit Reactance," R. H. Keil.

2 p.m.—Papers: "Report of Electric Furnace Committee for 1920," E. T. Moore, chairman.

FRIDAY, SEPT. 24

10 a.m.—Papers: "Standardization Committee Report," W. T. Snyder, chairman.

2 p.m.—Excursion.

Industrial Research on Black Pigments Used in the Rubber Industry

The Rubber Trade Laboratory (235 Plane St., Newark, N. J.) announces that an industrial research will soon be started to determine the importance and relative value of the various black coloring agents used in the rubber industry.

The investigation will include the gas blacks, lampblack, graphite, bone black and powdered coal, on the one hand, while another series of tests will be made on the pitch hydrocarbons made by treatment of gilsonite, asphaltum, petroleum residues, coal tar and stearine pitch or candle tar. Most of these hydrocarbons have become known in the rubber trade as "mineral rubber," although this is a misnomer.

The purpose of the investigation is to accumulate data which will stimulate the use of these products in the field of rubber and plastic compounds. All users of these materials are invited to write to Dr. Frederic Dannerth, director of the laboratory, concerning information they may have on the use of the products. It is known that many users have encountered difficulties in manipulating some of these products, and it is therefore hoped that chemists and superintendents will feel free to send to the Rubber Trade Laboratory such questions as have arisen. Collaborators and consumers are assured that this will not place them under any financial obligation to the laboratory.

Last of Surplus Gas Sold

With the recent sale of 150 tons of phosgene, the Chemical Warfare Service has disposed of practically all of its surplus gases. A sufficient reserve is being kept to be ready for use in case of an emergency. General A. A. Fries, the chief of the Chemical Warfare Service, hopes to be able to carry through a plan which will allow the sale of 25 per cent of the reserve gases each year. The gases sold are to be replaced by new gas manufactured by the Chemical Warfare Service. This will allow manufacture to proceed on a small scale, sufficient to provide training and opportunities to apply improvements. General Fries hopes to get permission to adopt the same procedure as is permitted in the Quartermaster Corps, which allows money obtained from sales of materials to revert to the funds of the corps for repurchase of fresh supplies. At present the receipts from all sales made by the Chemical Warfare Service are paid into the Treasury.

General Fries Announces Policy as to Patents

After careful consideration of the whole subject of patenting processes and devices developed in the Government service, General A. A. Fries, chief of the Chemical Warfare Service, has reached the conclusion that the Government should be entitled without charge to full benefits of such development. The employee responsible for the development would be allowed to take out a patent and reap the full benefits of its use by the public or by other governments.

General Fries points out that whether or not the United States keeps abreast with other nations in the matter of gas research depends on stimulating chemists of the Chemical Warfare Service to do their utmost. By following the policy outlined, be believes the public will obtain all the benefits from the patents that could reasonably be expected, and the inventor will not be denied a handsome reward if his discovery is of sufficient commercial value.

German Government to Release Nitrogen Supplies

According to a cablegram from Berlin, of recent date, it is planned by the government to release 30,000 to 50,000 tons of nitrogen, which has been made by the Haber process from air, to be exported duty free. The prices charged to German domestic fertilizer consumers will be reduced by the receipts of sales made abroad.

To Name Consulting Chemists

Brigadier General Amos A. Fries, head of the Chemical Warfare Service, is having difficulty in obtaining his consulting staff. While these places are honorary, General Fries insists on appointing no one who will not take the time to bring helpful thoughts and suggestions to the service. Connection with a Government bureau in a consulting capacity frequently has degenerated to the point where the bureau confers the honor and hears nothing further from its consulting engineers.

General Fries believes that there are distinguished chemists in the United States who will take an active interest in the affairs of his bureau. In laying the proposition before those who are asked to serve in that capacity, he makes it clear that he will expect frequent suggestions from them. If they will submit problems, he will furnish the young chemists to follow them up.

Prize for Method for Hardness Determination

Sir Robert A. Hadfield has placed in the hands of the Institution of Mechanical Engineers, 11 Great George St., Westminster, London, S. W. 1, England, the sum of £200, the income therefrom to be awarded at the discretion of the Council as a prize for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness.

Competitors should familiarize themselves with the ordinary tests of hardness, such as are described in the Report of the Hardness Tests Research Committee (*Proceedings* of the Institution of Mechanical Engineers, 1916, pp. 677-778). What is desired is the description of a research for or an investigation of some method of accurately determining hardness, suitable for application in metallurgical work in cases in which present methods partially fail.

Recommended Specifications for Green Paint — Semi-Paste and Ready Mixed

Circular 97 of the U. S. Bureau of Standards contains specifications for green paint—semi-paste and ready mixed—with special reference to chrome green paint, either in semi-paste pigment ground in linseed oil or ready mixed. The specification covers the general conditions and the maxima and minima of useful, harmful or neutral constituents and methods of sampling, and the details as to the laboratory examination and analysis. The detailed methods of preparing the reagents to be used are also given. The standard was prepared under the auspicies of the Bureau of Standards and submitted to large numbers of representative paint manufacturers, and was also recommended by the United States Interdepartmental Committee on Paint Specification Standardization.

Courses in Chemical Engineering

The Bureau of Education has just issued a leaflet describing "Opportunities for the Study of Engineering at American Higher Institutions." This is prepared to assist foreigners desiring to enter technical collegiate work in the United States, but affords also a valuable list of the institutions in this country where 4-yr. courses in various branches of engineering are conducted. Those where a chemical engineering course is given, leading to a degree, generally Bachelor of Science in Chemical Engineering, are shown in the following table, together with a statement of the total engineering enrollment of the institution—i.e., the enrollment including civil, electrical, mechanical and others, as well as chemical engineering. However, this list does not include institutions where there are given chemical courses not classed as chemical engineering:

Institution	Total Engineering Enrollment
Alabama Polytechnic Institute, Auburn, Ala.	543
University of Alabama, University, Ala.	201
University of Arkansas, Fayetteville, Ark.	177
University of California, Berkeley, Cal.	1,340
Throop College of Technology, Pasadena, Cal.	337
University of Colorado, Boulder, Col.	531
Sheffield Scientific School (Yale University), New Haven, Conn.	531
Catholic University of America, Washington, D. C.	160
George Washington University, Washington, D. C.	461
University of Florida, Gainesville, Fla.	145
Georgia School of Technology, Atlanta, Ga.	1,160
University of Idaho, Moscow, Idaho	115
Armour Institute of Technology, Chicago, Ill.	639
University of Illinois, Urbana, Ill.	1,712
Purdue University, Lafayette, Ind.	1,691
University of Notre Dame, Notre Dame, Ind.	215
Rose Polytechnic Institute, Terre Haute, Ind.	236
Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa	1,030
State University of Iowa, Iowa City, Iowa	368
University of Kansas, Lawrence, Kan.	649
Louisiana State University and Agricultural and Mechanical College, New Orleans, La.	——
Tulane University of Louisiana, New Orleans, La.	220
University of Maine, Orono, Me.	518
Harvard University, Cambridge, Mass.	——
Massachusetts Institute of Technology, Cambridge, Mass.	2,291
Tufts College, Tufts College, Mass.	400
Worcester Polytechnic Institute, Worcester, Mass.	567
University of Michigan, Ann Arbor, Mich.	1,915
Michigan Agricultural College, East Lansing, Mich.	450
University of Minnesota, Minneapolis, Minn.	1,469
University of Missouri, Columbia, Mo.	406
Washington University, St. Louis, Mo.	335
Montana College of Agriculture and Mechanic Arts, Bozeman, Mont.	180
University of Mexico, Albuquerque, N. M.	——
Polytechnic Institute of Brooklyn, Brooklyn, N. Y.	1,240
College of the City of New York, New York, N. Y.	150
Columbia University, New York, N. Y.	509
New York University, New York, N. Y.	370
Clarkson College of Technology, Potsdam, N. Y.	——
University of Rochester, Rochester, N. Y.	——
Syracuse University, Syracuse, N. Y.	328
Rensselaer Polytechnic Institute, Troy, N. Y.	920
North Carolina State College, West Raleigh, N. C.	734
Ohio Northern University, Ada, Ohio	300
University of Cincinnati, Cincinnati, Ohio	836
Case School of Applied Science, Cleveland, Ohio	781
Ohio State University, Columbus, Ohio	1,437
St. Mary College, Dayton, Ohio	98
University of Oklahoma, Norman, Okla.	320
Oklahoma Agricultural and Mechanic College, Stillwater, Okla.	159
Lafayette College, Easton, Pa.	279
Bucknell University, Lewisburg, Pa.	304
University of Pennsylvania, Philadelphia, Pa.	687
Carnegie Institute of Technology, Pittsburgh, Pa.	1,655
University of Pittsburgh, Pittsburgh, Pa.	500
Lehigh University, South Bethlehem, Pa.	807
Rhode Island State College, Kingston, R. I.	183
Clemson Agricultural College, Clemson College, S. C.	409
University of Tennessee, Knoxville, Tenn.	189
University of Texas, Austin, Tex.	542
Agricultural and Mechanical College of Texas, College Station, Tex.	800
Rice Institute, Houston, Tex.	232
University of Utah, Salt Lake City, Utah	307
University of Virginia, Charlottesville, Va.	238
State College of Washington, Pullman, Wash.	326
University of Washington, Seattle, Wash.	——
West Virginia University, Morgantown, W. Va.	580
University of Wisconsin, Madison, Wis.	1,075

Chemical Warfare Display Interests Public

The chemical warfare display, which was a part of the so-called shows given by the First Division on its journey from Camp Taylor, Ky., to its new home at Camp Dix, N.J., proved to be the most attractive feature of these entertainments. The use of colored smokes, signal rockets and flame throwers gave the public its first opportunity to see how chemical warfare is conducted. Stokes mortars were used to throw phosphorus and thermit bombs. This feature of the entertainment also proved very interesting to the crowds who watched the maneuvers.

War on Rats With Poison Gas

Rat extermination by the use of the poison gases of warfare is believed to be feasible under certain conditions, as a result of experiments conducted by the Chemical Warfare Service. The experiments were undertaken at the request of authorities at Gulf ports, where the occurrence of bubonic plague has made rat extermination imperative.

In one of the experiments a small cylinder of a mixture containing 30 per cent phosgene and 70 per cent chlorine gases was permitted to escape so as to spread over an area of 900 sq.ft. in which there were fifteen rats. In fifteen minutes the phosgene had been dissipated and in thirty minutes the chlorine could no longer be detected. All of the rats in the area were dead. The cost of the gas was 40c. and in thirty minutes the area could be frequented with entire safety by human beings.

As a result of this and other experiments, it is believed that an important new use has been found for these war gases. The fact that they are heavy and sink into depressions under docks and into cellars, sewers and other places which harbor rats is expected to solve the most serious problem that has confronted rat extermination by the methods heretofore used.

The use of irritating gases in breaking up crow roosts in the forest reserves also is being tried by the Forest Service. The existence of these roosts frequently makes it almost impossible to cultivate agricultural lands in their vicinity. The crows are very persistent in clinging to their established nesting places. It is believed that war gases can be used effectively in combating that pest. Experiments are also in progress looking to the use of gases in fighting grasshoppers and locusts.

Authorized to Buy German Dyes

The Government has decided to exercise its option on German impounded stocks of dyestuffs and has authorized the Textile Alliance, Inc., to purchase these stocks in the interest of the American consumer. The full official statement, issued by the War Trade Board Section of the Department of State, is as follows:

The United States Government, through the War Trade Board Section of the Department of State, has, in the interest of the people of the United States, authorized the Textile Alliance, Inc., of New York City, to undertake, *without profit to itself*, the following action in connection with Reparation dyes:

(1) To purchase certain dyes, being the final apportionment of impounded stocks covered by inventories of German manufacturers as of Aug. 30, Sept. 5, 19 and 27, 1919, in order that certain dyes which are not manufactured in this country and which are included in these impounded stocks might not be lost to the United States with detriment to American interests.

(2) To purchase dyes from the present existing stocks manufactured by Germany between the dates of Feb. 1, 1920, and June 30, 1920, both inclusive, in order that certain dyes which are not manufactured in this country and which are included in these stocks might not be lost to the United States with detriment to American interests.

(3) If found to be necessary and advisable to purchase such dyes as may be required and ordered through it by American consumers from future daily production of German manufacturers for the four and one-half year period commencing July 1, 1920.

(4) The authority of the Textile Alliance, Inc., to resell to American consumers the dyes acquired as above provided is subject to strict provisions regarding selling price and manner of sale for the purpose of insuring fair and equal treatment to all consumers who may wish to avail themselves of the opportunity offered.

The Government has decided to exercise its option upon German impounded stocks and has authorized the Textile Alliance, Inc., to purchase these stocks in the interest of the American consumer. Under existing regulations of the War Trade Board Section no dyes from these stocks may be imported by the Textile Alliance, Inc., which are either manufactured here or for which suitable substitutes are manufactured here on reasonable terms as to price, quality and production. No consumer will be allowed to receive more than a six months' supply of any dye at any one period from this source. Practically the same understanding is in effect regarding the daily production of the German factories from Feb. 1 to July 30, 1920.

Regarding the subject of future daily production, the Department of State has received information which would indicate that for some time to come the German factories will not be in a position to supply all expected requirements of the Allied and Associated countries and to fill Government orders emanating from these sources. If these indications are correct it would appear that unless this Government indicated a desire to exercise its option on future daily production and should render available machinery which would make it possible for American consumers, if they so desire, to obtain colors from this source, the American consumer might not be able to get such German dyes as he required. The consumer should clearly understand that he is not obligated or even advised to place orders through the machinery made available by the Government. If he believes that German dyes may be obtained from unofficial sources he may, subject to the then existing import regulations, either order such dyes as he needs direct from the German manufacturer or through such agent or agency as he may designate.

If the consumer, however, cannot obtain or believes he cannot obtain dyes by other means the Government can exercise its option on the subsequent daily production of the German factories and the Textile Alliance, Inc., can transmit his orders for purchase from official sources.

Experiment With Steel Plate for Canning Purposes

In an effort to determine the best type of base steel plate for use in making tinplate for canning purposes, the chemists of the American Canners' Association are directing an extensive series of experiments, in which they have the co-operation of the American Can Co. and the Granite City Enamel & Stamping Co.

Tests are being made under commercial conditions of the effects of fruit acids on the various types of steel plate. Previous experiments have shown that the weight of tin with which the steel is coated makes slight difference in the resistance of the can to the corrosion of the acids.

Experiments are being made, among others, with a copper-bearing plate killed with silicon, and with titanium-bearing plate.

In this connection, attention is called to the fact that the amount of tin which will produce a toxic effect is not well established. The tin which is dissolved into the contents of a can of acid-bearing food is for the most part in an insoluble condition and probably is not absorbed by the system.

Water Conservation Committee of Engineering Council Offers Services to Power Commission

The water conservation committee of Engineering Council has offered its services to the Federal Power Commission in an advisory capacity on technical matters. Calvert Townley is the chairman of the committee. Other members are Charles T. Main, H. Hobart Porter, M. O. Leighton, Allen Hazen, Arthur P. Davis, Arthur E. Morgan and F. W. Scheidenhelm.

Civil Service Examinations

The United States Civil Service Commission announces open competitive examinations to fill various vacancies in the departments as listed below:

Assistant examiner, Patent Office.
Metallurgical laboratorian.
Laboratory aid.
Laboratory assistant, intermediate grade, $1,080 a year.
Laboratory assistant, junior grade, $1,000 a year.
Senior aid, $900 a year.
Associate physicist qualified in physical metallurgy, $2,000-$2,800.
Assistant physicist qualified in physical metallurgy, $1,400-$1,800.
Assistant metallurgist (Bureau of Mines), $2,000-$3,000.
Catalytical chemist, $3,000-$4,000 a year.
Assistant catalytical chemist, $2,000-$3,000 a year.
Junior catalytical chemist, $1,600-$2,000 a year.
Chemist, $3,000-$4,000 a year.
Associate chemist, $2,000-$3,000 a year.

Further information may be had by writing to the Civil Service Commission, Washington, D. C.

Old Hickory Powder Plant Bids Postponed

The Director of Sales of the War Department announces that the date for receiving bids for the Old Hickory powder plant, near Nashville, Tenn., has been postponed from Sept. 2 to Sept. 30. This postponement was found necessary because of the large number of inquiries received and the magnitude of the proposition.

Old Hickory, which is a great modern plant and industrial town, was constructed for the manufacture of smokeless powder and explosives, but its several units are readily adaptable to many industries including chemical, rubber goods, such as auto tires; pulp and paper mills, sugar refinery, coking and coke byproducts, food, both evaporated and concentrated; iron and steel foundries, fibrated products, such as asphaltum shingles; aluminum, wood box or refrigerator manufacture, cellulose and photographic film manufacturing and a number of other minor industries, such as an ice plant or cold-storage warehouse.

Lead and Zinc Experiment Station

Lead and zinc problems will be studied at a new Bureau of Mines mining experiment station, which probably will be located at Rolla, Mo. The exact problems which will be taken up at the new station will not be determined until after a conference in St. Louis on Oct. 9 between officials of the bureau and representatives of the lead and zinc industries interested.

The laboratories probably will be located at Rolla, but the business office of the station will be in St. Louis. The name of the station will be the Mississippi Valley Experiment Station. At this writing the Secretary of the Interior has not approved the location of the station, but it is regarded as practically certain that he will have no objection to the selection of Rolla as a site for its laboratories.

C. W. S. Needs $10,000,000 Appropriation

Fully $10,000,000 will be required during the next fiscal year to carry on the work of the Chemical Warfare Service on a scale commensurate with the needs of the national defense, in the opinion of chemists who are following the work of the Service. Of that amount it will be advisable, it is estimated, to expend as much as $2,000,000 for research.

C. W. S. Will Need More Officers

The need of the Chemical Warfare Service in the matter of officers will not be met when the results of the recent examination for commissions are announced. Although more than 200 appeared for the examination, a considerable number failed to pass the physical examination or were disqualified for other reasons. Only about 100 completed the examination. It is certain that a considerable percentage will fail to make the requisite grades. The results of the examination have not been announced but, judging from similar examinations which have been held in the past, those failing to make passing grades vary from 60 to 80 per cent. Ninety-five officers are needed for duty with the Chemical Warfare Service. A very high standard has been required in the examinations.

Personal

A. N. JOHNSON will leave the Portland Cement Association Oct. 1 to take up new duties as dean of the Engineering School and director of engineering research at the University of Maryland, College Park, Md.

PAUL D. V. MANNING has joined the chemical staff of the International Coal Products Co. Newark, N. J. He formerly was with the Chile Exploration Co.

MORRIS METCALF has been appointed president and a director of the International Steel Corporation, 51 Chambers St. N. Y., a subsidiary of the American International Corporation.

KENNETH P. MONROE has resigned as chemist in the color laboratory, United States Bureau of Chemistry, Washington, to accept a research position in the Jackson Laboratory of E. I. du Pont de Nemours & Co., Wilmington, Del.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, has returned to Washington after an extended trip to the Western experiment stations of the Bureau of Mines.

Dr. E. F. NORTHUP has resigned his professorship at Princeton University to devote his entire time to the business of the Ajax Electrothermic Corporation, Trenton, N. J.

H. B. PULSIFER, who was formerly professor of metallurgy at the Montana School of Mines and state metallurgist, will be an assistant professor of metallurgy at Lehigh University, Bethlehem, Pa., commencing with the academic year 1920-21.

DAVID B. REGER, of Morgantown, W. Va., is on leave of absence from the West Virginia Geological Survey for the next few months and will devote that time to consulting work in petroleum and coal. He has just completed a month's trip to the prospective oil fields of Montana.

HARRY B. RIFFENBURG, formerly assistant professor of chemistry and chemical engineering at the Agricultural and Mechanical College of Texas, resigned on Sept. 1 to accept a position as junior chemist in the quality of water division of the water resources branch of the U. S. Geological Survey, Washington D. C.

Dr. LUDWIK SILBERSTEIN, formerly of Adam Hilger, Ltd., London, is now associated with the research laboratory staff of the Eastman Kodak Co. Dr. Silberstein is known for his mathematical papers dealing with electro-magnetism, optics, theory of relativity, projective geometry, spectrum theory, etc.

F. L. STACK has left the Cia. de Santa Gertrudi at Pachuca, Mexico, to join the staff of the Chile Exploration Co. in New York.

Dr. WALTER F. TAGGART, for many years professor of organic chemistry at the University of Pennsylvania, has been elected to succeed Dr. Edgar Fahs Smith, who resigned last June as Blanchard professor of chemistry at

that institution. Prof. Taggart is now head of the chemical department of the University.

G. M. WILLIAMS, who has been for a number of years a specialist in the cement investigations of the Bureau of Standards, has resigned to accept an assistant professorship in civil engineering at the University of Saskatchewan. Mr. Williams has been particularly engaged in the work of cement protection in regions where alkali waters prevail, having had an active part in the joint investigations of the Reclamation Service, the Department of Agriculture and the Bureau of Standards. It is expected that the Canadian work of this sort which is under way will receive Mr. Williams' active attention for some time to come, in connection with his university activities.

Book Reviews

SCIENCE AND LIFE. Aberdeen addresses by *Frederick Soddy*, M. A., F. R. S.: Dr. Lee's professor of inorganic and physical chemistry, University of Oxford; lately professor of chemistry, University of Aberdeen. 229 pp. New York: Dutton & Co., 1920.

This book is a collection of articles published and addresses made during Prof. Soddy's incumbency of the chair of chemistry at Aberdeen, and it includes the following subjects: Chemistry and Life; Chemistry and National Prosperity; Science and the State; The Future of Science and What Bars the Way; The Evolution of Matter; The Conception of the Chemical Element as Enlarged by the Study of Radioactive Change; Matter, Energy, Consciousness and Spirit; To the New Launch and the Ideals of a Science School. It concludes with an appendix in which the method of administering the Carnegie Trust for the universities of Scotland is subjected to fearless and lively criticism, and a report of the controversy that followed it.

The several essays are rather loosely put together, and there is a slight measure of repetition in them; but this is no fault. Prof. Soddy is a believer in the mission of science; many of the addresses were made during the war, and he spoke from the very depths of his soul, with no effort to hide the emotion which prompted him to issue his call. He tells with marked eloquence the gifts that science has made to humanity, and then he asks what we have done with these gifts. "The strong," he says, "have fed and grown fat upon a large and ever larger share of the manna (from science). Initial slight differences of strength and sagacity have become so emphasized by the virile stream that the more successful are becoming monstrously so, and the unsuccessful less able to secure a full meal than before the shower began." This, it would seem, might be the beginning of radical political propaganda, but it is not. The burden of his complaint is not against political conditions; these do not seem to worry him. His complaint is that we do not know enough; that our education is faulty. He blames our reactionary method of education. "Is there," he asks, "a single practical branch of human thought or knowledge which has been left untouched; nay, more, which has not been altered to its very foundations by the progress of science?" And the reply is, "The education of those to whom, for the most part, is entrusted the happiness and the destiny of nations ceases where it should begin!" He insists that science must not only be taught, but understood, if we are to meet the great obligations of the future.

"The wealth of a country," he says, "is in its matter and energy—matter, the passive resister that in the raw state will not do anything you want it to do; and energy, both animate and inanimate, which is forever trying to do what you do not want it to do, and needs to be controlled. So man found the world, and so, largely till the beginning of the last century, he left it, moralizing and philosophizing eternally about himself and leaving a vast legacy of these elegant accumulations for the 'education' of his children." And he declares we must break the entail of dead languages.

"Let us glance at the change that has come over the world with regard to the relations of man to energy and matter. Instead of being between the two as between a steam hammer and an anvil, man has climbed to the controlling gear and has his hand upon the valve. And the hands on this valve are the hands of the chemist and the physicist, and their executive officer, the engineer."

He recognizes the possibility of developing power from breaking down atoms of the heavier elements and he even hopes that with the immense capacity for use and destruction that will come with this achievement it may not be too soon at hand. For we are not ready to wield such power. We are not yet good enough.

The book is of special interest to men of science, because it brings out their immense burden of responsibility. He says that the elevation of human ideals and the inspiration of character has not progressed to keep pace with the growth of physical power at hand. For power is everything. We live on it, developing it very much as a steam engine develops it from fuel. When we get our power in immeasurable quantities we shall have such capacity to do harm that it may be we are better off without it. It would be well also for the educator to read the book. If he is a classicist it may worry him, but he will be unable to resist the demand to ask himself whether he is making his own work worth while.

The chapters on radioactivity are beautifully written, and, coming from Prof. Soddy, are authoritative.

ELLWOOD HENDRICK.

SURVEYING. By *W. Norman Thomas.* 536 pp. 18 chapters. London: Edward Arnold; New York: Longmans, Green & Co.

The latest surveying science as practiced in England is amply presented. While this text is not in the same class from an engineering viewpoint as the leading standard American treatises, nevertheless it can be read with profit by our surveyors who have the desire to import new ideas and incorporate them in their practice.

WALLACE SAVAGE.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Sept. 10, 1920.

It has become obvious that the peak has been passed in iron and steel demand and in prices, but no early cessation is to be expected in furnace and mill activity, nor are prices likely to decline in the near future.

Apparently it required the passing of the midsummer period to show conclusively that the market lacked fundamental strength. July and August are always very dull months in the iron and steel markets, hence the dullness in the bimonthly period just ended attracted much less attention than it would have attracted at any other time in the year. If the season of year were the governing influence, the passing of time would have brought an increase in activity, but the actual condition is one of stagnation.

EFFECT OF NORMAL RAIL TRAFFIC RESTORATION

A question that was a puzzling one a few weeks ago has now been answered, what would be the effect upon business, and upon steel demand in particular, of a restoration of rail traffic conditions to something like a normal basis, whether that would stimulate business by making it easier to do business, to produce and consume, or would put a damper on business by causing consumers to depend more upon their stocks. It may be difficult to establish precisely the connection between the improvement in rail traffic conditions and the present state of the iron and steel markets, if indeed there is any important connection, but at any rate two things have occurred, the rail situation has become almost normal and the iron and steel markets have become patently dull.

The condition is simply one of abstention from buying. Consumers are content with the material that is already due them on purchases and are indisposed to make additional commitments. Here and there some demand exists for early deliveries, but the total tonnage is not large and the material is wanted simply to "piece out."

Cancellations of Steel Orders

Much reference is made to cancellations that have occurred, or are likely to occur, of steel orders. The situation in this respect is much like what has obtained in the past after a great market movement. There are cancellations, but they involve no large tonnage in proportion to the total on mill order books. Each arises from some special condition obtaining with the buyer, so that the cancellations that have occurred are by no means typical or illustrative of a general condition. In the main the material that has been ordered is actually required to carry out engagements the buyer has made.

No Declining Tendency in Prices

There is no general declining tendency in prices of either pig iron or steel products. Some developments might be cited as indicating declines, but they would not be a real criterion. There have been several different markets, first the Steel Corporation market, at the Industrial Board prices that became effective March 21, 1919, and then several different markets among the independents. Some independents sold to regular customers at prices that have changed scarcely at all since the advance culminated early in the year. Other independents sold at approximately all they could secure, but only to regular customers. Others still made no distinction between strangers and those who had been regular customers. In this last-named market some declines might be found, but that is of no consequence. The producers that have maintained more or less steady prices are adhering still to those prices and possibly they are a shade stiffer than they were.

Except as to one matter, the whole steel market presents an appearance strikingly similar to conditions that have obtained at various times in the past when there had been an active buying movement with advancing prices. There is the same quiet market, the same maintenance of prices and the same willingness of buyers to accept deliveries on old contracts while they will not make additional commitments. The one exceptional feature is that the United States Steel Corporation, which makes about 44 per cent of all the steel, has no connection with the situation. It did not advance prices, and it is sold, in proportion to capacity, probably at least twice as far as are the independents. The corporation experiences few if any cancellations.

Just as has been the case at similar junctures in the past, the mills are indisposed to reduce their prices. Little if any business would be attracted, and the filling of the business now on books would be jeopardized more or less.

Outlook Is for Full Operation to End of Year

The only important question at this time is how long the momentum will carry the situation. The mills are operating as full as they can and have been shipping not only their current output but much of the material accumulated in the four months April to July, when it was impossible, on account of rail traffic conditions, to ship all the output. The various experiences of the past have been that a stagnant market is not followed quickly by lessened production. The mills run on their orders and the momentum carries them for quite a while. At the moment the outlook is that there will be substantially full operation to the end of the year, and quite possibly through the winter. The prices of independents may not decline for months, and when they do decline they will probably decline rapidly.

The Pig Iron Market

It has required only a very short time to make it plain that the recent advance in pig iron in various districts was not justified from any conservative viewpoint. Pig iron, being made to sell, is not benefited by a paper price, and the $50 level to which pig iron was pushed in several districts is a price on paper but a price at which little iron has been sold or is likely to be sold. Pig iron was already too high in relation to steel products and in relation to pre-war prices. Apart from that, some developments may be mentioned. The production of merchant pig iron increased by about 7 per cent from July to August, and to a rate that has been exceeded for only a few weeks at any time in a year and a half, while there are some idle furnaces ready to go into blast if they can secure coke, but they require the coke at a price much below that at which there would be left a good margin of profit on pig iron sold at $50. Another development is that two districts, Chicago and Birmingham, have not followed the advance. Chicago remaining at $46 and Birmingham at $42. That is not because the producers in those districts were unable to force their prices up, but because their judgment was that it was best not to do so. Even with the stiff advance in freight rates Birmingham iron could get into Pittsburgh and beat valley iron by over $2 in the delivered price, whereas in the past few years Birmingham iron has rarely been able to get into Pittsburgh.

Two other developments bearing upon the future of pig iron prices may be mentioned. The Steel Corporation has some pig iron production at Milwaukee that is sold as merchant iron, and the corporation has just set a price of $39, furnace, on its fourth quarter deliveries, these being confined, of course, to regular customers. The corporation also has some merchant production in the Birmingham district, on which its price has not gone above $38, Birmingham, and it is now announced that on Oct. 1 two more furnaces will be put into the merchant class, as their output will no longer be needed for the steel works.

The Chemical and Allied Industrial Markets

New York, Sept. 10, 1920.

Two weeks have gone by since the last market report in these pages, yet conditions have changed but little. Prices are no firmer; in some lines there has been a decline, while buying is practically at a standstill.

Spot supplies are mostly of those items which have been less active than the others in the past, and holders are consequently still finding difficulty in disposing of this material even with the concessions being granted. *Caustic potash* still remains firm around 28c. per lb., with very little obtainable for spot demand and producers pretty well sold up for some time to come. On the other hand, *caustic soda* and *soda ash* are somewhat weaker. Although former prices of $5.60@$6 per cwt. for the former and $3.20@$3.60 per cwt. for both grades of the latter still prevail, nevertheless those who do not seem to agree with these prices are remaining quiet. *Copperas* and *barium chloride*, two recently active items on the list, are now in better supply and quantities of the former can be obtained around $2 per cwt., although $2.25 seems to be the more average price, while *barium chloride* has come to $130, compared with a former low level of $150 per ton. *Arsenic* continues rather dull, with very little business recorded, at 14@16c. per lb. for the white grade and 17@19c. for the red. *Bleaching powder* maintains the firm tone which has been noticed for some time and is obtainable only in small lots at $7@7.50 per cwt., which is 50c. better than the last listing. The intention of the comment on the above items is to indicate that tendency of chemical prices at present is not upward.

Coal-Tar Products

All that has been said in the previous paragraph applies to this market and to avoid repetition it is sufficient to say that the condition is little more acute in this case. There is small room for doubt that the crudes would be more active if they were in better supply, as the demand for these continues brisk, but producers are handicapped under present labor conditions and are contracted for a considerable length of time in advance. The opposite is true of the intermediates. Supplies are greater than requirements at present and buyers, realizing this situation, are holding out for lower prices. Among the intermediates to come down during the period was *dimethylaniline*, which dropped to

80@90c., compared with the former quotation of $1@$1.05 per lb. *Beta naphthol*, technical, was also affected by this inactivity and dropped off 5c. per lb., from 85@95c. to the present listing of 80@85c. per lb. In line with the others *paranitraniline* is weaker, being available at $1.10@$1.15 per lb., with the possibility of still lower prices in large quantities, compared with the previous firm quotation of $1.10@ $1.20 per lb.

NAVAL STORES

Turpentine started on the decline about a week back and has been dropping steadily since then. Current quotations range around $1.49, against the previous quotation of $1.55 per gal. The slackening of foreign demand is responsible for this condition, which it seems will prevail a while at least. Savannah, which influences the local market, is quoted at $1.48 and is on the decline, being supported by the local buying, which in itself is not very heavy.

VEGETABLE OILS

This market is very much weaker than it was two weeks ago. No interest is being displayed by buyers even at the present low levels. Crushers are stocked up and are unable to dispose of their supplies. Noticeable declines occurred in *chinawood oil* in barrels, f. o. b. Pacific coast, listed at 14¾@16c. per lb. *Linseed* is also considerably weaker, being quoted at $1.22 per gal. as the general quotation, while it is rumored sales have gone as low as $1.10 per gal., for which level buyers seem to be waiting.

The Baltimore Market

Baltimore, Md., Sept. 8, 1920.

Purchasing of raw fertilizer materials on the local market for the past few weeks has been practically at a standstill. This has been due in part to the manufacturers' inability to get cars for shipping the finished products, also the general weaker tone in the market for many raw materials.

Now that the new freight rates have gone into effect, the local trade generally expects a greater supply of cars and a consequent speedier movement of mixed goods and raw materials. It is generally felt that the bearish condition is due to the tight money situation, rather than an excess supply or lack of demand.

Since our last letter a fire occurred at the plant of the Standard Guano Co., Curtis Bay, this city, which resulted practically in the complete loss of the bone mill, tankage house and a large stock of raw materials; this loss has been estimated at $250,000. Fortunately, the acid plant and adjoining properties were uninjured.

ACID PHOSPHATE

Acid phosphate continues to be strong in demand, with the market showing no weakness. Bulk acid phosphate, run of pile, is being nominally quoted at $20 per ton, basis 16 per cent A. P. A., f. o. b. Baltimore. Sales for spot parcels have been reported at somewhat higher figures. A number of recent inquiries for spot goods have failed to result in business because of the sellers' inability to get cars for shipment. The labor situation at the mines does not seem to have been appreciably improved, and as a consequence the raw rock shortage continues and a generally firm price for acid phosphate for spring is expected.

NITRATE OF SODA

The nitrate of soda market for nearby deliveries continues to work lower. Spot parcels, Southern ports, are being offered at $3.65, and in some cases sellers are soliciting bids. Spot parcels may be had locally around $3.75, and it is believed that delivery up to Jan. 1 could be had around the same figure. Importers are quoting nominal for forward deliveries at $3.80 Atlantic ports. Reselling of nitrate by Japan has been effected on rather a large scale; purchases made by local manufacturers were on a basis of ex vessel Pacific port; the prices paid, however, figured closely in line with the quotations given here.

POTASH

The demand for potash on the local market is quite limited at this time, and a number of resale lots of various grades of foreign salts are being offered for spot and nearby deliveries. Nominal quotations for August, September, October, arrival Atlantic ports, are as follows: Muriate potash, $2.35 per unit; manure salts and kainit, $1.95@$2.05 per unit K_2O; for November forward sellers are generally asking a premium of 10 to 15c. per unit. Domestic potash is being quoted nominally at $2.25 per unit f. o. b. mines for delivery November forward.

SULPHATE OF AMMONIA

A number of resale parcels of sulphate of ammonia from Japan are still in evidence. The last offerings noted were at $5.55 per cwt., bulk, basis Baltimore rate of freight.

FISH SCRAP

Menhaden fishing on the Chesapeake Bay during the past few weeks has been generally poor. The fish have been running uniformly low in oil, and as a consequence the fish factories are greatly disappointed in the results obtained so far this season. The production of scrap has been sold ahead at a uniform price of $7.50 and 10c. f. o. b. factories.

Due to the shortage in production and the steady demand for scrap, no weakening in this market is expected for the immediate present.

The Chicago Market

Chicago, Sept. 8, 1920.

In practically all lines the local chemical market is apparently in the doldrums. Instead of being surprised and disappointed at this condition, all parties concerned are sufficient students of economy to realize that it is inevitable and are complacent in the knowledge that they have so disposed their resources as to be able to get through this stagnant period with no real financial difficulty.

Sharp observers early in the spring saw that in the flood of orders being booked in all manufacturing lines a great many duplications and inflations were creeping into the swollen back order files, and that cancellations and a scaling down of orders must necessarily occur. The present slackness of trade is felt to be the natural reaction from the super-prosperity of the spring season, and as the chemical industry furnishes the basic raw materials in many lines, this slackness is naturally most keenly evident in the chemical trade.

One good feature of the current depression is the elimination of the numerous "vest pocket manipulators," dealers in chemicals whose stock in trade consisted of a list of obtainable supplies, whose participation in the trade tended only to increase the difficulties of legitimate buyers and sellers, to the profit of the speculators alone.

All consumers are today marking time—buying only sufficient materials to keep production up to the necessary mark, and in many lines that mark has been placed considerably lower than it was a few weeks ago. The price recessions on many lines are sharp, but quotations are still above what is felt to be the real intrinsic value of the commodities concerned, so that lower levels may be expected before business again strikes a normal stride.

HEAVY CHEMICALS

Trading is negligible. Those items which are firmly held in first hands remain steady in price, but those of which any great supply is in the hands of re-sellers are uncertain. With the exception of bleaching powder, the alkalis are showing little activity and are not strongly held. *Bleaching powder*, being very scarce and in need by the users, is worth whatever the customer can be compelled to pay. Small lots are being sold at prices ranging from 7@8c. per lb *Caustic soda*, under slack demand and improved supply, is offered at 5c. per lb. on spot, and it is probable some shading is being indulged in. *Soda ash* and *sal soda* are in a similar position, current quotations being slightly lower at 5c. and 2c. per lb., respectively, for sales from stock. No great activity can be expected in this class of material until makers announce contract prices for next spring.

But few items of interest are noted in the remainder of

the heavy chemical line. *Salt cake* is not available in sufficient quantity to supply all demands, though contracts are being filled. Trades in spot goods are running up to $50 a ton in car lots. *Arsenic*, as indicated in the last report, is off a cent to 14c. per lb. on the *white* and 18@18½c. per lb. on the *red*. *Copper sulphate* (blue vitriol) is firm at 9c. in cars and *copper carbonate* is still quoted at 27c. by both first and second hands with but few transactions noted.

Alcohols of all grades are unchanged in price while *formaldehyde*, under influence of a strong Eastern market, is quoted at 55c., with no great amount of sales. Holders and users of *glycerine* seem to differ in their opinion as to its worth, with a poor market at 28c. for c.p. grade as the result.

Coal-Tar Products

Retreachments in the textile industry are having their effect in keeping interest in color products at a low ebb. With the exception of *aniline oil* and *aniline salt*, no fluctuations of moment have been noted. These two items, in a very weak market, registered further declines and are easily obtainable at 25@26c. for the *oil* and 35½@36c. for the *salts*. Improved demand for oil has brought quotations up to 28c., but the *salt* continues as low as or even lower than before. Predictions of higher prices are heard, but it is difficult to find any facts to substantiate them. Prices on coal-tar crudes and acids are level, but with little trading being indulged in.

Vegetable Oils

Trade in all items of the list is very dull. Soap makers, paint makers and consumers of edible oils alike express themselves as satisfied to produce only sufficient finished product to fill actual orders and in many instances have sufficient raw material on hand to supply their needs for some time to come. In the face of a falling market no one can find justification for keeping up a heavy reserve stock, hence actual trading is at an exceedingly low level. *Cottonseed oil* last week reached a sufficiently low level to invite some investment. Prices are therefore fairly firm at 10¾@11¼c. per lb. on prime summer yellow and 15¼@15¾c. per lb. on refined, deodorized. *Red oil*, under pressure of a lack of buyers, is given a nominal quotation of 13@13¼c. with but few sales recorded, and *corn oil* excites no interest at the current quotation of 9c. Some buying by consumers is noted in *coconut oil* at 13@13½c. per lb. in sellers tanks, f. o. b. coast, and at 16@16½c. f. o. b. Chicago for Manila grade. The refined grade is 1c. higher. But little interest is displayed in *soya bean oil*, current transactions being reported at the unchanged price of 9½c. per lb. f. o. b. coast.

Linseed oil remains of uncertain value, the effect of low quotations on futures being very keenly felt. Holders of spot stocks decline to do business at less than $1.40 per gal., so that few actual transactions are being made.

Offers of *linseed oil* for future delivery at low prices have affected spots to such an extent that current quotation in tank cars, f. o. b. Chicago, is $1.15 per gallon. In barrels the price is 7c. higher. As futures are offered at still lower figures, the low prices have failed to induce heavy buying.

Naval Stores

Gradually falling prices, accompanied by a practice of hand-to-mouth buying by principal consumers, has made the local market in *turpentine* and *rosin* weak. *Turpentine*, under a plentiful supply, is off to $1.48@$1.55 for barrels in car load lots, f. o. b. Chicago. In quantities of from one to twenty barrels, quotation is 7c. higher. The prevailing weakness has also affected *rosins*, which three weeks ago were quoted at $16 per barrel in l. c. l. quantities on all grades. Today $14@$14.25 is quoted on WW grade with darker grades from 25c. to 35c. cheaper. Owing to insistent demand, market on pine oil remains firm at $1.90 per gal. This is one item of the line that needs no stimulation of foreign buying to maintain strength, as the best efforts of the producers are inadequate to supply the needs of our own country.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	-	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4 50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboy	cwt.	14.00 - 16.00	16.25 - ....
Boric, crystals	lb.	.15½ - .16	.16½ - .19
Boric, powder	lb.	.15½ - .16½	.17 - .20
Citric	lb.	.78 - .80	.82 - .84
Hydrochloric (nominal)	cwt.	2.25 - 3.00	3.10 - 4 00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ - .15½
Lactic, 44 per cent tech	lb.	10 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5 00
Muriatic, 20 deg. (see hydrochloric).		-	-
Nitric, 40 deg	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - 09½
Oxalic, crystals	lb.	.53 - .54	.55 - 57
Phosphoric, Ortho, 50 per cent solution	lb.	.18 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	-
Sulphuric, 60 deg., drums	ton	-	-
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	-
Sulphuric, 66 deg., carboys	ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30 00	38.00 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 -
Tannic, U. S. P	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - 70	.80 - .90
Tartaric, crystals	lb.	-	.74 - .77
Tungstic, per lb. of WO	lb.	-	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 - 5.75	6.00 - 7.00
Alcohol, Methyl (see methanol)		-	
Alcohol, denatured, 188 proof (nominal)	gal.	-	1.10 - 1 15
Alcohol, denatured, 190 proof (nominal)	gal.	-	1.05 - 1 10
Alum, ammonia lump	lb.	.05 - .05½	.05½ - 06
Alum, potash lump	lb.	.08½ - .08¾	.09 - 09½
Alum, chrome lump	lb.	- .17	.18 - .19
Aluminum sulphate, commercial	lb.	.04¾ -	-
Aluminum sulphate, iron free	lb.	.06 -	-
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	09½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 - .35½	.36 - .37
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - 13½	.13½ - .14½
Ammonium nitrate	lb.	.09 - .10	11 - .14
Ammonium sulphate	lb.	.07 - 07½	.08½ -
Amylacetate	gal.	-	5.00 -
Amylacetate tech	gal.	-	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	14 - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.17 - .18	.19 - .23
Barium chloride	ton	130 00 - 150 00	-
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .12	.12½ - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		-	-
Blue vitriol (see copper sulphate)		-	-
Borax (see sodium borate)		-	-
Brimstone (see sulphur, roll)		-	-
Bromine	lb.	.70 - .90	1.00 - 1.05
Calcium acetate	cwt	3 50 - 3 55	-
Calcium carbide	lb.	04½ 04½	.04¾ - .05½
Calcium chloride, fused, lump	ton	33.00 - 34.00	35.00 - 45.00
Calcium chloride, granulated	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	7 00 - 7.50	8.00 - 8.50
Calcium peroxide	lb.	-	1.50 - 1.70
Calcium phosphate, monobasic	lb.	-	.75 .80
Calcium sulphate, pure	lb.	-	.25 30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.14 - 15	.16 - .17
Carbonyl chloride (phosgene)	lb.	-	-
Caustic potash (see potassium hydroxide)		-	-
Caustic soda (see sodium hydroxide)		-	-
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	-	2.00 - 2.05
Copperas (see iron sulphate)		-	-
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	-	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		-	-
Epsom salt (see magnesium sulphate)		-	-
Ethyl Acetate Com. 85%	gal.	1.10 - 1.30	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		-	1.75
Formaldehyde, 40 per cent (nominal)	lb.	.48 - .50	
Fusel oil, ref	gal.	-	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	-	-
Glauber's salt (see sodium sulphate)		-	-
Glycerine, C. P. drums extra	lb.	-	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4 45
Iron oxide, red	lb.	-	.03 - .20
Iron sulphate (copperas)	cwt.	2 00 - 2.25	2.35 - 2.75
Lead acetate, normal	lb.	-	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	-	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	-	1.50 -
Magnesium carbonate, technical	lb.	.12½ - .13½	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 - 3.90	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	-	3.50 - 3.60
Methanol, 95%	gal.	-	3.25 - 3.30
Methanol, pure	gal.	-	3.50 - 3.55
Nickel salt, double	lb.	-	.14 - .16
Nickel salt, single	lb.	-	.13 - .14
Phosgene (see carbonyl chloride)		-	1.25 - 1 50
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	-	.35 - .37
Potassium bichromate	lb.	35 - .36	39 - .40

Olive oil, commercial	gal.	3.00 — 3 10
Palm, Lagos	lb.	10, — .
Palm, bright red	lb.	.[illegible] — .
Palm, Niger	lb.	.11 — .12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½ — .12½
Peanut oil, refined, in bbls	lb.	.17 — .18
Rapeseed oil, refined in bbls	gal.	1.40 — 1.50
Rapeseed oil, blown, in bbls	gal.	1.60 — 1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14 — .14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ — .11

FISH

Winter pressed Menhaden	gal.	$0.90 — $1.05
Yellow bleached Menhaden	gal.	0.95 — 1.05
White bleached Menhaden	gal.	1.00 — 1 25
Blown Menhaden	gal.	1.00 — 1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22 00 — $25 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00 — 20.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8 00 — 10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00 — 25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16 00 — 19 00
Barytes, crude, 88% @ 94% ba., Cartersville	net ton	12.00 — ..
Barytes, floated, f.o.b. St. Louis	net ton	26 50 — 28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11 00 — 11 25
Blanc fixe, dry	lb.	.05½ — .06
Blanc fixe, pulp	net ton	60 00 80 00½
Casein	lb	15 — .18
Chalk, domestic, extra light	lb.	.05 — .06
Chalk, domestic, light	lb.	.04½ — 05½
Chalk, domestic, heavy	lb.	.04 — .05
Chalk, English, extra light	lb	.05 — .07
Chalk, English, light	lb	.05 — .06
Chalk, English, dense	lb.	.04½ — .05
China clay, (Kaolin) crude, f o b. mines, Georgia	net ton	9 00 12 00
China clay (Kaolin) washed, f.o b Georgia	net ton	12 00 15 00
China clay (Kaolin) powdered, f.o b Georgia	net ton	18 00 22 00
China clay (Kaolin) crude f.o b. Virginia points	net ton	8 00 — 12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00 40 00
China clay (Kaolin), imported, lump	net ton	25 00 35 00
China clay (Kaolin), imported, powdered	net ton	30 00 — 60 00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50 — 8 00
Feldspar, crude, f.o.b. Maine	net ton	7 50 10 00
Feldspar, ground, f.o.b Maine	net ton	21 00 23 00
Feldspar, ground, f o b North Carolina	net ton	17 00 — 20 00
Feldspar, ground, f o b. N Y State	net ton	17 00 — 20 00
Feldspar, ground f o b Baltimore	net ton	30 00 .
Fuller's earth, granular, f o.b. Fla.	net ton	25 00 —
Fuller's earth, powdered, f o b Fla	net ton	18 00 —
Fuller's earth, imported, powdered	net ton	35.00 — 40 00
Graphite (dust polish grade 30%) Ashland, Ala	lb.	.... — 01
Graphite (dust facing grade 50%) Ashland, Ala	lb	— 02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	..... — 05
Graphite, crucible, 90% carbon Ashland, Ala	lb.	... — 10
Graphite, crucible, 85% carbon	lb	... 08
Graphite, crucible, 88% carbon	lb	. . 09½
Graphite, crucible, 90% carbon	lb.	. — 10½
Pumice stone, imported, lump	lb.	.04 50
Pumice stone, domestic, lump	lb	06
Pumice stone, ground	lb	.04 07
Quartz (acid tower) fist to head, f o b Baltimore	net ton	10 00
Quartz (acid tower) 1½ @ 2 in., f.o b Baltimore	net ton	14 00
Quartz (acid tower) rice, f.o.b Baltimore	net ton	17 00
Quartz, lump, f.o.b. North Carolina	net ton	5 00 — 7 50
Shellac, orange fine	lb.	1 35 — 1 40
Shellac, orange superfine	lb.	1 40 — 1 45
Shellac, A. C. garnet	lb	1 10 — 1 15
Shellac, T. N	lb.	1 15 — 1 20
Soapstone	ton	15 00 25 00
Talc, paper making grades, f.o.b. Vermont	ton	10 00 20 00
Talc, roofing grades, f.o.b Vermont	ton	9 00 15 00
Talc, rubber grades, f.o.b. Vermont	ton	10 00 15 00
Talc, powdered, Southern, f o b. cars	ton	20 00 — 25 00
Talc, imported	ton	60 00 — 70 00
Talc, California Talcum Powder grade	ton	20 00 — 35 00

Refractories

Chrome brick, f.o.b. Chester, Pa, carlots	net ton	100— 110
Chrome brick, 9-in. strs. and sizes, f o b Baltimore	net ton	100— 105
Fire clay brick, 1st quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	55 — 60
Fire clay brick, 1st quality, f o b. St Louis	1,000	45— .
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75— . .
Fire clay brick, 2d quality, 9-in shapes f o.b. Pennsylvania, Ohio and Kentucky works	1,000	50 55
Magnesite brick, 9 in. straights, f.o b. Baltimore	net ton	100 110
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90 — 100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55— .
Silica brick, f.o.b. Birmingham	1,000	56— 61
Silica brick, f.o.b. Mt. Union, Pa.	1,000	65—

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18 — .19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20 — 21
Ferro-manganese, 76-80% Mn, domestic	gross ton	195.00 — 200 00
Ferro-manganese, 76-80% Mn, English	gross ton	170.00 — 175 00
Spiegeleisen, 18-22% Mn	gross ton	75.00 — ..
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.25 — 2.75
Ferro-silicon, 10-15%	gross ton	60.00 — 65.00
Ferro-silicon, 50%	gross ton	80.00 — 90.00
Ferro-silicon, 75%	gross ton	150.00 — 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 — 1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 — ....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 — 7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20½% silica, not more than 14% moisture	gross ton	$10 00 $11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	60 65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	77 — 85
*Coke, foundry, f.o.b. ovens	net ton	20 00 —
*Coke, furnace, f.o.b. ovens	net ton	18 00 — 20 00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00
Fluor spar, lump, f o.b. Tonuco, New Mexico	net ton	17 50 —
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00 — 27 50
Ilmenite, 52% TiO_2, per lb. ore	lb.	0 ½ — 85 02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	65 — 75
Manganese ore, chemical (MnO_2)	gross ton	75.00 — 90 00
Molybdenite, 85% MoS_2, per lb of MoS_2, N. Y.	lb.	75 — 85
Monazite, per unit of ThO_2	unit	42 00 — .
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 — .
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½— .
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12 — 14
Pyrites, domestic, fines	unit	12 — .14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	6.00 — 7 00
Uranium Ore (Carnotite) per lb of U_3O_8	lb.	2 75 3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb	2.75 — 3 00
Vanadium pentoxide, 99%	lb.	12.00 14 00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 — .
Zircon, washed, iron free	lb.	.10 —

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	18 62
Aluminum, 98 to 99 per cent	34 90
Antimony, wholesale lots, Chinese and Japanese	7 00
Nickel, ordinary (Ingot)	43 00
Nickel, electrolytic	45 00
Tin, Straits, spot	48 50
Lead, New York, spot	8 90
Lead, E. St. Louis, spot	8 50@9 00
Zinc, spot, New York	8 50
Zinc, spot, E St Louis	7 70@8 05

OTHER METALS

Silver (Commercial)	oz.	$0 99½
Cadmium	lb.	1 40@1 50
Bismuth (500 lb. lots)	lb.	2 70
Cobalt	lb.	3 00
Magnesium (f o b. Niagara Falls)	lb.	1 75
Platinum	oz.	115 00@120 00
Iridium	oz.	350 00
Palladium	oz	100 00@110 00
Mercury	75 lb.	83 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb
Copper sheets, hot rolled	33 50
Copper bottoms	38 00
Copper rods	38 00@40 00
High brass wire and sheets	30 25
High brass rods	27 00
Low brass wire and sheets	28 50
Low brass rods	29 00
Brazed brass tubing	38 25
Brazed bronze tubing	41 75
Seamless copper tubing	34 00
Seamless high brass tubing	33 00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	20 00@20.50
Aluminum, sheet scrap	20 00@20 50
Copper, heavy machinery comp	13 50@13.75
Copper, heavy and wire	14 00
Copper, light and bottoms	12.50
Copper, heavy cut and crucible	15.00
Brass, heavy	9 50
Brass, light	7 00
No. 1 clean brass turnings	8 50
No. 1 comp turnings	12 50@13 50
Lead, tea	5 00
Lead, heavy	7 00
Zinc, scrap	5 00

Structural Material

The following base prices per 100 lb are for structural shapes 3 in. by ¼ in and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4 58	$3 97	$3.47	$5 00	$3 37	$3 97	$3 47
Soft steel bars	4.73	4.12	3.37	4 50	3 27	3 87	3 37
Soft steel bar shapes	4.73	4.12	3.37		3 27	3.87	3 37
Soft steel bands	6.43	5.32	4 07	6 25	....	....	.
Plates, ¼ to 1 in. thick	4 78	4.17	3.67	4 50	3 57	4.17	3 67

		Carlots		Less Carlots	
Potassium bitartrate (cream of Tartar)	lb.	$0 52	$0 56	$0.57	$0.58
Potassium bromide, granular	lb.	....		.70	.73
Potassium carbonate, U. S. P	lb.	.50	.55	.56	.60
Potassium carbonate, crude	lb.	.20	.25	.26	.28
Potassium chlorate, crystals	lb.	.17	.17½	.18	.20
Potassium hydroxide (caustic potash)	lb.	.27	28	.29	.33
Potassium iodide	lb.	....	......	3.35	3.60
Potassium nitrate	lb.	.17	.17½	.19	.21
Potassium permanganate	lb.	.75	80	.85	.95
Potassium prussiate, red	lb.	.85	.95	1.00	1.05
Potassium prussiate, yellow	lb.	.32	.36	.35	.40
Potassium sulphate (powdered)	ton	$240.00	255 00	.....	......
Rochelle salts (see sodium potas. tartrate)		......	......	......	......
Salammoniac (see ammonium chloride)		......	......	......	......
Sal soda (see sodium carbonate)		......	......	......	......
Salt cake	ton	.....	.. ...	48.00	50 00
Silver cyanide (nominal)	oz.	......	......	1.25	......
Silver nitrate (nominal)	oz.	......	......	.60	.62
Soda ash, light	100 lb.	..	......	3.20	3.50
Soda ash, dense	100 lb.	.	. ..	3.55	3.65
Sodium acetate	lb.	.10	.15	.20	.25
Sodium bicarbonate	100 lb.	2.50	2.75	3.00	3.50
Sodium bichromate	lb.	.22	.24	.26	27
Sodium bisulphate (nitre cake)	ton	7.00	8.00	9 00	11.00
Sodium bisulphite Powered, U.S.P	lb.	.08½		10	11
Sodium borate (borax)	lb.	.09	.10	.11	12
Sodium carbonate (sal soda)	100 lb.	2.00	2.10	2 15	2.25
Sodium chlorate	lb.	.11	.12	.12½	.14
Sodium cyanide, 96-98 per cent	lb.	.25	.30	.32	.35
Sodium fluoride	lb.	.18	....	.19	.20
Sodium hydroxide (caustic soda)	100 lb.	5 60	5.70	5.75	6.00
Sodium hyposulphite	lb.		......	.03	.04
Sodium molybdate	lb	2 50	.....	3 25½	...
Sodium nitrate	100 lb.	3 00	3.25	3.75	4.00
Sodium nitrite	lb.	.16	.18	.19	.20
Sodium peroxide, powdered	lb.	.32	.35	.35	.40
Sodium phosphate, dibasic	lb	.03½	.04½	.04½	.05
Sodium potassium tartrate (Rochelle salts)	lb.	.		.39	.40
Sodium prussiate, yellow	lb.	.23	.27	.31	.32
Sodium silicate, solution (40 deg.)	lb.	.01½	.01¾	.02	.02½
Sodium silicate, solution (60 deg.)	lb.	.02½	.03	.04	05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60	1.70	1.75	2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½	10	10½	.11
Sodium sulphite, crystals	lb.	.04	0 4½	04½	.05
Strontium nitrate, powdered	lb.	.15	.18½	.19	.20
Sulphur chloride red	lb.	.08	09	10	10.
Sulphur, crude	ton	16.00	20 00	..	.. .
Sulphur dioxide, liquid, cylinders	lb.	.09	......	10	.12
Sulphur (sublimed), flour	100 lb.	. . .	.....	3 80	4.35
Sulphur, roll (brimstone)	100 lb.		......	3 40	3.90
Tin bichloride (stannous)	lb.	.42½	.44	.45	.46
Tin oxide	lb.	......	......	55	.65
Zinc carbonate, precipitate	lb.	.16	.18	.19	.20
Zinc chloride, gran	lb.	.13	13½	.13½	.17
Zinc cyanide	lb.	.45	.49	.50	.60
Zinc dust	lb.	.12	.13	.13	.14
Zinc oxide, U. S. P	lb.	.17	.25		
Zinc sulphate	lb.	.03½	03¾	.04	06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb	$1.40	$1.50
Alpha naphthol, refined	lb	1 60	1.70
Alpha naphthylamine	lb.	.50	.52
Aniline oil, drums extra	lb.	30	.33
Aniline salts	lb.	.35	.40
Anthracine, 80% in drums (100 lb)	lb	.90	1.00
Benzaldehyde (f f.c)	lb.	2 00	2.10
Benzidine, base	lb	1 35	1 40
Benzidine, sulphate	lb.	1.15	1 25
Benzoic acid, U.S.P	lb.	.85	.90
Benzoate of soda, U.S.P	lb	.80	90
Benzol, pure, water-white, in drums (100 gal)	gal	.38	.40
Benzol, 90%, in drums (100 gal)	gal	.36	.38
Benzyl chloride, 95-97%, refined	lb.	35	.40
Benzyl chloride, tech	lb	.25	.35
Beta naphthol benzoate (nominal)	lb	3 50	4 00
Beta naphthol, sublimed (nominal)	lb.	.	.
Beta naphthol, tech (nominal)	lb	.80	85
Beta naphthylamine, sublimed	lb	2 25	2.40
Cresol, U. S. P, in drums (100 lb)	lb	18	.19
Ortho-cresol, in drums (100 lb)	lb	.23	25
Cresylic acid, 97-99%, straw color, in drums	gal	1 15	1 20
Cresylic acid, 95-97%, dark, in drums	gal.	1 05	1 10
Cresylic acid, 50%, first quality, drums	gal.	.65	75
Dichlorbenzol	lb	.08	.10
Diethylaniline	lb.	1 50	1 60
Dimethylaniline	lb	80	90
Dinitrobenzol	lb	.30	37
Dinitrochlorbenzol	lb	32	35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	40	.45
Dinitrotoluol	lb		.40
Dip oil, 25%, tar acids, car lots, in drums	gal	.38	.40
Diphenylamine (nominal)	lb.	80	.85
H-acid (nominal)	lb.	2 00	2.25
Metaphenylenediamine	lb.	1.25	1.30
Monochlorbenzol	lb.	.18	.20
Monoethylaniline	lb.	2.00	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	....
Naphthaline, flake	lb.	.. .	.19
Naphthaline, balls	lb.	...	.19
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	.85
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.30	.35
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1.10	1.15
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.50	2.65
Paratoluidine	lb.	2.00	2.25
Phthalic anhydride	lb.	.60	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.20
Pyridin	gal.	2.00	3.50
Resorcin, technical	lb.	4.25	4.50
Resorcin, pure	lb.	6.25	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	.52
Salicylic acid, U. S. P	lb.	.50	.60
Salol	lb.	.90	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	.26
Sulphanilic acid, crude	lb.	.32	.35
Toluidine	lb.	1.70	2.50
Toluidine, mixed	lb.	.45	.55
Toluol, in tank cars	gal.	.35	.....
Toluol, in drums	gal.	.38½	.40½
Xylidine, drums, 100 gal.	lb.	.50	.65
Xylol, pure, in drums	gal.	.47½	.50½
Xylol, pure, in tank cars	gal.	.45	.....
Xylol, commercial, in drums, 100 gal.	gal.	.32½	.35½
Xylol, commercial, in tank cars	gal.	.30	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	$0.39
Beeswax, refined, light	lb.	.37	.38
Beeswax, white pure	lb.	.63	.68
Carnauba, No. 1. (nominal)	lb.	.90	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	.86
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.17	.18
Montan, crude	lb.	.25	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	.11½
Paraffine waxes, refined, 125 m.p.	lb.	.12½	....
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18½
Stearic acid, single pressed	lb.	.20	.21
Stearic acid, double pressed	lb.	.22	.23
Stearic acid, triple pressed	lb.	.24	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.15
Pine oil, pure, dest. dist	gal.	1.80
Pine tar oil, ref., sp. gr. 1 025-1.035	gal.	.48
Pine tar oil, crude, sp gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o b. Mich., sp. gr., 0 960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$14.60	.....
Rosin E-I	280 lb.	14.50	.....
Rosin K-N	280 lb.	14.50	.....
Rosin W. G.-W. W	280 lb.	14.50	.....
Wood rosin, bbl	280 lb.	15.00	.....
Spirits of turpentine	gal.	1.49	.....
Wood turpentine, steam dist	gal	...	.....
Wood turpentine, dest. dist	gal.	....	....
Pine tar pitch, bbl	200 lb.	....	8.50
Tar, kiln burned, bbl. (500 lb)	bbl.	14.50	15.00
Retort tar, bbl	500 lb.	15.00	15.50
Rosin oil, first run	gal.	.72	....
Rosin oil, second run	gal	.75	....
Rosin oil, third run	gal.	.92	.....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.29	$0.31
Upriver coarse	lb.	.19	.20
Upriver caucho ball	lb.	.20	.22
Plantation First latex crepe	lb.	.30	.....
Ribbed smoked sheets	lb.	.28	.....
Brown crepe, thin, clean	lb.	.26	.....
Amber crepe No. 1	lb.	.28	.....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.16½	$0.18
Castor oil, AA, in bbls	lb.	.19	.. .
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.14½	.16
Cocoanut oil, Ceylon grade, in bbls	lb.	.15	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17	.17½
Corn oil, crude, in bbls	lb.	.12	.13
Cottonseed oil, crude (f.o.b. mill)	lb.	.09	.11
Cottonseed oil, summer yellow	lb.	.12½	.13½
Cottonseed oil, winter yellow	lb.	.17½	.18½
Linseed oil, raw, car lots (domestic)	gal.	1.25	..
Linseed oil, raw, tank cars (domestic)	gal.	1.22	....
Linseed oil, boiled, car lots (domestic)	gal.	1.33	....

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

PHOENIX — The Arizona Gypsum Co., 313 West Washington St., will build a 2-story gypsum plaster plant. Estimated cost, $40,000. Work will be done by day labor.

Colorado

DENVER—The Concrete Steel Co., 42 B'way, New York City, will build a 1-story, 200x200-ft. steel fabricating shop here. Estimated cost, $200,000. Work will be done by day labor.

Connecticut

SEYMOUR—The Seymour Mfg. Co., 87 Franklin St., has awarded the contract for the construction of a 1-story foundry addition to the H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $25,000.

STAMFORD—Richards & Co., Inc., Ludlow St., has awarded the contract for the construction of a 1- and 3-story factory on Canal and Ludlow Sts. to the J. W. Ferguson Co., 602 West 110th St., New York City. Estimated cost, $75,000.

Florida

KEY WEST—The Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans to build a distillation plant here.

Illinois

CENTRALIA — The Township High School Bd. has awarded the contract for the construction of a 2-story, 130x130-ft. high school to the G. E. Tillman Constr. Co. A chemical laboratory will be installed in same. Estimated cost, $100,000.

EAST ST. LOUIS — The Eagle-Picher Lead Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for the construction of a factory to the Wimmer Contg. Co., Victoria Bldg., St. Louis, Mo. A chemical laboratory will be installed in same. Estimated cost, $600,000.

EAST ST. LOUIS—The Monsanto Chemical Wks., 1800 South 2d St., St. Louis, Mo., has awarded the contract for the construction of 7 factory buildings to the Wimmer Contg. Co., Victoria Bldg., St. Louis, Mo. Estimated cost, $400,000.

GRANITE CITY — The Bd. Educ. had plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $225,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., archt. Noted Aug. 4.

HERRIN—The Bd. of Educ. has awarded the contract for the construction of a 2-story, 130x142-ft. high school to P. Cordani. A chemical laboratory will be installed in same. Estimated cost, $123,600. J. W. Kennedy, East St. Louis, archt. and engr.

McLEAN—The Bd. Educ. has awarded the contract for the construction of a 46x 102-ft. high school to J. C. Newlin, Bloomington, Ill. A chemical laboratory will be installed in same. Estimated cost, $100,-000. J. Howard Baker, secy.

Indiana

INDIANAPOLIS — The Milan Tire & Rubber Co., c/o Myron Wilson, Hotel Cleveland, Cleveland, Ohio, plans to build a 3-story rubber factory. Estimated cost, $350,000. Carter-Richard-Griffith Co., Illuminating Bldg., Cleveland, Ohio, archts. and engrs.

MICHIGAN CITY — The Amer. Iron & Steel Corp. plans to build a 1-story steel plant consisting of a 250-ton blast furnace, 6 open-hearth furnaces and a 12-mill sheet steel plant, etc. Estimated cost, $50,000,-000. L. L. Slick, Engineers' Bldg., Cleveland, Ohio, dir.

PRINCETON — City Council will soon award the contract for the construction of a sewage disposal plant. Estimated cost, $41,850.

Iowa

WATERLOO—The Bd. Educ. has awarded the contract for the construction of a school to H. A. Maine Co. A chemical laboratory will be installed in same. Estimated cost, $600,000.

Kansas

TOPEKA—The city is having plans prepared for the construction of a water purification plant. Estimated cost, $400,000.

Kentucky

LOUISVILLE—The Ewald Iron Co., 224 North Clay St., plans to build an addition to foundry. Estimated cost, $3,000,000. R. B. Hickman, pres.

Maine

BANGOR—The Keyes Fibre Co., Waterville, plans to build a 40-ton capacity, electrically operated mill.

Maryland

BALTIMORE—The Baltimore Brick Co., 708-710 Maryland Trust Bldg., will soon award the contract for the construction of a 1-story brick drier and brick kiln.

BALTIMORE—The Bd. of Awards, c/o City Register, will soon award the contract for the construction of a sludge digestion tank, pipe lines, etc., at the sewage disposal works on the shore of the Back River here. A. E. Christhilf, engr. Noted Aug. 25.

BALTIMORE—The Johns Hopkins University is having plans prepared for the construction of a 2-story chemical laboratory. Estimated cost, $150,000. Carrere & Hastings, 52 Vanderbilt Ave., New York City, engrs.

BALTIMORE — The Prest-O-Lite Co., Inc., 30 East 42d St., New York City, has awarded the contract for the construction of a 1-story, 25x50-ft. acetylene plant in connection with the 8 proposed acetylene buildings here to the West Constr. Co., Foster and 13th Aves. Estimated cost, $75,000. Noted June 23.

Massachusetts

BROCKTON—The city has awarded the contract for the construction of filter beds to the Geo. Howard & Sons Co., 153 Main St. Estimated cost, $155,207. H. S. Crocker, city engr. Noted Sept. 1.

FALMOUTH—The Standard Oil Co. of New York, 50 Congress St., Boston, has awarded the contract for the construction of a 1- and 2-story oil plant to Hardy & Streeter, 95 Milk St., Boston. Estimated cost, $30,000.

HARWICH — The Standard Oil Co. of New York, 50 Congress St., Boston, has awarded the contract for the construction of a 1-story oil plant to Hardy & Streeter, 95 Milk St., Boston. Estimated cost, $30,000.

HYANNIS — The Standard Oil Co. of New York, 50 Congress St., Boston, has awarded the contract for the construction of a 1-story oil plant to Hardy & Streeter, 95 Milk St., Boston. Estimated cost, $35,-000.

NEW BEDFORD—The Sassaquin Sanatorium plans to build a 1-story, 38x70-ft. laboratory here.

SPRINGFIELD — The Forging Service Corp., 318 Main St., will soon award the contract for the construction of a 1-story, 45x125-ft. forge shop on Switzer Ave. Estimated cost, $20,000.

WAKEFIELD—Heywood Bros. and the Wakefield Co., 206 Central St., Gardner, has awarded the contract for the construction of a 1-story factory addition to the Leighton Mitchell Co., 99 Chauncey St., Boston. Estimated cost, $75,000.

WARE — The Ware Coated Paper Co., South St., has awarded the contract for the construction of a 1-story, 70x100 ft. paper factory on Cummings St. to P. H. Provencal, 127 North St. Estimated cost, $40,000.

Michigan

HOUGHTON—The Michigan College of Mines, College Ave., has awarded the contract for the construction of a 2-story chemical building to Herman Gundlach, Leopold Bldg. Estimated cost, $125,000. Noted May 19.

MONROE—The Monroe Auto Equipment Co., East 1st St., plans to build a 1-story, 90x200-ft. foundry. Reed M. Dunbar, archt.

SAGINAW—The American Safety Navigation Co., c/o Managing Secy. Bd. of Commerce, is having plans prepared for the construction of a 1-story factory for the manufacture of aluminum life rafts, etc., and a 6-story office building. This is first unit of a $10,000,000 plant.

Missouri

GRANT CITY—The City Clerk will receive bids until Sept. 21 for the construction of a disposal plant including a Imhoff tank, filtering material, etc. Black & Veach, Mutual Bldg., Kansas City, engrs.

ST. LOUIS—The Bridge & Beach Mfg. Co., 503 South 1st St., has awarded the contract for the construction of 17 buildings on Union and Brown Aves. to the Fruin Colnon Contg. Co., Merchants' Laclede Bldg. A small chemical laboratory will be installed in same. Estimated cost, $800,000.

ST. LOUIS—Lindenwood College, 3715 McCousland St., has awarded the contract for the construction of a 4-story, 104x168 ft. college building to the Sutherland Constr. Co., Syndicate Trust Bldg. A chemical laboratory will be installed in same. Estimated cost, $350,000.

ST. LOUIS—St. John's Hospital, Euclid St. and Parkview Pl., has awarded the contract for the construction of a hospital addition on Euclid St. to the Rodman Bldg. & Constr. Co. A chemical laboratory will be installed in same. Estimated cost, $175,000.

ST. LOUIS—The Magnus Metal Co., 4153 Clayton Ave., has awarded the contract for the construction of a 1-story foundry on present site to the Wimmer Contg. Co., Victoria Bldg. Estimated cost, $60,000.

New Jersey

BRIDGETON—The Illinois Glass Co. plans to build a glass factory. Estimated cost, $3,500,000. Alex. Godfrey, genl. mgr.

NEW BRUNSWICK—The Western Sulphur Co. plans to construct a fertilizer plant. Estimated cost, $150,000. J. G. Lipman, State Agricultural College, pres.

TRENTON—The Luzerne Rubber Co., Muirheid Ave., has awarded the contract for the construction of a 1-story, 60x60-ft. rubber plant on Muirheid Ave. to the Karno Smith Co., Broad St. Estimated cost, $15,000.

TRENTON—The Mutual Pottery Co., Clinton Ave., has awarded the contract for the construction of a pottery plant to Stone & Webster, 120 B'way, New York City. Estimated cost $500,000. Noted May 4.

TRENTON—The Puritan Rubber Mfg. Co., Perrine Ave., plans to construct a 1-story rubber plant. Estimated cost, $7,000.

New York

BROOKLYN—C. A. Benoit, Jerome Ave., will soon award the contract for the construction of a 3-story dye factory on Ave. I. Estimated cost, $200,000.

BUFFALO—Pratt & Lambert, Inc., 79 Tonawanda St., has awarded the contract for the construction of a 4-story, 55x100-ft. factory for the manufacture of varnish to the John W. Cowper Co., Fidelity Bldg. Estimated cost, $75,000.

North Dakota

MARMARTH—The Bd. Educ. will soon award the contract for the construction of a 2-story, 61x91-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. Noted Aug. 25.

Ohio

BEXLEY (Columbus P. O.) — The city received bid for the construction of an extension to the sewage disposal plant from the Sheets Constr. Co., 1468 Pennsylvania Ave., $5,800.

CHAGRIN FALLS — Ernest McGeorge, engr., 1900 Euclid Ave., Cleveland, will soon award the contract for the construction of a 2-story, 60x120-ft. paper mill addition for the Adams Bag Co., Chagrin Falls. Estimated cost, $100,000. Noted July 7.

CLEVELAND—The Atlantic Fdry. Co., East 75th St. and Morgan Ave., has awarded the contract for the construction of a 1-story, 21x100-ft. foundry addition to the Bolton Pratt Constr. Co., Columbia Bldg. Estimated cost, $10,000.

CLEVELAND—The Bd. Educ. is having plans prepared for the construction of a 3-story high school at Woodland Hills. A chemical laboratory will be installed in same. Estimated cost, $2,000,000. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

CLEVELAND—The Cleveland Camshaft Co., 6520 Carnegie Ave., has awarded the contract for the construction of a 1-story, 39x11-ft. heat treating plant to the Stevens Iron Works Co., 4300 Perkins Ave. Estimated cost, $15,000.

CLEVELAND—The Concrete Steel Co., 42 B'way., New York City, will build a 1-story, 200x200-ft. steel fabricating shop here. Estimated cost, $20,000. Work will be done by day labor.

CLEVELAND—The Concrete Steel Co., Guardian Bldg., plans to build a 1-story, 70x200 ft. factory on Berea Rd. Estimated cost, $75,000. W. Bright, mgr.

CLEVELAND—The A. S. Gilman Co., 623 St. Clair Ave., has awarded the contract for the construction of a 2 story, 90x119-ft. factory addition to the Myers-Kuhn Constr. Co., 210 Metropolitan Bldg. Estimated cost, $50,000.

CLEVELAND—The Natl. Carbon Co., West 117th St. and Madison Ave., plans to build a 1-story factory addition. Estimated cost, $150,000. P. R. Magee, engr.

COLUMBUS—The Capital City Products Co., West First Ave., is having plans prepared for the construction of a 2-story, 100x165-ft. factory addition. Estimated cost, $100,000. Bosset & Trisselt, Central Natl. Bank Bldg., archts.

COLUMBIA—The Cleveland Trinidad Paving Co., Grand Theatre Bldg., is having plans prepared for the construction of a 1-story, 100x175 ft. asphalt plant on Dublin Rd. Estimated cost, $60,000.

HOLMESVILLE—The High School Bd. plans to build a 2-story, 63x76-ft. high school. A chemical laboratory will be installed in same. I. E. Crawford, clk.

SPRINGFIELD—The Bd. Educ. will receive bids until Sept. 21 for the construction of a 2-story, 110x128 ft. high school on Malden Lane. A chemical laboratory will be installed in same. Estimated cost, $225,000. O. D. Himud, 8 East Broad St., Columbus, archt.

Oklahoma

LAWTON—The city has received preliminary report for the construction of a sewage disposal plant and pumping station. Estimated cost, $200,000. V. V. Long & Co., 1300 Concord Bldg., Oklahoma City, consult. engrs.

PURCELL—The city plans an election to vote on $382,000 bonds to construct a filtration plant, etc. Johnson and Benham, Firestone Bldg., Kansas City, Mo., engrs.

STIGLER—The city has received preliminary report for the construction of waterworks extensions including water purification plant, etc. Estimated cost, $35,000. V. V. Long & Co., 1300 Concord Bldg., Oklahoma City, consult. engrs.

Pennsylvania

ERIE—The Bd. Educ. will soon award the contract for the construction of a high school. A chemical laboratory will be installed in same. W. B. Ittner, Bd. Educ. Bldg., archt.

KITTANNING—The Kittanning Iron & Steel Co. is having plans prepared for the construction of a 1-story steel plant addition. Estimated cost, $100,000. Arthur G. McKee Co., 2422 Euclid Ave., Cleveland, Ohio, engrs.

PHILADELPHIA—Rinald Bros., 1142 Hancock St., will soon award the contract for the construction of a 2-story, 16x55-ft. varnish building on Grove and Wharton Sts. Peuchert & Wunder, 1415 Locust St., archts. and engrs.

Tennessee

CHATTANOOGA—The Cole Eng. Co. of Philadelphia, Pa., has purchased a site here and plans to build a factory for the manufacture of lubricating steel on same.

CHATTANOOGA—The DuBois Rubber & Tire Co. plans to construct a factory for the manufacture of rubber products.

Texas

DALLAS—The city is having plans prepared for the construction of a water purification plant for the White Rock Reservoir. Estimated cost, $350,000. G. D. Fairtrace, City Hall, engr.

DUBLIN—The Keystone Refining Co. has awarded the contract for furnishing equipment for the proposed refinery here. Estimated cost, $400,000.

Vermont

BELLOWS FALLS—The Liberty Paper Co., Inc., has awarded the contract for the construction of a 3-story factory to the Guarantee Constr. Co., 140 Cedar St., New York City. Estimated cost, $130,000.

HARTFORD—The International Paper Co., 15 Milk St., Boston, Mass., has awarded the contract for the construction of a 2 story paper factory to the H. P. Cummings Constr. Co., 14 Prospect St., Ware, Mass. Estimated cost, $50,000.

Virginia

HAMPTON ROADS—The Bureau Yards & Docks, Navy Dept., Washington, D. C., plans to build a distillation plant here.

MONTPELIER—The School Bd., c/o J. W. Hall, Supt. of Public Schools, Ashland, is in the market for chemical laboratory equipment.

Washington

YAKIMA—The Puritan Rubber Co., 16-17 Wilson Bldg., plans to build a 60x250-ft. factory for the manufacture of tires, tubes, etc. Estimated cost, $250,000. W. L. Lanning, Wilson Bldg., engr.

Wisconsin

BURLINGTON—The city plans to build a sewerage system including a septic tank. Estimated cost, $75,000. C. H. Tubbs, engr.

BUTTERNUT—Edward Ross, Phillips, will soon award the contract for the construction of a 1 story, 60x250-ft. veneer plant on Main St. Estimated cost, $100,000.

FOND DU LAC—The Bd. Educ. will soon award the contract for the construction of a 3-story, 66x260-ft. high and vocational school. A chemical laboratory will be installed in same. Estimated cost, $350,000. Childs & Smith, 61 East Van Buren St., Chicago, archts. Noted July 16.

MILWAUKEE—The Sewerage Comn. plans to build a fine screen building including equipment. Estimated cost, $325,000.

SAUKVILLE—George Sulman & Sons Co., 337 1st St., Milwaukee, has awarded the contract for the construction of a 2½-story, 57x119-ft. leather factory on Main St. to John Schramka, Port Washington. Estimated cost, from $15,000 to $50,000.

SHEBOYGAN—Juul & Smith, archts., Imig Bldg., will soon award the contract for the construction of a 2-story, 70x100-ft. foundry for the Columbia Rubber Mills, 176 16th St., Milwaukee. Estimated cost, from $50,000 to $75,000. Noted Aug. 11.

Wyoming

DOUGLAS—The city voted $75,000 bonds for the construction of a water supply system and filtration plant. Geo. T. Prince, c/o Prince, Nixon Co., Omaha, Neb., consult. engr.

Canada

WELLAND—The Joseph Stokes Rubber Co. has awarded the contract for the construction of a 1-story rubber mill and power plant on Johns and Bernard Sts. to the Karno Smith Co., Broad St. Bank Bldg., Trenton. Estimated cost, $100,000.

Manitoba

WINNIPEG—The Dominion Oxygen Co. will soon receive bids for the construction of a plant for the manufacture of oxygen for welding purposes. Estimated cost, $100,000.

Nova Scotia

WINDSOR—T. B. Akins, Windsor, and Wright & Jodrey, Wolville, are interested in a company which is having plans prepared for the construction of a small pulp mill, etc. Estimated cost, $250,000.

Ontario

SUDBERY—The International Nickel Co. will soon receive bids for the construction of a rolling mill. Estimated cost, $3,000,000.

NEWMARKET—The city has awarded the contract for the construction of an outfall sewer and activated sludge plant to Currant & Briggs, Orillia. Estimated cost, $34,000. E. A. James Co., Ltd., 36 Toronto St., Toronto, engr. Noted Jan. 7.

PORT ARTHUR—The Provincial Paper Mills, Ltd., of Toronto, plans to construct a paper mill here.

Prince Edward Island

CHARLOTTETOWN—Bruce Stewart & Co. will receive bids for the construction of a 60x120-ft. plant for the manufacture of gasoline engines.

Quebec

ALLARD FALLS—The Manouay Pulp & Paper Co. will soon receive bids for the construction of a plant here. Frank L. Moore, Newton Falls Paper Co., Watertown, N. Y., is interested.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 1.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

THE CHEMICAL WARFARE POST of the American Legion will hold its next meeting Sept. 22, at 8 p.m., in the conference room of the Grand Central Palace, New York City.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE RUBBER SECTION of the National Safety Council will consider safety problems of especial interest to the rubber industry at a section conference to be held Sept. 29 to Oct. 1, in connection with the national session of the Council to be held in Chicago.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Western Editor
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Industrial Editors
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The Cost of Hospitality

IF FORTUNE favored you with attendance at the Chicago meeting of the American Chemical Society week before last you probably were impressed with the generous hospitality and the cordial goodfellowship that marked that happy occasion. From Northwestern University on the north to Chicago University on the south and among the industrial plants in the environs of the city there was open house for visiting chemists. Careful forethought was given to every detail and a suitable setting was provided for every function. The program proceeded with clocklike precision. At no recent convention within our recollection, confined to a single city, was there a better opportunity for social intercourse as well as exchange of technical information. The entertainment was in good taste, and personal preference was anticipated in great variety. If there was a hitch anywhere it was not evident to the visitor.

We wonder, however, whether those who enjoyed all that was offered had a lively sense of what was involved in preparation for the event: the detailed work of committees, the co-operation of varied interests, the conferences, the devotion of time and money. We may take for granted the personal service and sacrifice involved in preparing for a great meeting of scientists, but the financial burden is likely to be overlooked and not appreciated. Certainly $20,000 would not cover the cost of entertainment and hospitality afforded at Chicago. Somebody has to pay for special trains, dinners, orchestras, operettas, organ recitals and all the trimmings that go to make up a successful convention. Undoubtedly the most distasteful job was that of the finance committee, which had to solicit funds from companies which, in many cases, had only a remote interest in the convention and whose ability to contribute constituted the best reason for approaching them.

In the light of these considerations the Council of the Society is to be commended for resolving that at future meetings the attendants shall bear a share of the cost of their entertainment. The mechanism whereby this is to be accomplished is not decided upon, but the principle is fair. We can go further and question whether, after all, it is necessary to provide entertainment on such a scale that it becomes a burden. As the Society foregathers at one city after another a commendable spirit of rivalry not only leads each successive local organization into emulation of the plans of its predecessor but creates a desire to "go one better," thus adding another limitation to the centers that are able and willing to act as occasional hosts to the parent organization. From every point of view it seems as though less stress should be laid on the formal entertainment of guests and more on the facilities and natural attractions of possible convention centers. Delightful as the social features are, they may add too much to the cost of hospitality.

The First Meeting of American Engineering Council

ANNOUNCEMENT is made elsewhere in this issue of the first meeting of American Engineering Council of the Federated American Engineering Societies. It will be an important occasion in the history of American engineering, and the national capital will be a fit setting for it.

We have followed with more than ordinary interest the development of this organization, which is an earnest attempt to provide a vehicle for expression of engineering thought and for impressing that kind of thinking on public affairs, municipal, state and national. Of the value of engineering opinion on public affairs we are thoroughly convinced, and we are committed to the necessity of making the composite engineering thought of this country articulate. The war brought the engineer and kindred technical men out of their professional seclusion and aroused in them a modest sense of importance in the general scheme of things. The consciousness thus created must now be fostered for at least two good reasons: recognition of engineers as a powerful and intelligent group of citizens, and the benefit which will result to the country from their participation in the conduct of its affairs. The effect will be cumulative. Intelligent participation will lead to public recognition of the profession; and that public recognition, in turn, will foster the spirit of professional solidarity and consciousness that will encourage further public service.

The principal need at this time is an active instrument for accomplishing these aims and purposes. The work of the Organizing Conference in Washington last June resulted in the creation of the Federated American Engineering Societies. Its constitution calls for representation of constituent societies in American Engineering Council, which, in turn, shall function through an elected Executive Board. It is for the formal organization of the Council and its Executive Board that the forthcoming Washington meeting is called.

The Federation is now an established, going concern. Since it was organized last June, five societies, national and local, have joined, making it the largest engineering society in the world. Delegates from the member societies—American Society of Mechanical Engineers, American Institute of Electrical Engineers, Technical Club of Dallas, Cleveland Engineering Society and Detroit Engineering Society—will comprise and organize American Engineering Council. Between now and November

18, when the meeting will be held, as many as possible of the fifty-seven societies which participated in the Organizing Conference last June, should take action on membership in the Federation so that they can send delegates to the opening session. The success of this movement is not going to reside in the participation of the large national societies alone, but in the large number of local, state and regional organizations that can represent engineers from every part of the country. On these bodies we urge immediate and favorable action. Two months remain in which to inform their members of the movement, stimulate interest and hold a referendum.

We are unwilling to believe that, if the aims and purposes of the organization are placed intelligently before engineers generally, they will fail to give it cordial support. And we are equally certain that in joining the movement every society will be rendering an incomparable service to engineering. From now to November 18 should be a campaign period for membership in the Federated American Engineering Societies.

Keeping the Two Schools of Chemists Apart

AT THE semi-annual luncheon of the Harvard Alumni Chemists Association during the A.C.S. meeting at Chicago, Dr. WILLIAM J. HALE voiced the opinion that the chemical department of the college and graduate school should confine itself to pure science and not allow industrial interest to divert the attention of the students. Granting the need of sound scientific training, we might report Dr. HALE'S remarks without any comment, but the situation really calls for a little illumination.

Back in the '50s when Professors COOK and HORSFORD taught at Harvard College and Lawrence Scientific School, respectively, the students of the one were not allowed to attend the lectures of the other. That they should have been denied the privilege was a great misfortune, especially for Professor HORSFORD'S students, because the latter cared little for teaching and devoted almost his entire attention to phosphoric acid technology. Ever since, it has been the experience of the university that the best teachers usually have been those who have not had their attention divided between industry and science, who did not seek the financial reward of the former but were content with the honor attached to the latter. This has had important exceptions, the faculty of the graduate school of engineering being the most notable. Recently it has been decided to place industrial chemistry in the Harvard Engineering School and professional industrial chemists will be invited to join the faculty on a part-time basis.

Professor PAUL G. BAXTER has been appointed director. He is a great teacher, being a leader in the instruction of quantitative analysis. The future success of the industrial course depends on two things: Teaching engineers must be enlisted of the caliber now serving in the mechanical, civil, sanitary, metallurgical and electrical departments, able men, such as MARKS, DAVIS, SWAIN, HUGHES, WHIPPLE, SAUVEUR and KENNELLY. Next this new department must be tied up with and get co-operation from the chemical, physics, mathematics, economics and English departments. All policies such as Dr. HALE advocates should be limited in execution, the college laboratories never being allowed to become the hired workshops of industry or the playground of would-be chemical philosophers. Chemical engineers must be well founded in pure science and their attendance should be welcomed in the chemical courses. It does not seem right that the engineering school should be forced to establish a department of its own, though it did so in mathematics, but by reason of the large numbers requiring specialized mathematics.

Steering An Even Course

THE War Trade Board has announced that it "does not feel it advisable to take active steps to place upon the market foreign-made drugs which would compete with those of domestic manufacture, and therefore will not exercise its option upon impounded stocks of chemical drugs of German manufacture or upon stocks of chemical drugs manufactured during the months of January, 1920, to June, 1920, inclusive." In choosing this course the Board avoids the Scylla of encouraging competition with domestic industry.

Moreover, to reassure us that we are not to run upon Charybdis, which guards the other side of the entry to our port of established chemical industry, we also read that undue aloofness in international trade is not to be expected. The Board says: "This Government will, however, retain its right to participate in allotments from future daily production of chemical drugs which may be manufactured by Germany during the next four and one-half years, in view of the possibility that a need in this country may arise at some future time for certain chemical drugs which may at that period be unobtainable from domestic sources."

The principles which guide to these decisions are right and rightly applied here. The only question which can disturb us is whether there will be enough facts always at hand to permit intelligent decision upon each new case which will arise. The industries must see that there is no lack of such information, both with respect to industrial needs and regarding the demonstrated ability of industry to fill these demands.

What About It Next Time?

THE War Department has just announced a summary of the causes of injury resulting in admission to American Expeditionary Force hospitals during the war period. Gas was the most frequent cause of injury, having occasioned almost 90,000 hospital cases, or over one-third of the total. The chemist can well ask what will happen next time, when the practice of gas warfare will doubtless begin from the outset and continue even more vigorously than it was practiced at any stage of the recent hostilities. It seems that this situation alone should be ample demonstration of the need of continued support for the Chemical Warfare Service not only by chemists but also by the General Staff of the Army, which as yet does not seem to have "seen the light."

It is to be hoped that both offensive and defensive preparations by this arm of the service will be developed to the full. We have no desire to develop our military forces to the point where, like Germany's, it will wag the entire economic life and international relations of the country, but they were at least prepared—so prepared in materials and methods that two allied soldiers had to give their lives to kill one Hun.

The Peace Treaty And Germany's "Ability"

EXTENDED reference to the moral and political questions involved in the Treaty of Versailles is not especially called for in these columns, but discussion of the engineering, metallurgical and economic matters bearing upon fulfillment by Germany of the treaty's terms is strictly in place. As everyone knows, there is heated debate in many quarters as to Germany's "ability" to carry out the terms imposed. From most of this debate knowledge of what engineering has accomplished and recognition of how industries have grown are conspicuously lacking.

There is the question of Germany's ability to furnish certain tonnages of coal. This matter is sagely discussed on the basis of the quantity of coal Germany was producing before the war. There is no reference to the quantity of coal lying beneath Germany's soil or to the number of men that can be transferred from the prosecution of strictly private affairs in Germany to the equipment and operation of coal mines and to the provision of the necessary transportation. It is an engineering or industrial fact, however, that a country can increase its production of coal and its capacity to produce coal. There is the case of the United States, for example. Fifteen years ago, in 1905, we produced 315 million net tons of bituminous coal, which was a large output for the time, being a 12 per cent gain over the previous record, made a couple of years earlier, so that it is fairly citable as a measure of the state of affairs in the United States in 1905. If we had been signing a peace treaty in 1906 requiring us to furnish coal to the victors, the 315 million tons would have been used by the statesmen as the measure of our ability. Now, however, we have the United States Geological Survey reporting that in the week ended Aug. 21 last we produced 11,048,000 net tons of coal, and that the average operation of the mines was 60 per cent, this being in reference to mine capacities based on an eight-hour day. Working an average of 4.8 hours a day, our mines actually produced coal at the rate of 575 million tons a year, or an 83 per cent gain in fifteen years, while our capacity, if we pulled ourselves and our railroads up to the point of eight-hour operation, would be just three times our output of fifteen years ago.

That is the viewpoint of engineering and industry rather than of statesmen and those who defend or criticize them. Germany's production of coal had actually increased by 18 per cent in ten years before the war, but that was a matter of business. It was not the measure of ability to produce or to increase productive capacity. In the same period the production of iron ore by Germany and Luxemburg had increased by 69 per cent. That increase was due to the fact that the increase was desired.

As inappropriate as the disregard of engineering and industrial possibilities is the importance attached to the redistribution of the Minette iron ore deposits. It is even alleged by some that the mental attitude of the men in the respective countries will prevent the iron ore being used to advantage. Of course Europe cannot be repaired physically if mental attitudes are allowed to stand in the way, but what is physically necessary to be done must be done. The whole space circumscribed by the ore mines, coal mines and blast furnaces involved in the peace treaty is astonishingly small from the viewpoint of what the American industry does. Thirty, fifty, seldom more than a hundred miles! We transport iron ore from the Mesaba Range a thousand miles to Pittsburgh, and bring ore from Cuba and Chile to Pennsylvania.

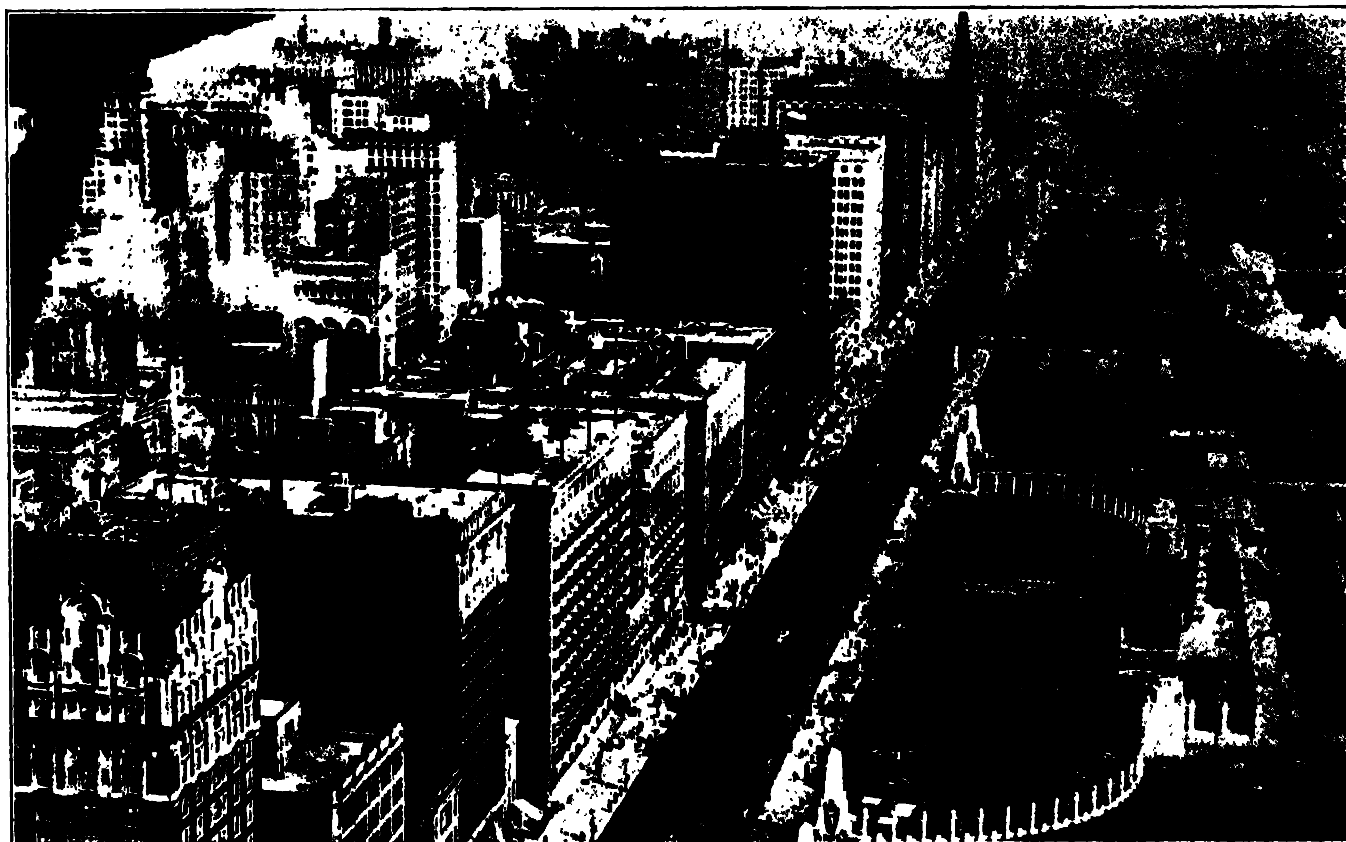
Time may be required for the necessary equipment to be provided and for business arrangements to be made, but the iron ore and coal are in the occupied territory, some blast furnaces are there and others can be built. The things necessary will have to be done. The Treaty of Versailles might be all right or all wrong—neither of which it is—but an American engineer would be far from holding up his helpless hands if he had to get out the necessary quantities of ore and coal asked for. Give him time to organize the task along sound engineering principles, and the job would be merely a routine matter.

Steel Treaters, Bon Voyage!

PHILADELPHIA entertained the first meeting of the amalgamated heat treating societies last week, and the occasion gave gratification to its sponsors. A few scientifically inclined men working in hardening and tool rooms realized the advantage of interchanging experiences only a few years ago, yet the movement, started in so small a way, has gathered great impetus within the past year or two, and the technical meetings, industrial exhibits and other features of this convention were quite worthy of a long-established society.

As pointed out by ALBERT E. WHITE, the president, the outstanding opportunity of the new society is to replace the rule-of-thumb methods inherited from an ancient and honorable craft by the scientific control made possible by researches into physical metallurgy. Primarily, of course, it will do its share in this big task of education by exchange of information in the local and national meetings; an intelligent and inquisitive state of mind, if it can be thus aroused, will go forward by its own volition. In addition, steel maker and steel treater can be brought closer together. This new society is not greatly interested in the metallurgical and mechanical operations in the steel mill; it primarily wants to know how to distinguish good steel from bad, and then institute the proper methods of working stock metal into highly fabricated articles of unexceptionable endurance and quality. Yet the steel maker should know the steel-treater's requirements so he can furnish the raw material; on the other hand reciprocal knowledge is necessary so that the hardener may not try to develop properties not latent in his available raw material. Shop men, from foremen to apprentices, should also utilize the new society as a meeting ground. Most of the shop men are still craftsmen, practicing an art rather than applying a science. Foremen and managers can most easily dispel prejudice and ignorance, develop enthusiasm and enlist co-operation in the solution of vexatious economic problems of production by joining the artisans and technicians man to man in the technical sessions of this society.

Truly the newly amalgamated American Society for Steel Treating has picked out a limitless and inspiring field of action—education. Its influence for good should be immeasurable. Unquestionably we voice the thoughts of all men interested in making good steel better when we say heartily, "Godspeed!"



Chicago Meeting of the American Chemical Society

An Account of the Social and Technical Features of the Sixtieth Meeting—Council Meeting—Addresses at the General and Industrial Division Meetings—Synopsis of Papers on Physical and Inorganic Chemistry, Cellulose, Sugar and Dyes

THE sixtieth general meeting of the American Chemical Society was held in Chicago, Sept. 6 to 10. Headquarters was maintained at the Congress Hotel, where several general lectures and the banquet were held. The technical sessions were held in the lecture rooms of Chicago University, while the social functions were given at Northwestern University. This scattered the meeting's activities over a rather wide area, but it was deliberately done in an attempt to adapt the various parts of the program to the most favorable environment. The lecture rooms of Chicago University afforded the best atmosphere and facilities for scientific talks, while the campus of Northwestern University could not be excelled for the social features which formed such an important part of this meeting.

Council Meeting

The Council met at 4 p.m. Monday at the University Club, about eighty-five councillors attending and President NOYES in the chair.

The date of the spring meeting was fixed for the week of April 25, 1921. The proposal of the Chemical Society of London to enable members of the American Chemical Society to subscribe for the annual record of the Progress of Chemistry prepared by the Chemical Society and the Society of Chemical Industry was referred to the secretary and the editor of *Chemical Abstracts* to arrange for subscriptions and deliveries.

Whether to hold the fall meeting in Pittsburgh or New York was left with the president and secretary with power to act. It is desired to make the meeting a joint one with the Canadian Chemical Society and the British or Canadian members of the Society of Chemical Industry in case this is possible, but this may only be concluded after a conference.

The invitation of the Federation of American Engineering Societies to attend its next meeting and to initiate plans for co-operation was declined. The resolution declining the invitation was unanimously recommended by the Advisory Committee, and the short discussion that followed was, with one exception, favorable to the resolution, and it passed. It was held that the Society should offer the Federation aid and encouragement in any manner it could, but that the fields of chemists and engineers were distinct and separate and that more and better work can be accomplished without interlocking the several organizations.

The editors of the various journals were re-elected, and vacancies on the associate boards were filled. The former editors of the Society's journal were severally elected to the post of editor emeritus.

The Pharmaceutical Division was changed in name

to the Division of Chemistry of Medicinal Products, with a view to making a clearer distinction between this Division and that of Biological Chemistry.

Dr. PARSONS reported informally on the meeting of the International Union of Pure and Applied Chemistry in Rome and was requested to give his report in full, already published in the *Journal of Industrial and Engineering Chemistry*, at the General Meeting on Tuesday morning.

It was resolved that the president appoint a committee of thirteen members, with Dr. Charles H. Herty as chairman, to represent the Society in co-operating with the Chemical Warfare Service of the U. S. Army in whatever manner they may be able. It is to consist of three members each representing research, development, production and physiological subjects.

The question brought over from the last (St. Louis) meeting whether or not the Society should meet but once a year at a general assembly, while other joint meetings of various sections be arranged according to geographic sections, brought forth extended discussion. It was lost by a large majority.

A resolution was introduced and unanimously adopted to the effect that hereafter it shall be expected of members and guests attending general meetings to bear a share of the cost of their entertainment, on the ground that the burden of expense assumed by the local sections which act as hosts is greater than is fair to ask of them.

ANNUAL DUES FIXED AT $15

At 6:30 the Council dined as guests of the Chicago Section at the University Club, and after dinner continued in the dining room to consider the final question at issue, which proposed such change in the bylaws as to make the annual dues $15 instead of $10. There was considerable division of opinion, and for a time the air was thick with amendments, but President Noyes, after splitting them up into their component parts, succeeded in getting the views and votes of the councillors on every phase of the question, and in the end it was resolved by a large majority that the dues should be $15 under the original resolution. The privilege of full membership and subscription to one of the society's journals for $6 was extended to include graduate students as well as students; and under another resolution it was decided to allow students and graduate students a discount of one-third, making the net cost of membership and all three journals $10, as before, instead of $15. The definition of a student for the purpose of the two last resolutions was referred to the president for determination.

General Meeting

At the General Meeting in the Gold Room of Congress Hotel Dr. JULIUS STIEGLITZ, the Honorary Chairman, made an address of welcome, and so did JOSEPH R. NOEL, vice-president of the Chicago Chamber of Commerce. Mr. Noel said that in reducing the cost of the necessaries of life chemists were humanitarians, and that the reduction of costs was the great problem of the day. President W. A. NOYES responded by emphasizing the obligations of chemists in reconstruction, observing that achievement is only possible in case they work together and unite in their efforts.

Secretary PARSONS made his report as requested at the Council Meeting on the meeting of the International Union of Pure and Applied Chemistry in Rome. As this has already been printed in full details will not be given here except that the Union has resolved to meet in Poland in 1921, and that martial conditions may prevent this. The members would like very much to hold an annual meeting in the United States, but the current rates of exchange make the undertaking too expensive. It is planned to have general meetings once every three or four years in the place of the former triennial International Congresses of Applied Chemistry, of which the last was held in New York in 1912. An interesting note made by Dr. Parsons was the disposition of Europeans in international conclave to discuss details in general meeting rather than to refer them to special committees according to American usage.

The General Addresses were made by THOMAS E. WILSON, president of Wilson & Co., packers, and Dr. A. S. LOEWENHART, head of the department of pharmacology at the University of Wisconsin.

CHEMISTRY IN THE PACKING INDUSTRY

Probably no man eminent in business affairs has been so unhappily bespangled by the advertising writer as Mr. Wilson, and it was a great pleasure to find that despite the scarehead "studies" of him he is a gentleman at once simple in speech and habit, clear in vision, concise in his statements and persuasive in argument. He gave an outline of the incidence of chemistry in the packing industry, which he said had had its beginning and development within the life of the present generation. When he first went into the stock yards (and according to "Who's Who," that was in 1890), there was no such thing as a chemical laboratory there. The first laboratory was opened by H. W. Schmidt, now of Cincinnati, and the undertaking was generally regarded as a foolish experiment. The first thing Mr. Schmidt did was to install a vacuum pan to make extract of beef. It was not a laboratory apparatus, nor was making beef extract a laboratory operation, but Schmidt kept it there in order to show a credit from the operation of his laboratory in the only language that was effective. The profit on beef extract made it "pay" the while he was able to continue in research, and finally to achieve results.

In the early stages the packers were merely butchers on a large scale, and they could not offer for a live steer more than they could get for the beef. Today the sum realized for the beef is much less than the price paid for the animal that furnishes it. Chemistry has made this possible. The establishment of Wilson & Co. started a few years ago with but one chemist; today it employs nearly a hundred, and these are divided into analysts, research chemists, chemical engineers and commercial or business chemists. The co-ordination of science and technology in the packing industry made it possible to do what would otherwise have seemed impossible when the call came in February, 1918, to furnish 300,000,000 lb. of pork products per month for three months on pain of losing the war. There was actually shipped 9,000,000,000 lb. in February, March and April of that year, at a time when the country was in large part snowbound and the railways were nearly broken down.

Chemical research and control have enabled the packing industry to operate on a very low margin of profit. During the fiscal year of 1919 just closed the five large packers did a business of $3,521,000,000 and made profits of $34,500,000. They handled 40,000,000 head

of live stock at a profit of 89½c. per head, the profit on the turnover being less than one cent on a dollar.

Mr. Wilson pointed out that whereas we have heretofore striven for volume the time has arrived when we must conserve what we have and strive for improvements. It sounds well enough to say that they use everything in the pig except the squeal, but the fact remains that there is still great work to do in the science and more particularly in the chemistry of the industry of packing, that many fields are still undeveloped for lack of adequate research, and that it is the business of the men of today to attack them. Speaking for the industry with which he is connected, he said there are great opportunities open to the chemist, and he believes that there are in other lines as well. In conclusion he urged chemists to offer their work to business men in a language that business men can understand. He was sure that this could be done, and he hoped chemists would master the art of doing it.

Chemistry in Biology

Dr. Loewenhart followed with a discussion of chemistry in biology. Biology, he said, rests on three systems: chemistry, physics and on one part which is pure biology. The only process in biology that yields energy is oxidation, and after a discussion of oxidation in respiration he noted that fats, hydrocarbons and proteins oxidize at 37 deg. C. within the body, while outside it they are stable at this and higher temperatures. The explanation of the fact is found in oxidizing enzymes, of which the chemistry is at once very complex and very interesting, as well as full of unanswered questions. Why, for instance, does dextroglucose oxidize within the body, and why does not lævoglucose do the same thing? Again, oxalic acid and carbon monoxide will oxidize without the body, but within it they will not. All recent work on slow oxidation shows a great difference between it and combustion. It also shows that interference with biological oxidation starts different series of processes within the body which yield entirely different end products from those reached by normal processes. Such disturbances are caused by various chemicals and by temperatures that are abnormal. Another interesting question has to do with the relation of internal oxidation to the stimulation of an organ.

An important note is the similarity of oxidizing enzymes to organic peroxides. Most important antiseptic agents are oxidizing agents, and these are useful when they are not interfered with by proteins. Certain such organic oxidizing substances, if injected intravenously, increase the production of anti bodies, and decrease the inflammation, while remaining unaffected by the proteins. Therefore organic peroxides are very important, and new and better methods of preparing them are needed, as well as are new organic peroxides. Indeed, Dr. Loewenhart issued what was in effect a call for new organic peroxides from chemists, in the hope that they may aid in the conquest of disease. They must not be too active, and yet they must be active enough. And they should be water-soluble.

The notion still seems to prevail that there is a specific cure for every disease. It dies hard, but it is hoped to overcome the superstition in time. Now some excellent drugs were in use apparently before the beginnings of history—as we have it—and some began in religious ceremonies in connection with sacrifices to various deities. The co-operative study of drugs and



WALK BY THE LAKE, NORTHWESTERN UNIVERSITY CAMPUS

their effects, however, has had the surprising result that due to the activities within the Chemical Warfare Service we are better informed of the effects of a number of new substances than we are of medicines that have been in use over two thousand years. It was the co-operation of chemists, biologists and physiologists that made this possible.

In addition to his call for more organic peroxides, the speaker made a plea for real chemical training for those who are about to study medicine. It is, he held, almost impossible to superimpose chemistry upon the practitioner of medicine if he has not had the training beforehand; and he could even say the same thing of biologists. He has known only one who, having neglected chemistry in his academic years, went back and got it. Whoever would engage in research should first study chemistry.

Tuesday Afternoon and Evening at Evanston

At the conclusion of Dr. Loewenhart's masterly address the members ate an early luncheon and took special trains for Evanston, where the meeting continued on the campus and within the gymnasium of Northwestern University. Right here we desire to say —and we are likely to repeat it elsewhere—that the Chicago Section as hosts provided a rare welcome and entertainment for the members and guests of the American Chemical Society. In generosity, in careful and intelligent planning, and in grace, in charm, and—to apply an old meaning to a familiar word—in elegance, it has probably not been equalled in the history of the society. It would be hard to find a lovelier spot than the Northwestern campus on the lakeside. It was decorated with the colors of many universities and colleges, and few who were present will ever forget the beauty of the vision as they walked about before the afternoon session began in the Patten gymnasium. While the orderly arrangement could not have been brought about without complete team work on the part of the committee, it would be unfair to omit the special praise due to Dr. W. Lee Lewis, chairman of the Chicago Section and professor of chemistry at Northwestern University. There was not a hitch or a failure in the whole program. The only criticism that could possibly be

made was the heavy expense with which the Chicago Section burdened itself whereby it gave far and away more in the way of special trains and other pleasant conveniences than the Society could ask for or expect.

Dr. Talbot's Address

At 3 o'clock President Noyes called the meeting to order, and Dr. Henry B. Talbot, of the Massachusetts Institute of Technology, delivered an address on "The Relation of Educational Institutions to the Industries."

Dr. Talbot believes that men of business have too little understanding of the responsibilities, the obligations and the opportunities of the professors. Occasionally business men appear at colleges and universities and occasionally they lecture, but usually they fail in this because they lack the talent of exposition. It is easy enough to talk about hand-in-hand work and co-operation between industries and educational institutions, but as soon as we undertake a realization of this we find that it means considerable change of routine, and often it involves expense. Therefore the effort is likely to be abandoned at about this point.

Now the community has a right to demand that young men shall be trained in abstract science and in public affairs no matter what their profession or occupation is to be, and this holds especially true of those who are about to enter industry. The present performance does not seem wholly adequate, and yet the speaker believes that the indictment lay less against the training and instruction than against the attitude of graduates.

In the monograph on technical education prepared by C. R. Mann for the Carnegie Foundation the requirements were set down in what was deemed to be the order of their importance. Here character, initiative, leadership and responsibility and a long list of native attributes were listed before technical knowledge, which stood seventeenth instead of first. Colleges cannot select their raw materials; they must make their selection from what comes to them. Character may be developed in a measure by the supervision of student activities, but the process is not always effective. In regard to the quality of leadership it often happens that the best young men are debarred by the self-assertion of others who are far less worthy. There are schools of business and engineering administration that are designed to provide training for leaders, but while the form is new and it has promise, a difficulty lies in the selection of the right young men for these courses.



SCENE ON NORTHWESTERN UNIVERSITY CAMPUS

The atmosphere of a works is not and cannot be produced in a college. What the college tries to do is to arouse enthusiasm and eagerness to learn. The greater the effort a student makes to get his education, the greater as a rule is his appreciation of it. It is to be regretted that this ratio of appreciation to effort does not apply so frequently if the appreciation is expected of the student, in consequence of the efforts of his parents.

The speaker described the five-year course at the Institute of Technology that leads to the M.S. degree in connection with work done at the General Electric Works at Lynn, the Eastern Manufacturing Co. at Bangor, the Lackawanna Steel Co. at Buffalo, the New England Gas & Coke Co. and the Merrimac Chemical Co. at Everett. This course has already been described and discussed at length. It is open only to men of superior type who have already made good, and it has the destinctive advantage of revealing the practical value of "all that theoretical stuff," while it also trains men to handle others. There has been no trouble with the foremen and workmen in the works. They like it. The trouble is that many of the best young men cannot afford the five years.

Dr. Talbot made a plea for industries to take on for summer months the best students who are striving for the best education they can get but who are inhibited by the expense. It offers an excellent opportunity to get a line on a good man. Of course they are immature and occasionally they may be in need of a measure of forgiveness, but if we look back upon our own student days the chances are that we shall find traces of green paint there too. He made an urgent appeal for vacation positions in industrial works for good students.

Another point of contact which he believed might be developed with profit is the use of professors in research, not for problems of daily improvement and administration which are best worked out in the factory laboratory, but for special problems of a more abstract nature for which special training is necessary. He believed that this would also be of peculiar value to teachers, and that an occasional summer in the works would be of advantage all around. He concluded by an appeal to make use of members of college staffs as consultants, at all events until the supply of chemists is greater.

Walter A. Patrick, of Johns Hopkins, spoke briefly on the adsorption of vapors by silica gel, a special grade manufactured by the Davidson Chemical Co. of Baltimore being used. It was found that vapors of liquids of a high boiling point were more strongly adsorbed than those of low. Adsorption decreased with rise of temperature until the critical temperature was reached, where no adsorption took place. Full details of the theory and applications of adsorption were recently read before the A.I.C.E. and will soon be published in this journal.

The President was authorized to appoint a committee to revise the general programs of meetings of the Society with a view to providing more time for divisional papers.

As trustee of the body having in charge the collection and publication of physical and chemical contents Dr. Julius Stieglitz announced that this work was an obligation undertaken by the chemists and physicists of America and that the funds for the prosecution of it

were not yet collected. He urged upon members the need of providing funds for this purpose without delay.

It was also resolved to record the sincere regret of the Society that the dye bill failed to pass the Senate in the last Congress and that the urgent need of affirmative action in regard to it be taken at the earliest moment be communicated to the national legislature.

Entertainment and Reception

At the conclusion of Prof. Patrick's address the combined entertainment and reception began—from 4:30 to 10:30 at night. There was a concert by the Chicago Band on the lawn. About the campus at various tables punch was served by ladies of Evanston under the charge of Mrs. L. V. Redman and Mrs. W. L. Lewis. In the pool of the gymnasium, Tom Robinson, swimming instructor at Northwestern, gave an exhibition of swimming by his pupils, consisting of Evanston boys and girls that was as pretty a show as one could wish to see. It was more than that, it was a sight of memorable beauty to watch those lithe young bodies swimming and playing and racing—almost like so many seals. There was also an organ recital in Fisk Hall by Hugo Goodwin, and of course there had to be a baseball game on the campus in which the Chicago Chemicos under Dr. L. V. Redman challenged All the World which (i.e., All the World) was led by Dr. Charles H. Herty. Dr. Edgar F. Smith was umpire.

While all these activities were in progress there was a dance provided on the second floor of the gymnasium, and here again we cannot forbear to mention the distinguished quality of the hospitality of the Chicago Section. Mrs. Redman and Mrs. Lewis had secured the presence of the young women of the best Evanston society to meet the chemists and the only objection raised by those present was that it was all too short.

From 4:30 to 5:30 a visit was made by a number of the more technically minded to the Evanston Filtration plant, but there was abundant excuse for all who did not go, because there was so much doing on and around the campus and it was so engaging withal that it was asking too much to expect one to leave. At 6 a supper was served by the ladies of Evanston at tables arranged for alumni of the various universities and their wives, and by 7:15 the great hall of the gymnasium was filled again. Here twenty-five members of the Chicago Symphony Orchestra led by Osbourne McConathy gave a beautiful concert at once popular and distinguished. Then followed some good chorus singing by everybody present, led by Mr. McConathy, and after a few monologues there followed Gilbert and Sullivan's old operetta, "Box and Cox." The singers were well-known professionals, and the performance, with the Symphony Orchestra, went without a hitch and was delightfully rendered to its rollicking, cheerful end. Then special trains carried the visitors back to Chicago.

The Banquet

The banquet was held on Thursday evening in the Gold Room of the Congress Hotel. Dr. W. LEE LEWIS, chairman of the Chicago Section, presided, and he proved to be a witty toastmaster. The speakers were Raymond F. Bacon, Charles H. Herty, William A. Noyes, Harrison E. Howe, William R. Moss, an attorney of Chicago, and Otto Eisenschiml. Listed among the speakers was Miss Margery Maxwell, soloist of the Chicago Grand Opera Company, who sang selections from operas and songs occasionally between courses, and interspersed among speeches afterward. Miss Maxwell's contributions had the same quality of eminent distinction that characterized the complete entertainment provided by the Chicago Section.



SIXTIETH CONVENTION AMERICAN CHEMICAL SOCIETY BANQUET, CONGRESS HOTEL, CHICAGO, SEPT. 9, 1920

The speeches were short. Dr. BACON advised chemists to make themselves proficient as business men. Dr. NOYES emphasized the need of team work and ideals of service. Dr. HERTY made a plea for the dye bill. Major HOWE made a plea for better tools, among which the most important was the publication of tables of physical and chemical constants. Mr. MOSS wanted chemists to speak so that they could be understood by those who are not chemists, and Dr. EISENSCHIML told some profitable tales. . . . .

General Meeting, Industrial Division

CHARLES BASKERVILLE, of the College of the City of New York, reported that he has found several solvents for gaseous phosgene, among them gasoline, benzine and ethyl acetate, which dissolve about an equal weight of the gas at ordinary temperatures. These solutions do not have high vapor pressures, so may be transported with safety within ordinary closed containers. On exposure to the air the liquid and dissolved gas evaporate. By suitable distillation and rectification, the phosgene can be recovered from the solution in a pure state. The solutions of phosgene may find application as a rodent exterminator and offer a method of legally meeting the present railroad restrictions on the shipment of this poison gas.

Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel

EDWARD G. MAHIN, of Purdue University, gave an account of an electrometric method for detecting segregation of dissolved impurities in steel. If the hypothesis that steel acts to some extent as a solvent for segregation materials is correct, the electrode potential of the metal should be altered in the regions immediately surrounding the inclusion. It is not possible to determine this point by the usual method involving immersion of the specimen in an electrolyte, but a method was devised for exposing microscopic areas of metal surface to an electrolyte, so that the microelectrode thus formed could be connected with a standard calomel half-element and the emf. of the system measured by the compensation method.

Soda-Lime for Industrial Purposes

ROBERT E. WILSON, director of the Research Laboratory of Applied Chemistry, M.I.T., gave two papers. The first, on soda-lime for industrial purposes, was an outgrowth of work done in the C.W.S. for military use. Industrial soda-lime must have greater activity and capacity. It need not be so hard nor contain an active oxidizing agent, both of which requirements seriously limited the efficiency of military soda-lime. The factors determining the type of lime and the percentage of caustic soda solution to use were found to be the most important variables.

The flow of viscous oils through pipes, a crude asphalt base and a refined high boiling point paraffine base oil being used, was next discussed and Poisenille's formula found to hold, in the following form:

$$P = \frac{0.000668\, z\, l\, v}{d^2} \text{ or } \frac{0.000273\, z\, Q\, l}{d^4}$$

where P = pressure drop in lb. per sq.in.
z = relative viscosity to water at 68 deg. F.
l = length of pipe in feet.
v = velocity of flow in feet-seconds in pipe.
d = inside diameter of pipe in inches.
Q = flow in gallons per minute.

A log log chart for converting Saybolt, Redwood and Engler time for efflux to relative viscosity was given having co-ordinates z/sp.gr. and seconds. The points (18, 100) and (1,500, 8,000) determined the Saybolt line. The pressure drop through a 90 deg. elbow in equivalent lengths of straight pipe in units of pipe diameter lengths was plotted against the ratio v/z.

H. K. BENSON reported that rosin extraction has been under a heavy handicap due to the retention of the solvents by the wood to an extent of as high as 25 gal. per cord. Two solvents offer more economical extraction costs, 5 per cent ammonium hydroxide and 70 per cent denatured alcohol solutions. When resinous wood of pulp size is treated with eight times its weight of 5 per cent ammonium hydroxide for ten hours, 94.5 per cent of the rosin is extracted. The ammonia extract decomposes slowly in the air at ordinary temperatures, and at 90 to 100 deg. C. is rapidly and completely decomposed, yielding ammonia vapor and finely divided humus in suspension. Ammonia extracted wood chips can be completely de-ammoniated by steam distillation. Denatured alcohol at 70 per cent strength is as efficient a solvent for rosin as ammonia, benzene, or gasoline.

Reports by Other Investigators

H. C. HOWARD, of the B. F. Goodrich Co., reported that certain arrangements of rubber balls were found very effective vibration absorbers.

HUGO SCHLATTER, of the Hercules Powder Co., confirmed Senderen's experiments on the action of aluminum sulphate in the manufacture of ether. Lead sulphate, broken porcelain, etc., were found to have the same action in aiding the formation of the vapor phase.

HARRY MCCORMACK reported that benzene in motor fuel mixtures could readily be determined by bromene absorption. Evidently it is assumed that the petroleum fractions contain no double bonds, which does not seem justified.

W. D. COLLINS, of the U. S. Geological Survey, reported that the package committee recommended 500-g. containers for chemicals. R. M. WILHELM'S report on standard thermometers and F. W. SMITHERS' specification on sulphuric acid were given.

O. L. BARNEBEY, of Columbus, Ohio, spoke on the recovery of industrial vapors with activated charcoal. This material has been greatly improved since the close of the war and has much greater absorbing capacity than gas mask charcoal. It has proved excellent for the recovery of ammonia, sulphur dioxide, spent acid vapors, and solvents such as ethyl ether, gasoline, toluene, benzene, carbon tetrachloride, choroform.

H. V. MAIN, formerly engaged in the manufacture of metallic arsenic with the Hoskins Process Development Co., described a nose dust respirator. Australian lamb's wool pads are held firmly over the nostrils by means of a guard made of packing rubber.

O. R. SWEENEY, of the University of Cincinnati, reported that a marked increase in the initial rate of hydrogenation of cottonseed oil with cobalt catalyzers was found when over 10 per cent of hydrogenated fat was present. This indicated that the product of the reaction had some undetermined role in the reaction itself.

CHARLES L. PARSONS gave an account of a special study, which he had recently made while in Europe, of the application made there of ammonia oxidation for the production of oxides of nitrogen to be used in the manufacture of chamber sulphuric acid. In Germany this method was used almost exclusively, while in England about thirty plants have adopted it. About 20 per cent saving was obtained and such impurities as chlorine were not accumulated in the chambers, as in the ordinary niter process.

Physical and Inorganic Chemistry

R. H. BOGUE discussed the hydrolysis of sodium silicates, showing that the resistance to hydrolysis increases with the amount of silica in the compound.

H. H. WILLARD and R. K. MCALPINE made a final report on the revision of the atomic weight of antimony using carefully purified and fractionally distilled tribromide. The value obtained, 121.77, is considerably higher than the one given in the international table.

LOUIS KAHLENBERG showed how certain crystalloids like lithium chloride, silver nitrate or cane sugar could be separated from other crystalloids, including sulphur, camphor or napthalene, using pyridine as solvent and a vulcanized rubber membrane. Any of the last three mentioned would be separated from any of the first three by passing through the membrane. In a similar manner it has been possible to separate certain colloids from certain crystalloids by having the colloids pass through the membrane.

HARRY N. HOLMS and W. C. CHILD described the action of gelatine in securing emulsions of water in kerosene. The stability of the emulsions was greatest for a definite viscosity which could be obtained either by using pure gelatine, by using less gelatine with a coagulating agent like sodium sulphate or by using more gelatine with a peptonizing salt of the type of sodium iodide.

Using electrometric titration, W. S. HENDRIXSON has been able to show that on titrating potassium dichromate against hydriodic acid there was no evidence of any superoxidizing power. Air has no effect on this titration.

W. D. HARKINS pointed out that the generalization of the ratio of one electron to two positive charges in the nuclei of most of the atoms would hold for that isotope of lithium having an atomic weight of 6.

ARTHUR E. HILL has found that silver perchlorate, a strong electrolyte, when shaken with water and benzene, is found to the very slightest extent in benzene in spite of its appreciable solubility, 25 g.p.l., in that solvent. This indicates that it exists as entirely different molecular species in the two solvents. On using solid salt in excess it is possible to cause the separation of a layer of liquid in this system. W. D. BANCROFT pointed out the probable existence of a large number of similar cases.

D. A. MACINNES, by multiplying together the ionic transport number, the equivalent conductance and the viscosity for solutions of the chlorides of hydrogen, potassium, sodium and lithium, obtained a constant value at 0.2 normal and 1 normal concentrations.

A. F. O. GERMANN has studied the cryoscopy of the systems of boron trifluoride with hydrogen sulphide, phosgene, sulphur dioxide, nitric oxide and hydrogen chloride. In each case one molecule of the trifluoride combined with one molecule of the other and in some cases evidence was obtained of the existence of an unstable compound between one molecule of boron trifluoride and seven molecules of the other.

ELLIOT Q. ADAMS pointed out a number of peculiarities of the actinium series which indicate that it may be of independent origin. A new name for the inert emanations of these three series, radon, actinon and thoron, was proposed.

A report was given of the progress of Dr. ACREE in the study of the hydrogen electrode with F. A. ELLIOT and Miss A. D. DUSHAK. By the use of combined hydrogen-calomel electrodes the contact potential for solutions of potassium chloride has been determined and found to check the calculated value rather closely. To secure greater accuracy, more than one electrode can be used.

S. E. SHEPPARD and F. A. ELLIOT have found that the gold number has no connection with the quality of a gelatine. The great care in the making of gold hydrosols in order to secure a gold particle of uniform size was emphasized.

H. B. WEISER and ALLEN GARRISON have been studying the oxidation of phosphorus. When the current of air or oxygen is increased the rate of oxidation is decreased. On the other hand any increase in amount of phosphorus vapor increases the amount oxidized.

F. DANIELS has made a study of the thermal decomposition of nitrogen pentoxide and finds it to be a molecular reaction. From the velocity of the reaction the heat of the reaction had been calculated. According to the quantum relation using this reaction heat the pentoxide of nitrogen should be decomposed by infra-red light, $\lambda = 1.15\ \mu$. Actually, however, blue light of much higher frequency is required. A possible explanation of this is that there is an induction period till some tetroxide is formed, after which the reaction goes more rapidly. It is possible that the lower oxide absorbs the blue light and re-emits it in the infra-red.

H. S. TAYLOR is carrying out some important studies on catalytic hydrogenation at Princeton University. The mechanism at the surface of the nickel catalyst has great technical interest.

In the study of the hydrogenation of benzene it had been found that at 180 deg. C. the formation of cyclohexane is complete, but at 300 deg. dehydrogenation sets in and carbon is formed. Dr. TAYLOR and G. DOUGHERTY showed that at 200 deg. an equilibrium is secured with 92 per cent cyclohexane. The velocity of the reaction does not fit the mass action law for three molecules of hydrogen, but does fit it for one molecule. In a similar way it had been noted that the reaction velocity for the oxidation of carbon monoxide in contact with quartz glass is proportional to the square root of the carbon monoxide concentration. These results tend to show that a catalyst may considerably alter the mechanism of a reaction. The final result, however, is probably not affected.

Cellulose Symposium

The program of the Division of Industrial and Engineering Chemistry opened on Wednesday morning with a second Cellulose Symposium, which had been organized in accordance with a vote passed at the St. Louis meeting. That the interest in the subject justified the action was demonstrated by the fact that nearly 200 members were present at the meeting.

REGENERATING BOOKSTOCK

The first two papers were directly in line with the motto of the Chicago meeting, "Increased Production Through Chemistry." The first of these was "Regenerating Bookstock," by CHARLES BASKERVILLE and CLARENCE M. JOYCE. The possibilities were pointed out of regenerating the chemically prepared pulp to be found in old magazines and books rather than using it for boxboard, roofing paper, etc. A new patented process for doing this was presented which consists in mechanically loosening and drawing apart the fibers

with as little tearing as possible. The ink is then "lifted" by treatment with borax, soap, kerosene and pine-oil. The pigment particles of the ink thus loosened are carried away in a subsequent washing.

Recovering Newsprint

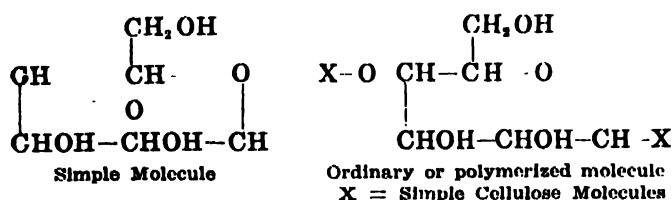
In the second paper, entitled "Recovering Newsprint," Charles Baskerville and Reston Stevenson presented a novel method for completely de-inking newsprint stock containing a large percentage of groundwood, with a minimum production of yellow color. The method depends on the use of American fullers earth suspended in the alkaline solution used for pulping and lifting the ink. The oils of the ink are adsorbed by the earth and the solid particles of ink adhere to it. The fullers earth is then washed away through a fine screen, leaving the pulp free from pigment and binder, and as clean as when first made.

Cellulose Content of Various Compound Celluloses

In discussing "The Cellulose Content of Various Compound Celluloses," Prof. Louis Kahlenberg presented results of experiments in which the cellulose content of various compound celluloses had been estimated by the ferric chloride hydrolysis method. Twelve different woods, nine straws, nine nutshells and two barks were investgated. Where comparable results have previously been published, the present results are of the same order of magnitude.

The Constitution of Cellulose

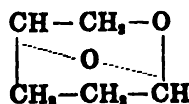
The most important paper of the symposium was on "The Constitution of Cellulose," by Prof. Harold Hibbert. About an hour was devoted to the presentation of this paper and the considerable discussion which it aroused. Formulas which have previously been proposed by Tolens, Cross and Bevan, Green, Vignon and others were first briefly considered and the facts pointed out which any structural formula for cellulose should explain. The new formula which Dr. Hibbert proposed explains all of these and some others. The formula follows:



Simple Molecule

Ordinary or polymerized molecule
X = Simple Cellulose Molecules

A characteristic feature of the new formula is the presence of a primary alcohol group which the recent work of Denham and Woodhouse and of Pictet has shown to be present. Up to the present, work on the constitution of cellulose has been carried out chiefly along the lines of (1) "Hydrolysis," (2) Xanthogenate Reaction, (3) Acetolysis, (4) Methylation. The author has started work on the direct synthesis of cellulose by synthesizing



and outlined a method on which he is working for the synthesis of mono-molecular cellulose. A new formula for starch was also proposed and the application of the new formulas was indicated in explaining the formation of dextrose, starch and cellulose in plants.

The Acid Hydrolysis of Sugarcane Fiber and Cottonseed Hulls

In the absence of the authors, E. C. Sherrard and G. W. Blanco, the next two papers were presented by Dr. Hawley. In the first one, on "The Acid Hydrolysis of Sugarcane Fiber and Cottonseed Hulls," it was shown that by one method of treatment bagasse gave about 27 per cent xylose and cottonseed hulls 14 per cent; by a second method, bagasse gave 21 per cent figured on the dry fiber basis, and of this 57 per cent was obtained crystalline. It was pointed out that pentose sugars influence the equilibrium which is established in the conversion of cellulose to hexose sugars by hydrolysis. When present in sufficient quantity, they entirely prevent the formation of fermentable sugars. Attention was called to bagasse as a promising source of xylose or furfural.

Hydrolyzed Sawdust as a Cattle Food

In the second paper "The Preparation and Analysis of a Cattle Food Consisting of Hydrolyzed Sawdust," results were presented indicating that a cattle food with a very considerable food value can be prepared by hydrolyzing Eastern white pine sawdust with sulphuric acid of 1.8 per cent concentration for twenty minutes at 120 lb. steam pressure. The average of twenty-nine cooks showed a yield of 18.85 per cent total sugars. The indications are that there are other digestible ingredients which have food value besides the sugars. Feeding experiments seem to justify further work and this is now being conducted.

A Comparison of Wood Cellulose and Cotton Cellulose

Another contribution from the Forest Products Laboratory was "A Comparison of Wood Cellulose and Cotton Cellulose," by S. A. Mahood and D. E. Cable. Samples of wood cellulose and cotton cellulose which had been subjected to various conditions of cooking and bleaching were analyzed to determine first, the best conditions for high yield of purified cellulose, and second, to determine points of similarity of difference in cellulose from wood and that from cotton. Munition linters were taken as standard and suggestions were offered for improving the yield of similar cellulose from wood. Acid cooking or acid and alkaline cooking are more effective for this purpose than alkali cooking. It was pointed out that since the results showed that cellulose from wood was a different chemical aggregate from cellulose from cotton, the practice of checking wood cellulose according to the specifications for cotton is questionable.

The next paper on the program had to be omitted owing to the inability of Dr. Hugh P. Baker to be present at the symposium.

Cellulose Mucilage

In a paper entitled "Cellulose Mucilage," which was presented in abstract owing to the author's absence, Dr. Jessie E. Minor pointed out that recent work of Schwalbe and Becker confirms her theory that reactive,

insoluble, colloidal hydrocellulose is pure cellulose which has adsorbed dextrines formed by the hydrolysis of some of the cellulose itself. These dextrines thus adsorbed catalyze further hydrolysis, as does also hemicellulose or acid treatment of the pulp prior to beating. Use is made of this phenomenon in making parchment paper. The adsorbed dextrines assist in holding size, dye, coating, etc., but impregnation with metal weakens the strength of the resulting paper.

Cellulose Section to Be Formed

Following the formal papers, consideration was given to the advisability of forming a Cellulose Section, a number of those present taking part in the discussion. It was the unanimous opinion that both the importance of the cellulose industries in this country and also the interest in the subject manifested at the two symposia were sufficient to justify the formation of a Cellulose Section, and it was voted that the necessary steps should be taken for the formation of such a section.

Section of Sugar Chemistry

C. E. Coates, discussing the subject of "Refining Raw Sugars Without Bone Black," explained the important economic development which would be possible through the use of Louisiana sugar factories as refineries during the period of the year when not active for direct cane campaign. The use of bone black methods of refining in these plants is inexpedient, as the required extra investment would be considerable.

This author presented a large number of results from his own experience where various systems of operation had been attempted. Sulphatation, sulphitation, carbonation and direct filtration processes were all discussed. Yields were presented for these various processes under different circumstances, showing that with careful control returns which compare favorably with some refinery practice can be obtained.

Important results were reported particularly on the use of activated char. This material as prepared from rice hulls and other sources lends itself to frequent revivifying by washing and several reburnings at longer intervals. In one case thirty successful uses of certain samples of char seem to be entirely feasible. The use of kieselguhr was also discussed in this connection.

Application of Clarifiers

W. D. Horn reported on the application of the Dorr classifier and the Williamson clarifier. The former apparatus, commonly used as a thickener for metallurgical slimes, lends itself also to the separation of insoluble materials from cane juices. A system of continuous subsidence and decantation of the clear liquor is accomplished, it is claimed, with very little inversion, the production of a clear juice, and a large fuel saving. The Williamson clarifier operates with violent aëration of the warm solution and subsequent skimming from the surface of the liquid in shallow pans of the scum thus collected. The skimming permits siphoning off of clear liquors and is reported to be very satisfactory.

Sugar Industry of France

T. H. Murphy, discussing the sugar industry of France, reported interesting figures regarding the present status. Before the war 213 factories had sufficient output to permit exports of 80,000 tons per year. The present output of sixty rather small factories leaves a deficit requiring import of 400,000 tons. It is reported that 142 factories were 85 per cent destroyed, particularly by removal of the copper equipment and the electrical apparatus and machinery. The damage is estimated by this author at $89,000,000. Reconstruction is inevitably slow because of the very special equipment needs of the factories.

Sugars in Bacteriological Work

E. H. Eitel discussed the application and availability of certain rare sugars for bacteriological work. These are applied particularly for the differentiation between different classes of bacteria, affording an important field where co-operation of chemist and bacteriologist is essential.

Laboratory Methods

Laboratory methods received considerable attention, especially by a group of papers presented by F. J. Bates and his associates in the sugar laboratories of the Bureau of Standards. C. A. Browne reported on a graphic method for estimating reducing sugars in the presence of sucrose. His charts will permit correction for dextrose figures between zero and 250 mg. in the presence of sucrose ranging from zero to 5 g. The same author discussed fully the chemical, physical, mycological and entomological characteristics of imported cane sugars.

He pointed out that the trend at present is to produce 96 deg. test sugar. There is some 98 to 100 deg. test imported for direct use and slight indication that more of this will be imported, especially if care and cleanliness are exercised in preparation of material suitable for direct consumption.

Changes in Sugars During Refining

Discussing the changes in sugars during refining, A. F. Blake treated the relationship of Clerget values to plant processes and stages. He pointed out the importance of true sucrose determination in order to secure reliable information for plant and refinery control. The true percentage of sugar is not usually computed from polarization figures and one may be misled if this is not done, with serious consequences.

Division of Dye Chemistry

New Naphthalene Dyes, by A. S. Wheeler. When naphthalene is sulphonated to a disulphonic acid in the 1-5 position, then treated with NaOH and oxidized, a product called juglone is produced, and this, treated with bromine or with chlorine, gives a series of red, yellow and brown dyes that are very beautiful on silk. The colors range according to mordants—which are necessary only for shade—from red to brown and yellowish bronze. He suggested further coupling with azo compounds.

Applications of Maleic and Fumaric Acids and Their Salts in the Textile Industry, by J. H. Carpenter, of The Barrett Co. These are now available in commercial quantities, and their uses are indicated as mordant assistants in chroming, in wool printing, in silk dyeing and finishing, increasing luster, and in certain blacks on cotton and in mercerizing. The acids are oxidation products of benzene in which vanadium is used as a catalyst.

The Education of the Research Chemist, by R. E. Rose, of the du Pont company. The author pointed out that the dye industry of the United States represents

a large-scale experiment with men not experienced in the industry. He traced the education of the men so taken over in general, and expressed the belief that the educational system of the country was the best available to develop ingenuity, energy, etc., but that it was less effective in preparing for advanced research. Many failures were due to the fact that men experimented first and thought afterward, while the opposite is the rule of research. Another defect was the tendency to get quick results by hitting the high spots. Then all the valleys have to be laboriously filled out. Often, too, in industrial laboratories the quantities used in experiment were so large as to delay results. He was urgent in favor of training in history, English, etc., and a better grounding in the principles of physics and chemistry in preference to technology courses.

Dr. DERRICK, of the National Aniline Co., pointed out the peculiar value of group work in research, holding that two good men working together and helping each other are worth more than four good men working alone.

There followed several papers from the Color Laboratory of the Bureau of Chemistry at Washington on photo-sensitizing dyes, and one by C. R. SENSEMAN which bore on the production of resorcinol, as did also a paper by HENRY MCCORMICK, of Chicago, called "The Extraction of Resorcinol From the Alkali Melt." Another paper by E. E. BRUNSKILL, of the Cincinnati Works (formerly Ault & Wiborg), discussed the Analids of Beta Oxy-napthonic acid.

The Qualifications of Organic Chemists was presented by L. CROSSLEY, chief chemist of the Calco Works, in which he, like Dr. Rose (and both Drs. Crossley and Rose have had wide experience as professors of chemistry before entering into industry), felt that so-called utilitarian work was of least value, while training in general principles in those studies which are necessary for the meditations of thoughtful men was of leading importance.

The same author, together with C. B. OGILVIE and G. S. SIMPSON, described a circulating burette provided with temperature control for making quantitative analyses of amines and noting the variations in shade produced by the decomposition of coupled products. Also an agitator for long-continued stirring of volatile liquids. Dr. Crossley also called attention to the explosion hazard of naphthalene vapors in the presence of SO_3.

Reports of the meetings dealing with Leather, Fuels, Fertilizers and Rubber, and an account of the visits to the various industrial plants will be published in subsequent issues.

First Meeting American Society for Steel Treating

First General Meeting of Amalgamated Societies Held in Philadelphia—Exhibit of Heat-Treating Equipment—Excursions to Many Important Industrial Plants—Abstracts of Some Technical Papers Presented

DURING the past few months, a movement toward the amalgamation of the Steel Treating Research Society—the pioneer organization of technical men in hardening rooms—and the younger and more vigorous American Steel Treaters' Society has been effected. Overtures for this desirable step were commenced by Prof. A. E. WHITE, of the University of Michigan, who easily convinced the influential men in each society that much duplication of effort could be avoided, needed funds conserved, and better progress made in all respects should these two organizations cease their sharp competition for support. As a disinterested third party, he was thus responsible for the merger which was finally confirmed by an overwhelming letter ballot of each society. It was therefore fitting that he should be unanimously elected president of the new society, the American Society for Steel Treating, at its first meeting, held last week in Philadelphia. T. D. LYNCH, of the Westinghouse Co., and T. E. BARKER, of the Miehle Printing Press & Mfg. Co., are vice presidents, while W. H. EISENMAN, the energetic secretary of the American Steel Treaters' Society, will occupy the same, but enlarged position. Directors are HOWARD J. STAGG, Halcomb Steel Co.; E. J. JANITZKY, Illinois Steel Co.; W. C. PETERSON, Packard Motor Car Co.; and FRANK FAHY, consulting engineer, New York.

A very creditable exhibition of apparatus used in heat treating was held by the society at the Commercial Museum. Many firms manufacturing tool and alloy steel; furnaces, refractories and fuel burning equipment; pyrometers and physical testing machines; quenching oils and carbonizing compounds displayed their lines, and were visited by many society members and guests. Some of the exhibits contained full-sized equipment in operation, a fact which influenced the comfort of the occasion materially. A dozen large gas furnaces produce more or less noise and considerable heat; the heat could be endured by most of the men—it felt like home—but the noise detracted very materially from the technical sessions: often it was absolutely impossible for the speakers to be heard by those at the rear of the hall. Yet despite this regrettable fact, the eight technical sessions were quite well attended and the papers were followed with extreme attention. Several of the more interesting contributions are abstracted on the following pages.

Messrs. SAUVEUR, RICHARDS and VAUCLAIN formed the attractions at the banquet. Dr. RICHARDS spoke on "The Ancient and Honorable Art of Steel Treating" and cited evidence to support his view that iron and steel were discovered even earlier than bronze. By virtue of his skill in making tools and weapons the smith and armorer have always held a most honorable position among craftsmen. Dr. RICHARDS, together with Prof. SAUVEUR, ventured the hope that the new society would add much luster to the ancient prestige by adding newly discovered science to the heat-treaters' equipment. Prof. SAUVEUR even went further in citing the fact that whereas steel-metallurgy has been revolutionized in the last three centuries by the labors of a galaxy of French

and English masters, the efforts of Americans have largely been confined to the introduction of grand labor-saving devices, and the procurement of tremendous tonnage. Yet the new society, in emphasizing quality as its prime aim, should have a great influence in the future development of substantial advances in steel metallurgy; an advance which is pacing civilization.

Some of the Technical Papers

Heat-Treating Small Alloy Steel Parts

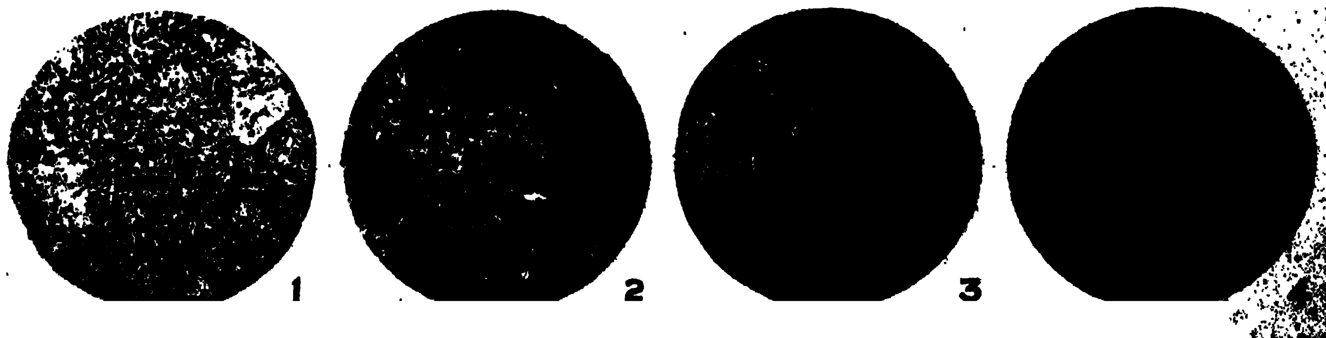
A method of heat-treating small high-carbon or chromium-vanadium steel parts in quantity for maximum hardness and strength was described by R. L. GILMAN, of the Standard Steel & Bearing Co. He uses three rotating tube furnaces, connected in series, with the necessary quenching tanks and conveyors between, so that the operation is continuous and requires no manual labor. The furnaces are gas fired, with automatic regulation for close temperature control. Parts are charged into the cold end of the carburizing furnace at the rate of 150 lb. per hr., together with crushed charcoal. These work their way forward so that at the end of 30 min. they attain a low red heat. A mildly carburizing atmosphere is maintained by illuminating gas from municipal mains. Gradually the pieces attain about 1,600 deg. F., and at the end of two hours drop out of the end of the furnace into circulating oil. A conveyor quickly removes them at a smoking heat to boiling soda solution for cleaning, and thence to the hardening furnace at a uniform temperature. This furnace is heated to a considerably higher temperature (1,750 deg.) than the piece attains, owing to its short stay—6 or 7 min. is sufficient for $\frac{5}{16}$-in. work to reach the hardening temperature superficially. Quenching and annealing follow, a similar furnace practice being used. Small pieces of correct shape, such as many bearing parts, may be safely treated in this manner, which gives extreme uniformity of surface hardness and finish. Subsequent operations may proceed with sufficient precision and speed to pay amply for the long carburization period.

Heat-Treatment of Chromium-Nickel Steel Spindles

Details of the heat-treatment given chromium-nickel steel spindles for automatic screw machines were given by H. B. SMITH and F. J. OLCOTT, of the New Britain Machine Co. S.A.E. Steel 3440 (Fig. 1) is delivered in 5¼-in. rounds, and forged to 3½ in. at temperatures from 2,000 to 1,600 deg., giving the microstructure of Fig. 2 after air cooling. Four thousand pounds of forgings is then loaded into a car-type furnace at 600 deg. F., and in twelve hours is heated to 1,600 deg. Doors are then opened and the charge removed after it has cooled to 600. Annealing is done in a similar furnace. Seven hours is required to reach 1,380 deg.; the furnace is then sealed, and in four hours has dropped to 600 deg., when the charge is removed. Maximum allowable Brinell hardness is 200, and the structure is as shown in Fig. 3. After machining into a hollow tube 3⅜ x 32 in., with $\frac{11}{16}$-in. walls, the spindle is hardened in a lead pot, 8 in. diameter by 54 in. deep, containing 450 lb. lead at 1,400 deg. F. One spindle is immersed, lowering the lead to 1,375, which temperature gradually increases, reaching 1,400 in 10 min., when the spindle is oil quenched. Drawing is done in an electric furnace at 400 deg. F., automatically controlled to within 7 deg. plus or minus, 80 min. being required. Fig. 4 reproduces the structure; minimum hardness is 418. Finish-grinding with a soft wheel, slow feed and plenty of water will produce no soft spots, in fact total rejections over a period of two years amount to but 1 in 700. Hardening warps some pieces as much as 0.05 in. out of line; this is corrected under a press, but is a feature which requires further study for its elimination.

Hardening Tractor Worms

J. L. McCLOUD described some interesting results obtained at the Ford Motor Co. in the routine of hardening tractor worms. As a result of preliminary work on rather an extensive scale, they became convinced that the best combination of machining qualities, high physical properties, ease in heat treatment and grinding could be had from oil-hardening gear stock (carbon 0.42 per cent, Mn 0.85, Cr 0.90, Ac 1,450 deg. F., Ar 1,280 deg. C.). By the use of a continuous furnace the annealing and normalizing time was reduced from 12 hr. to 2½ hr.; the furnace, although only three times as large as the intermittent type, handles six times the work, or 1,900 lb. per hr. Normalizing consists in bringing the steel to 1,575 deg. F., where it remains long enough to relieve all forging strains and to place all carbide in solution; then it is cooled at a definite rate just below Ar, then quenched in boiling water. Machinability is found to be a function of the Brinell hardness, which is therefore held between 179 and 207. After finishing, the gear is heated in a salt bath (50 per cent Na_2CO_3, 37½ per cent NaCN and 12 per cent NaCl). It requires 10 min. to reach 1,540 deg. C.; after remaining 6 min. longer it is quenched in oil; the resulting Brinell hardness is about 500, both at edge and center. Its ductility, however, is low—the elastic limit and ultimate are prac-



FIGS. 1. to 4. CHROMIUM-NICKEL STEEL IN SPINDLE
All etched by NHO_3 in alcohol. × 70.
Fig. 1. As received. Fig. 2. Unannealed forging. Fig. 3. Annealed forging. Fig. 4. Finished spindle.

tically the same. If now the hardened steel worm is plunged into another salt bath at 1,470 deg. F. for 12 min., its temperature at the center will reach 1,375 deg. F.; upon second quenching the hardness in the tooth section will still be 500 but at the center it is reduced to 340, while the ductility is immeasurably improved (e. l. 60,000 lb., ult. 100,000+ lb.).

Quenching Mediums

V. E. Hillman, metallurgist of the Crompton & Knowles Loom Works, discussed "The Efficiency and Applications of Various Quenching Mediums." He defined the main useful characteristics of oil to be five: First, the hardening efficiency, measured by the Brinell number of a coupon after quenching from a proper temperature; second, the quenching uniformity, or the production of substantially equal hardness despite material variations in oil temperature; third, the viscosity, which as it increases, increases the difficulty of circulation and reduces the hardening efficiency; fourth, the flash point, which must be high from a safety standpoint; and fifth, the permanency under constant use. While practically all oils when used as quenching baths act in the same way when new, when maintained at a uniform temperature, and when used as a still bath, animal oils in general have a good hardening efficiency, but deteriorate rapidly in use and vary much in quality shipment to shipment. Vegetable oils also give good hardness, but are liable to deteriorate through oxidation. Mineral oils, while subjected to some fractional distillation in continuous quenching duty, are excellent in service not too severe. Compounded oils of good repute are on the market which overcome many of these difficulties.

Peace-Time Uses of War-Time Lessons

A clear account of some "Lessons Learned in the Manufacture of Munitions and Ordnance That Can Be Applied to the Peace-Time Pursuits of Industry" was given by F. V. Larkin, head of the department of mechanical engineering, Lehigh University. Tracing the manufacture of projectiles and gas cylinders from the furnace to the finished state, he remarked that if the furnace operators will compile an accurate history of every open-hearth heat, many mysterious "off-heats" may be easily explained and become much less frequent. Proper attention to pouring, giving a smooth, clean surface on the ingot, followed by careful rolling-mill practice will reduce chipping or grinding of surface defects in the blooms down to zero. Pyrometric control of forge furnaces gives more uniform heat, reducing wear on tools and the number of rejections. Heat treaters should know enough about pyrometers to regard them as aids in their work rather than telltales. Time was demonstrated to be an important factor here—continuous furnaces were operated on the stroke of a gong, effecting remarkable results in volume and quality of production. Turning to the human side of the work, Prof. Larkin emphasized that with the right spirit in a new organization, the existence of unknown trade secrets is a spur to accomplishment rather than a handicap, and he knew of no secret process which could not be bettered by proper study and execution. Specifications, too, if properly drawn and fairly met, cannot but work to the advantage of the workmen, establishment and product. Never ask a customer whether a product will do. Know that it is right, and then he will have to take it.

Manufacture of Stainless Steel Articles

Certain metallurgical features of the manufacture of stainless steel articles were given by W. H. Marble, manager of the American Stainless Steel Co. An analysis of C 0.20 to 0.40 per cent, Cr 13 per cent, Si 0.30 per cent and Mn 0.50 per cent has been all but standardized. Carbon must be above 0.20 per cent for necessary hardness, yet not above 0.40, else difficulty will arise in forging. Silicon tends to neutralize the hardness of carbon, yet enough should be present to insure soundness. Chromium is the essential element furnishing the peculiar resistance to corrosion, tungsten and nickel being sometimes added for an increasing luster in polish. Freedom from corrosion is independent of the surface shape and smoothness as long as it is clean and not cold-worked. In practice, however, a polished surface insures cleanliness. Stainless steel is manufactured much like high-speed steel. Ingots are box-annealed at 1,380 deg. F., air-cooled, reheated to 2,100 deg., and hammered carefully, never allowing the temperature to drop below 1,650 deg. F. Cooling after forging gives hard material, the higher the uninterrupted cooling the harder. Rough forgings are now re-annealed at 1,380 deg. F., using all the precautions necessary for high-grade steel; furnace-cooled to 1,100, and then air-cooled—resulting in Brinell hardness, 200. After machining and finishing the piece may be hardened from 1,750 in air, oil or water, depending upon the intricacy of the shape, and tempered at a suitable heat, varying from 280 deg. F. for knife blades to 1,100 deg. F. for exhaust valves. One early trouble in using this material in the cutlery trades occurred here, since the temper colors appear at approximately twice the temperature indicated by plain carbon steels.

Helical Springs for Heavy Duty

Unusual springs of particularly heavy duty are required to transmit the power from a motor-driven quill, through a flexible coupling to the driving wheels of heavy electric locomotives. T. D. Lynch, of the Westinghouse Co., presented a tentative specification for manufacture of such helical springs, or indeed, for higher grade locomotive springs than those now available.

He favors an analysis as follows:

Carbon	0.50 to 0.60
Manganese	0.60 to 0.80
Silicon	1.90 to 2.20
Phosphorus	0.04 Max.
Sulphur	0.04 Max.

It should be made by crucible or electric furnace, cast in 9-in. ingots with smooth surface, free of surface blemishes. Such steels must be reheated very slowly; rolling temperature is 1,100 deg. C. After careful reduction to 3-in., the billet is cooled, cropped thoroughly, and any surface defect chipped or ground out. Reheat to 1,100 deg. C., roll to size (in this case 1 in. ± 0.025), shear, cool, inspect and carefully bundle so that no scratch or nick may mar the finished surface. In spring making, the rods are coiled on a hot mandrel after heating to 925 deg. C. Allow no water to come in contact with spring or mandrel; notch for length at a dull red heat, cool slowly and uniformly. All operations should guard against producing the slightest surface damage. Recommended heat treatment: preheat to 700 deg. C., soak at 900 deg. C., quench in light oil; draw in salt bath at 455 deg. C., and finally clean in a hot soda wash, followed by an oil dip to prevent corrosion. Bri-

nell hardness should be between 375 and 450; structure troostitic or troosto-sorbitic; tensile strength 200,000 lb. per sq.in. or more. The specification covering reaction under load depends upon the use to which the spring is to be put.

Highly Resistant Alloy Steel

CHARLES M. JOHNSON, director of research department, Crucible Steel Co., described the "Properties and Microstructure of Heat-Treated Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel." The analysis was not given, but the statement was made that the carbon was 0.3 to 0.4, and micrographs of ingot structure indicate it to be a complex alloy which reverts to a homogeneous solid solution upon annealing at 1,300 deg. C. (Brinell 160), and upon very long-continued tempering—a matter of days—allows an excess constituent to divorce itself and become spheroidized. It is quite non-magnetic—its residual magnetism after charging did not exceed four lines per sq.cm. It resists staining and rusting remarkably; the resistance to corrosion being compared with other well-known steels as follows, the figures representing loss in grams per sq.in. in 24 hr.:

	Glacial Acetic	10% H_2SO_4	32% HNO_3	19% HCl
New steel	6 1	3 2	0 4	
Monel metal	0 7	1 3	soluble	
High Cr-Si steel	0 0	soluble	0 5	
38 per cent Ni steel	13 8	4 1	soluble	19 0
High Cr steel	0 7	soluble	0 1	soluble

Approximate physical results on the new steel are as follows:

	E. L.	Ult	Elong	Reduc.	Brinell
Heated 5 n . at 2,400 F	90,000	120,000	30	45	230
Quenched i oil from 2,000+ F.	60,000	110,000	50	60	200

Although the metal can be forged, rolled or sheared in thicknesses 0.1 to 1 in., and is machinable, it offers a maximum resistance to prolonged heating at temperatures up to 2,000 deg. F. and is cut by the oxy-acetylene torch with the utmost difficulty.

Blades for Power Shears

Aside from the hand and machine tools required in their extensive shops, a modern steel plant requires much tool-stock for shear blades and pneumatic chisels, the latter for chipping surface defects from high-grade billets. GEORGE PORTEOUS, of the Minnesota Steel Co., called attention to the fact that a high-grade open hearth steel analyzing C 0.90 to 1.00, Mn 0.30 to 0.40, Si 0.02, P 0.01, S 0.03, can be used successfully for such service with better economy than crucible or alloy steels costing at least four times as much. He described in his paper precautions to be observed in the forging and hardening of pneumatic tools, drills, taps and reamers. Fig. 5 shows some of the tools, as well as two pairs of shear blades, the larger for billets and the smaller one for rounds. A pair of the latter were exhibited and were in excellent shape, even after having cut 20 tons of cold 1⅝-in. rounds of 1.20 carbon, 0.70 manganese steel. These blades are carefully forged, furnace annealed at 1,475 deg. F., machined and hardened at 1,450 deg. by quenching in water to harden the surface, then transferring the still hot piece to oil. Drawing temperature is 490 to 500 deg. F. If the bolt line through the center of the blade is kept tough by protecting with bolts, washers and strips during the heat-treating operations, as shown at the right of Fig. 5, no breaks at this weak section will occur either during fabrication or service.

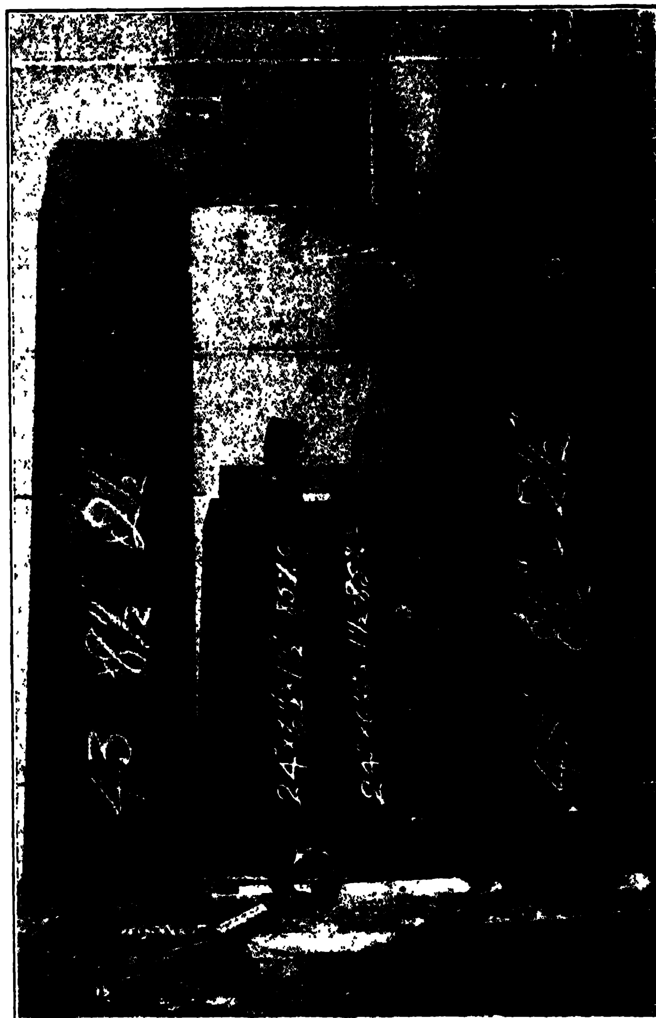


FIG. 5. TOOLS MADE OF OPEN-HEARTH STEEL

Cyanide Hardening Due to Nitrogen

G. R. BROPHY and S. B. LEITER, of the General Electric Co., have discovered that whereas pearlite due to carbon and pearlitic structure due to nitrogen are indistinguishable after picric or nitric acid etching, STEAD'S cupric reagent darkens the former very slightly but turns nitride black. Using this test, cyanided cases were found to contain much nitrogenized material. They therefore conclude that absorption of nitrogen is responsible for the properties of articles case hardened in cyanide, as well as the carbon, which latter had formerly been thought the preponderating cause. If a bar containing 0.04 per cent carbon be immersed four hours, the resulting surface will analyze only 0.33 per cent carbon, yet it will easily resist a file. Quenched 30-point steel Brinells 207, but the cyanided bar is hard to file even after annealing. Further confirmation of the authors' ideas is found in the fact that if a cyanided case be ground off, the rod is still very brittle, and remains so after ordinary annealing.

Acknowledgment

Through an oversight in the article on "Problems of the Petroleum Industry," by William A. Hamor, page 425 of the Sept. 8 issue, we failed to acknowledge the courtesy of the Petroleum Iron Works Co., Sharon, Pa., in supplying the author with photograph reproduced in Figs. 2, 3 and 4, illustrating stills and agitators manufactured by that concern.

Studies in Evaporator Design*—IV

An Investigation of the Boiling Points of Salt Solutions—Critical Examination of the Vapor Pressure and Temperature Data Given in the Literature, Checked by Determinations—Charts and Tables on Salt Solutions

By W. L. BADGER and E. M. BAKER

As a part of the extensive program of research, undertaken in the Evaporator Experiment Station of the University of Michigan, on heat transmission in evaporators and the various factors affecting evaporator design, a study is being made of the loss in effective temperature drop between heating steam and boiling liquid, due to excess boiling point of the solution being evaporated. To this end it has been found necessary to attempt to collect all possible data on vapor pressure-temperature curves at varying concentrations of the more important chemicals recovered from solution in the industries, and where information is not available or is of doubtful value, to determine the necessary data in this laboratory. This paper particularly concerns an investigation of such curves for sodium chloride, and a critical review of such data contained in the literature.

Elevation of Boiling Point With Salt Concentration

In the design of an evaporator installation, it is necessary to know the "excess boiling point" of the solution being evaporated in each effect, at the temperature and pressure existing in that effect, in order to be able to calculate the heating surface required in any given case. This so-called "excess boiling point" is merely the elevation of the boiling point of the solution over the boiling point of pure water at the given pressure. The difference between the temperature of the steam supplied to the evaporator, t_1, and the temperature of the vapor coming from the solution, t_2, may be divided into three parts:

a. Loss of effective temperature drop due to the excess boiling point of the solution.

b. Loss of effective temperature drop due to the effect of hydrostatic head.

c. Temperature drop available to cause heat transference from the steam to the boiling solution.

Hence, the available or effective temperature drop may be much less than the total temperature drop, since $c = (t_1 - t_2) - (a + b)$.

For example, a saturated solution of NaCl will boil at 108.7 deg. C. under a pressure of 760 mm. mercury, while water boils at 100 deg. C. If steam at 115 deg. C. were used to cause evaporation of water, and also of a saturated NaCl solution, in evaporators operating under 760 mm. pressure, there would be an effective temperature drop (neglecting for the moment the hydrostatic head losses) across the heating surface of only 6.3 deg. C. in the case of the salt solution, as compared with 15 deg. C. in the case of water or a solution that does not have an excess boiling point. Moreover, the heat transmission per degree temperature drop per square meter of heating surface will be much less the smaller the temperature drop.[1] The excess boiling point represents a loss of temperature drop, which means loss of evaporator *capacity*, not of thermal efficiency of the set of pans.

Direct Determinations Required

While the literature shows a large number of determinations of elevation of the boiling points of aqueous solutions, many of these are for dilute or only moderately concentrated solutions, or are at atmospheric pressures. On critical examination, many of the values given are found to differ widely. Hence this laboratory has undertaken the rather ambitious program of examining the values given in the literature, and of making such determinations as may be necessary to prepare tables of sufficient range and accuracy for the purpose of evaporator design.

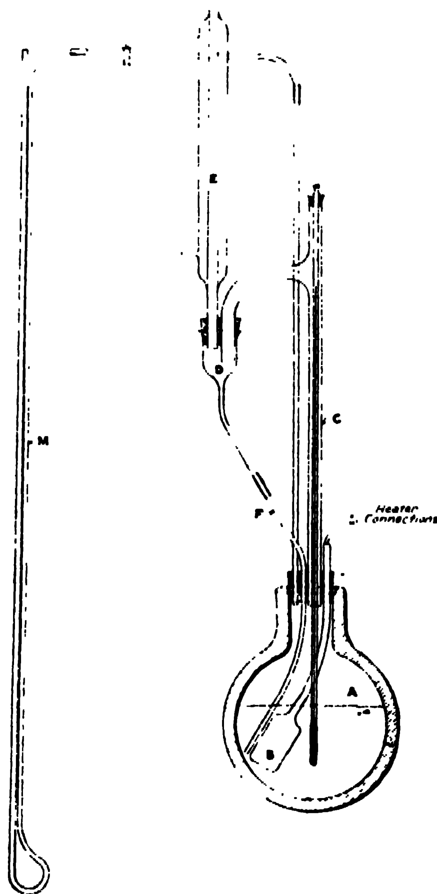
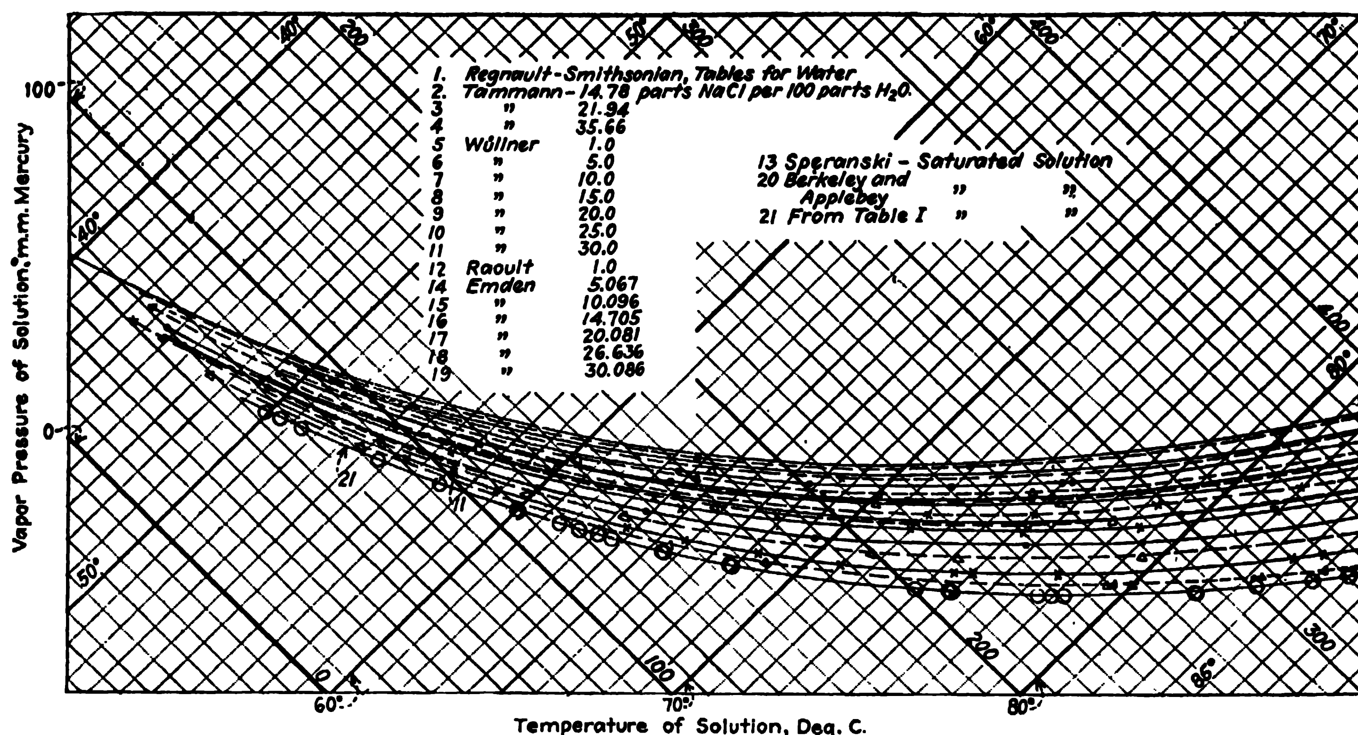


FIG. 1. BOILING-POINT APPARATUS

*Read before the American Institute of Chemical Engineers, Montreal, June 29, 1920.

[1]See "Studies in Evaporator Design—I," CHEM. & MET. ENG., vol. 23, No. 6, Aug. 11, 1920, p. 237. The relation of temperature drop and temperature level to heat transference in the vertical tube evaporator.



CURVE 1. VAPOR PRESSURE OF NaCl SOLUTIONS AT VARIOUS TEMPERATURES

The first problem to be studied has been the excess boiling point of sodium chloride solutions. This was taken up with the intention of later testing our theories by actual test on salt pans regularly in operation.

It should be pointed out here that it is impractical to calculate elevation of boiling point or depression of vapor pressure from the physicochemical considerations. Many of the laws, as Raoult's, hold rigidly only for ideal solutions. Equations and formulæ have, however, been advanced which attempt to take into consideration all the factors involved, but these, at least from the engineering standpoint, are impractical. It is evident that for exact application of such formulæ a knowledge of the degree of dissociation of the solute and of association of the molecules and ions of the solute with the solvent must be known over the entire range of concentrations and pressures. Much of the theoretical work has attempted to establish a quantitative relationship between the boiling points of solutions and osmotic pressure. Some excellent work of Dr. Orin E. Madison on the theory of osmose, not as yet published,[a] shows that such relations cannot be expected to hold rigidly in the case of electrolytes. It therefore seems unprofitable to go into a theoretical discussion of these factors in this paper, but a bibliography of articles dealing with this question and methods of determining boiling points is appended.

The direct determination of the vapor pressure of the solution under the desired conditions of temperature and pressure either by the static or ebullistic methods is far more satisfactory than an attempt to get at it from theoretical considerations or empirical formulations.

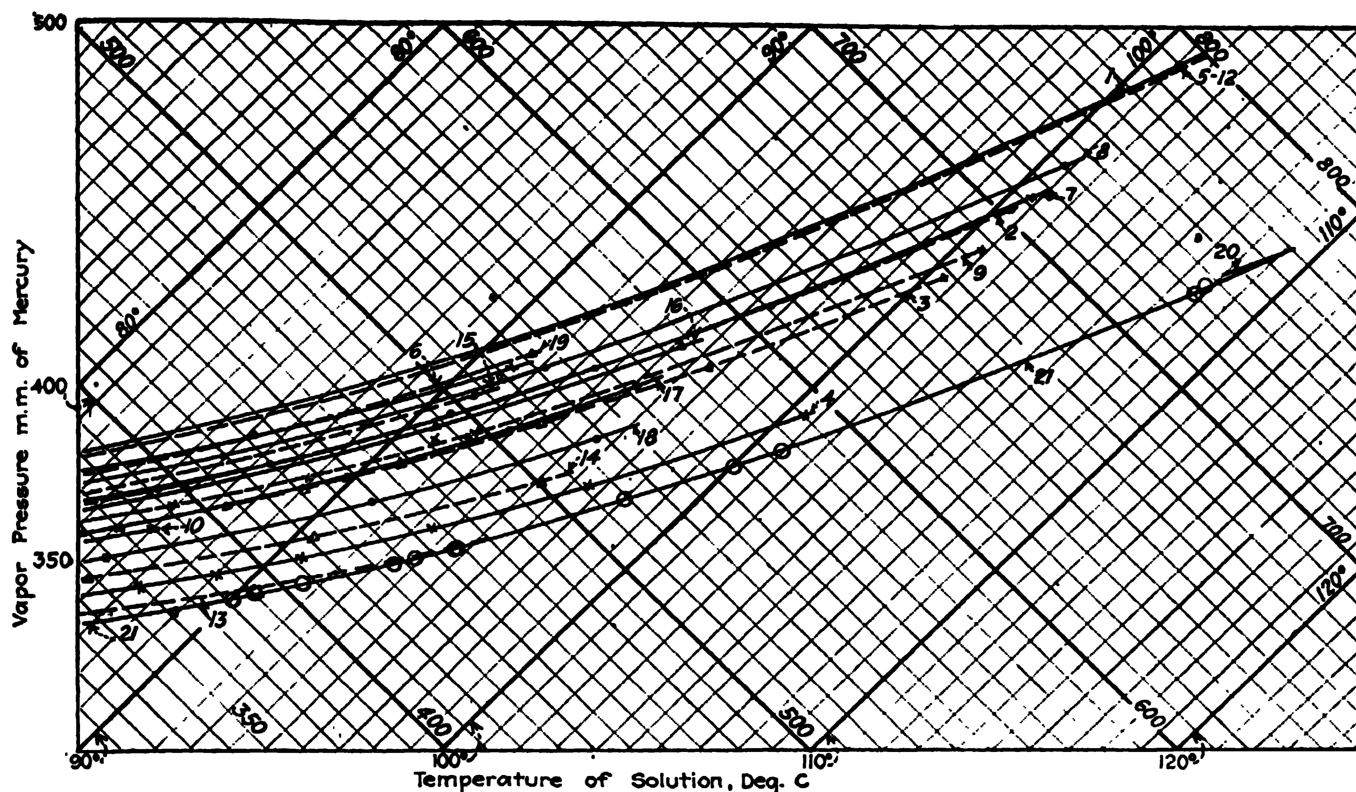
The work on sodium chloride was therefore divided into two parts: first, a determination of the boiling point of saturated sodium chloride solution over the temperature range 50 deg. C. to the boiling point at 760 mm. pressure, to supplement the values found in the literature, and second, a critical study of the values given for the boiling points (or vapor pressures) of salt solutions of various concentrations over the range of temperatures and pressures employed in evaporator practice.

Boiling Point Apparatus

Several types of boiling point apparatus were experimented with, but the apparatus finally used is shown in Fig. 1. The drawing is nearly self-explanatory. A saturated solution of sodium chloride, together with an excess of salt, was placed in the 2-l. flask *A*, which was protected from radiation and air currents by a layer of asbestos ½ in. thick, molded onto the flask. The solution was heated by the small electric heater *B*. The amount of heat input, or rate of boiling, was regulated by varying the current by means of an external resistance in series with the heater. The vapor passed up around the thermometer through the tube *C*, which was also protected, with asbestos covering, except at the point where temperatures were being read, thence to the trap *D* and the condenser *E*. All condensed water was returned to the flask at the base of the heater by the tube *F*. By thus steam-jacketing the thermometer, the steam correction to the reading taken was reduced to 0.12 deg. C. for the maximum correction for the temperature of the emergent stem. The vacuum was measured by the U manometer *M* which communicated directly with the flask, thus measuring the pressure at a point very near the thermometer bulb. The importance of this precaution is well shown by E. von Rechenburg.[b] The vacuum was maintained and regulated by means of an ordinary laboratory water jet vacuum pump. In this way it was possible to hold the vacuum steady within 1 to 2 mm. for periods of over 30 min., during which a number of simultaneous readings of vacuum and temperature could be taken. The vacuum readings were corrected for the temperature of the mercury, before subtracting from the barometer to give the absolute pressure. The thermometer used for the readings below 100 deg. C. was graduated in tenths of degrees, and the thermometer

[a] By personal communication.

[b] *J. prakt. Chem.*, vol. 79, p. 475.



CURVE I (CONTINUED). VAPOR PRESSURE OF NaCl SOLUTIONS AT VARIOUS TEMPERATURES

used for the higher temperatures was graduated in fifths of a degree. These were both certified thermometers, which had been rechecked at the boiling point of water. It should be remembered that the values were wanted for engineering design, and that an accuracy of 0.1 deg. C. or 2 mm. of mercury would be amply accurate for this purpose.[4] The values so obtained are given in Table I. This table also includes some values obtained with essentially the same apparatus, but with different methods of heating. In one case the heating was done by a small copper coil placed in the solution and heated by means of steam, and in the other case direct heating by a gas flame was used.

THE LITERATURE ON VAPOR PRESSURES AND BOILING POINTS

The study of the values given in the "standard" tables and scattered through the literature was carried out as follows: The data could be separated for the most part into two divisions: (a) the vapor pressure of certain NaCl solutions over a range of temperatures, and (b) the boiling point of various NaCl solutions at 760 mm. pressure. Curves I and II were then plotted on a very large scale. Curve I shows the value given for the vapor pressure of NaCl solutions over a range of pressures. Values below 50 deg. C. were discarded as not being pertinent. Smooth curves were drawn through the points given by each investigator. Our results for saturated sodium chloride solutions were included in this graph. From Curve I a table was made up showing for each 5 deg. interval, from 50 to 100 deg. C., the concentration of sodium chloride and the corresponding vapor pressure given by each investigator.

Curve II shows various concentrations of NaCl solutions plotted against their boiling points under 760 mm. pressure. Some of the points at the same concentration differ by over 2 deg. C.[5] At this point it was found necessary to know the solubility of NaCl at different temperatures. For this purpose Curve III was plotted

TABLE I. VAPOR PRESSURE OF SATURATED SALT SOLUTIONS

Experimental Values

Mean Values of Temp. of Solution Deg. C	Vapor Pressure mm. of Mercury	Number of Readings Averaged to Give Mean Values Cols. 1 and 2	Mean Values of Temp of Solution Deg. C	Vapor Pressure mm of Mercury	Number of Readings Averaged to Give Mean Values Cols. 4 and 5
107 90	735 7	20	78 16	239 3	3†
107.80	731 6	40	77 87	236 7	4
108 84	575 0	2*	75 30	213 5	10
99 90	558 0	5*	75 23	212 1	10
97 92	518 7	3*	73 98	201 5	4*
94 68	456 9	10	68 11	155.3	7
94 66	458 0	10	68 04	154 0	7
93 83	444 9	4*	65 86	139 0	10
93 39	437 3	3*	65 70	138 3	10
91 37	406 0	3*	63 85	127 0	9
90 38	391 8	4†	63 36	123 9	7
90 02	381 5	10	62 73	120 2	5
89 98	381 0	10	61 82	116 7	10
86 36	331 6	10	60 27	109 6	5*
86 24	329 9	10	60 05	108 4	10
85 13	319 5	8†	57 38	92 9	20*
83 66	301 5	6*	54 79	84 2	4*
82 44	281 9	7	51 59	70 0	7
82 25	280 3	12	50 61	67 7	5
78 56	242 5	9	50 04	64 8	4*

*Heating by direct heat.
†Heating by steam coil.
Other values heating by electrical heater.

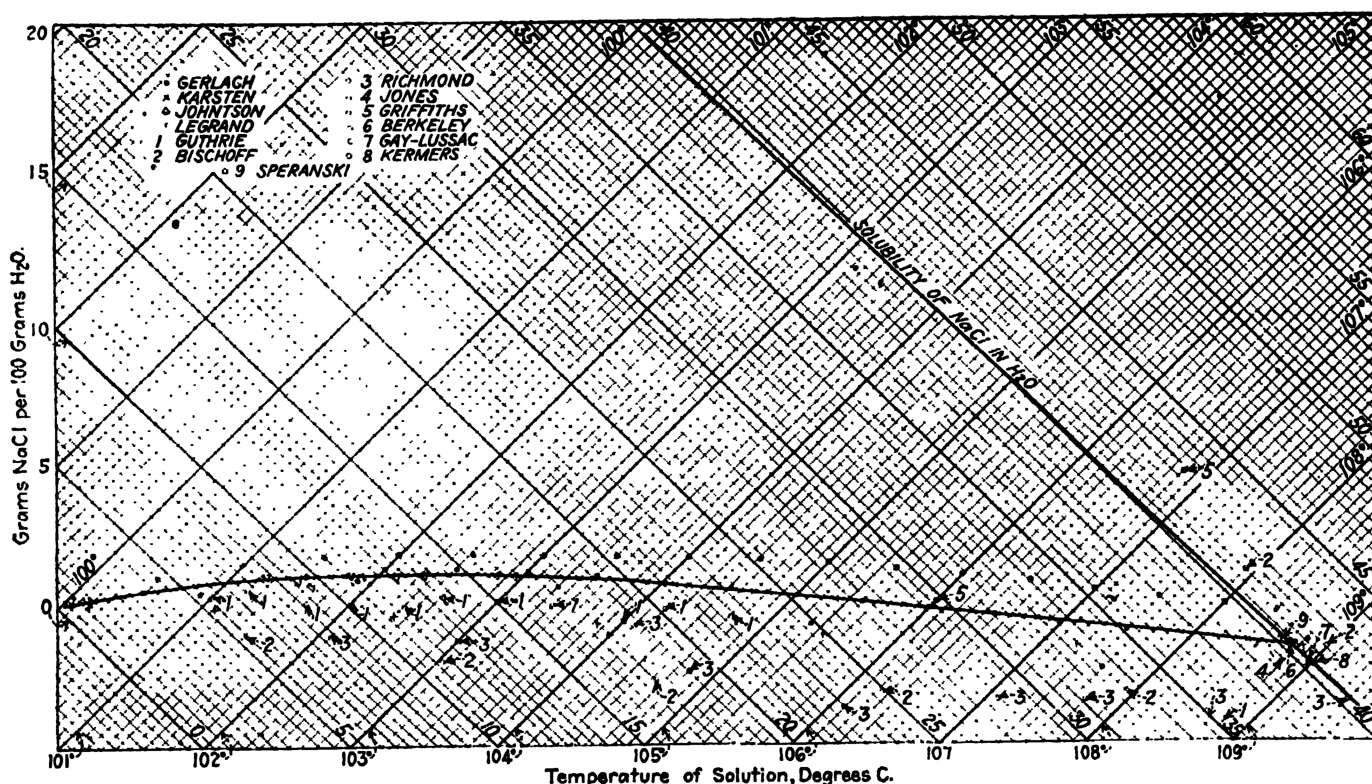
TABLE II SOLUBILITY OF NaCl IN H_2O

Values Read from Curve III

Temperature, Deg. C.	Grams NaCl Dissolved by 100 g H_2O at Temp. g.	Temperature, Deg. C	Grams NaCl Dissolved by 100 g H_2O at Temp. g
50	36 95	101	39 80
55	37 05	102	39 88
60	37 30	103	39 93
65	37 55	104	40 00
70	37 85	105	40 08
75	38 12	106	40 15
80	38 40	107	40 23
85	38.70	108	40 30
90	39 00	109	40 37
95	39 30	110	40 45
100	39.70		

[4]Many values given in the literature were found to differ by two full degrees C., even though pressures were expressed in hundredths of millimeters and temperatures in thousandths of a degree.

[5]The values given by Droop Richmond, Gmelin-Kraut, 7th ed., vol. 3, p. 359, should be for per cent NaCl instead of g. NaCl per 100 g. H_2O.



CURVE II. BOILING POINT OF NaCl SOLUTIONS AT 760 MM. PRESSURE

showing grams NaCl dissolved by 100 g. H_2O at various temperatures as given by different investigators. A smooth curve was drawn, and this curve was taken as giving the true solubility of NaCl in H_2O. Values read from this curve are given in Table II. These values were also plotted on Curve II, and a smooth curve was then drawn through the values previously plotted, and extending just up to this solubility line. In drawing Curves II, III and IV an effort has been made to weight the values according to the care, accuracy and date of the original investigations.

Vapor Pressure of Salt Solutions

Curve IV was next plotted from data obtained from Curves I and III. That is, for each 5-deg. interval, from 50 to 100 deg. C., the vapor pressures of solutions of concentrations ranging from pure water to saturated solution were plotted against the corresponding concentrations. The concentration for the saturated solutions was taken from Curve III. The 100 deg. C. curve was supplemented by values given by Tammann for the vapor pressures of salt solutions at 10 deg. C., these data being plotted as solid circles. Smooth curves were drawn through these points, thus giving mean values for the vapor pressure of solutions of various concentrations at 5 deg. temperature intervals. Table III, showing the

TABLE III. VAPOR PRESSURES OF SODIUM CHLORIDE SOLUTION

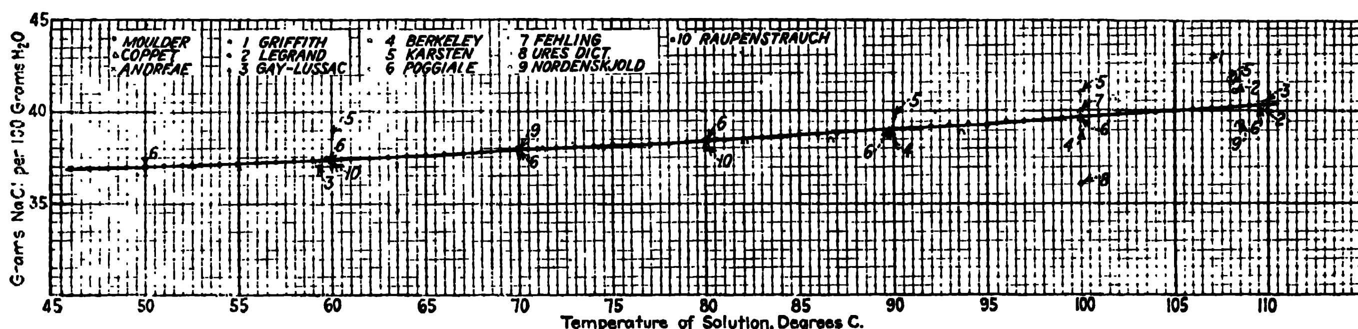
Values Read from Curve IV

Grams NaCl per 100 g. H_2O	Vapor Pressure of Solution at Temperature of— 50 Deg. C.	55 Deg. C.	60 Deg. C.	65 Deg. C.	70 Deg. C.	75 Deg. C.	80 Deg. C.	85 Deg. C.	90 Deg. C.	95 Deg. C.	100 Deg. C.
0	92 0	117 5	148 8	186 9	233.1	288 5	354.6	433.0	525 4	633 8	760
4	90	115	145	183	228	282	347	423	513	620	743
8	88	113	141	178	220	275	338	412	500	605	725
12	86	110	138	174	217	268	329	401	487	589	769
16	84	107	134	169	211	261	320	390	474	573	687
20	81	103	130	163	204	252	310	379	460	555	666
24	78	100	126	158	197	244	300	366	444	537	646
28	75	96	121	152	190	234	289	353	428	519	624
32	71	92	116	146	182	226	278	339	412	500	602
36	67	87	110	139	174	216	267	325	395	481	580
Saturated Solutions:											
Grams NaCl per 100 g. H_2O Vapor	36.95	37 05	37.30	37.55	37 85	38.12	38 40	38 70	39 00	39.30	39.70
Pressure	66	86	108	137	170	212	261	316	383	465	559

TABLE IV. TEMPERATURE AT WHICH NaCl SOLUTIONS HAVE A VAPOR PRESSURE OF 760 MM.

Values Read From Curve II.

Grams NaCl per 100 H_2O	Temperature of Solution, Deg. C.	Grams NaCl per 100 H_2O	Temperature of Solution, Deg. C.
0	100	24	104.6
4	100 6	28	105.6
8	101 2	32	106 6
12	102 0	36	107 6
16	102 8	40 37 (Sat.)	108 7
20	103 7		



CURVE III. SOLUBILITY OF SODIUM CHLORIDE

vapor pressure at these temperatures of solutions of various concentrations, was then made up by reading values from Curve IV. Table IV, derived from Curve II, shows the temperature at which solutions of various concentrations have a vapor pressure of 760 mm. From these values Curve V was plotted, which shows the vapor pressure, at different temperatures of water, of solutions containing 4, 8, 12, 16, 20, 24, 28, 32 and 36 g. NaCl per 100 g. H_2O and of saturated NaCl solution. It is noteworthy that smooth lines, conforming in curvature with the curve for pure water, could be drawn through *every* point so plotted. From this it is inferred there could be no great error in the values given by either Curves II or V.

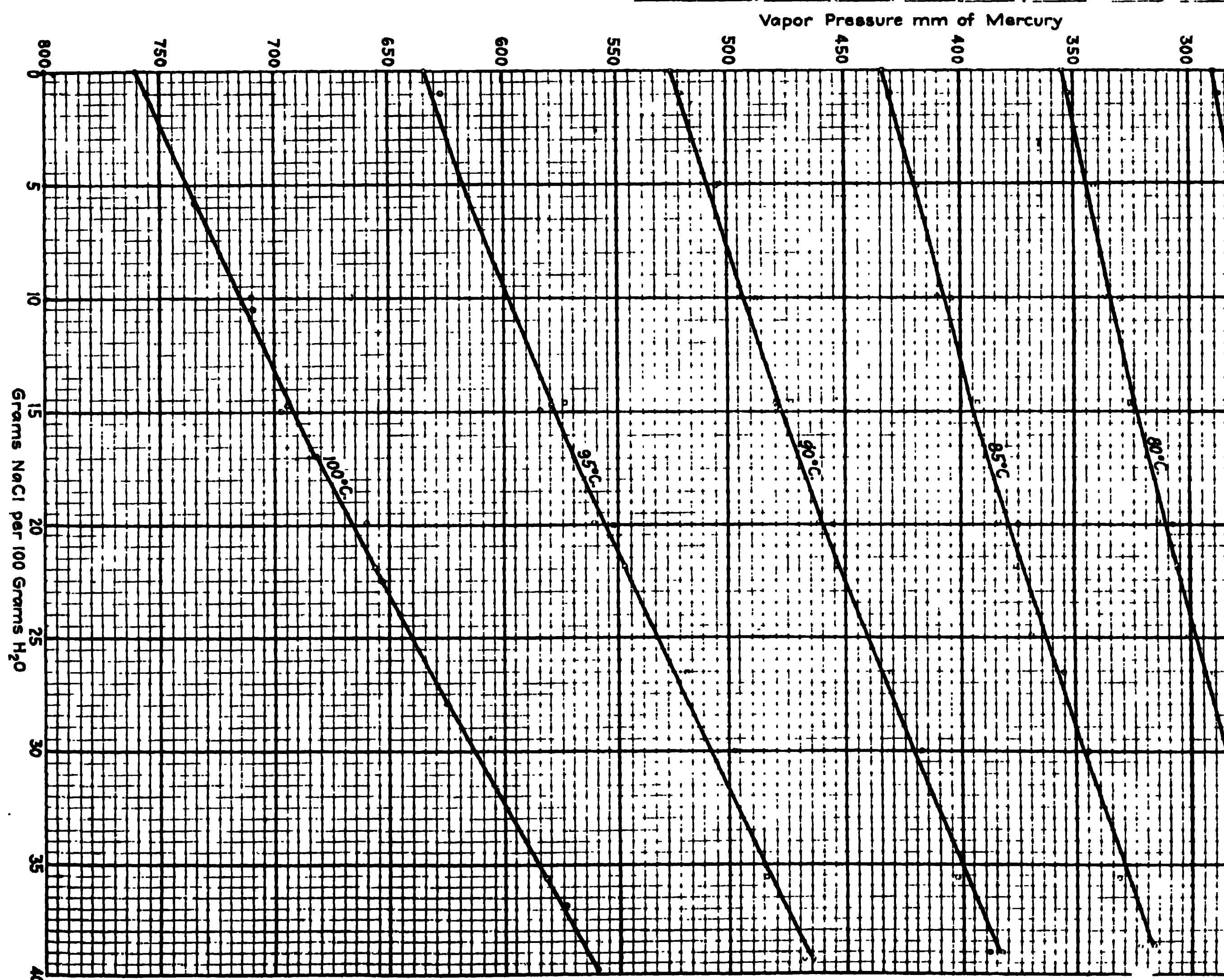
Temperature Heads

Curve V is useful in giving a close approximation of the temperature drop available for heat transference in a salt pan. The temperature of the vapor coming from the solution in any effect is the temperature at which water would boil under the pressure P_1, existing in that body, and hence may be read from the curve, $G = 0$ (call this temperature t_1). Now if the mean hydrostatic head, expressed in mm. of mercury, is added to P_1, the mean total pressure in the boiling liquid, P_2, is obtained. On Curve V follow over the pressure P_2 until the particular concentration of salt existing in the pan is reached. The abscissa corresponding to this point gives the mean temperature, t_2, at which the solution boils. The difference between these two temperatures, $t_2 - t_1$, is temperature drop lost due to excess boiling point and hydrostatic head. The difference between

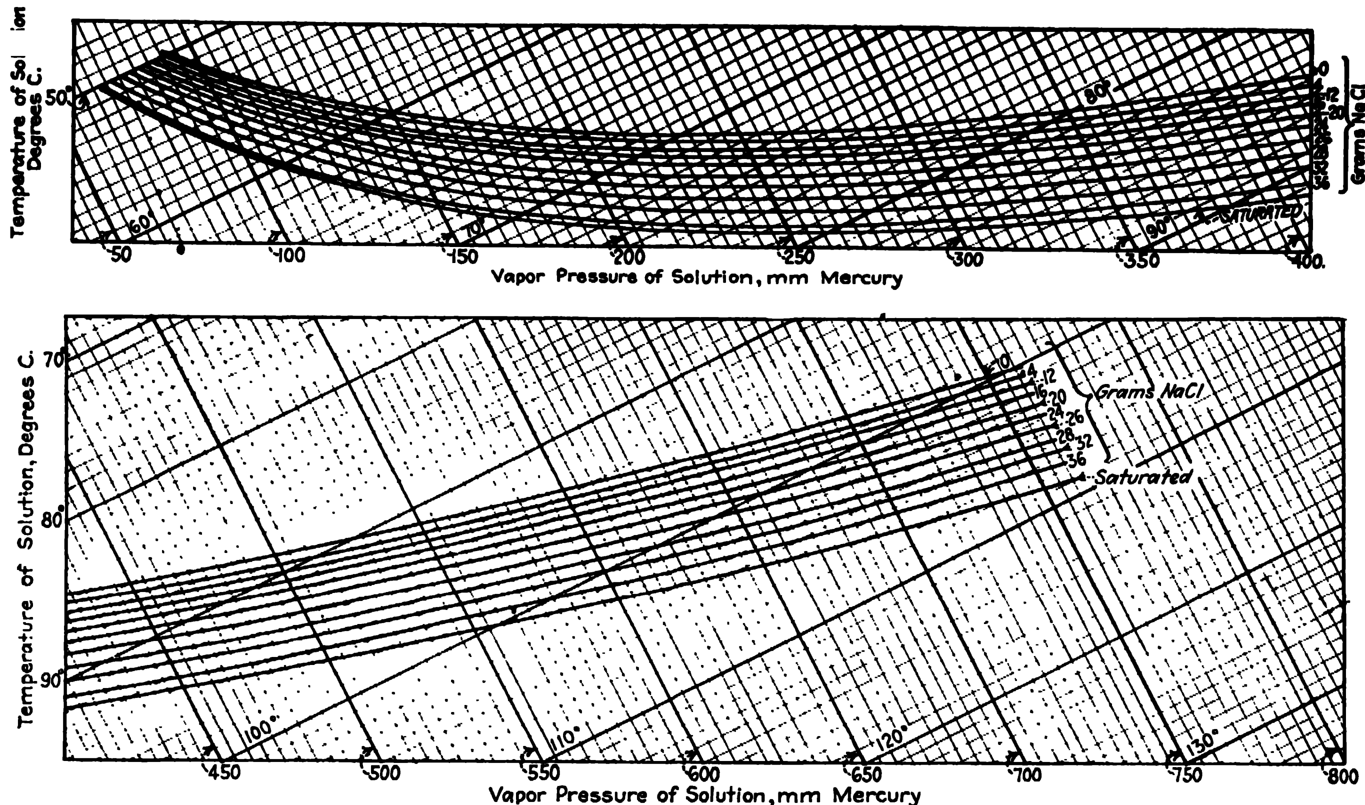
TABLE V. VAPOR PRESSURE OF SODIUM CHLORIDE SOLUTIONS AT VARIOUS TEMPERATURES

Values from Curve V

Vapor Pressure of Solution at Temp. T.	Temperature of Solutions Containing G Grams NaCl per 100 Grams H_2O										
	G = 0	G = 4	G = 8	G = 12	G = 16	G = 20	G = 24	G = 28	G = 32	G = 36	Saturated Solution
760	100.0	100.6	101.2	102.0	102.8	103.7	104.6	105.6	106.6	107.6	108.7
740	99.3	99.9	100.5	101.3	102.1	103.0	103.9	104.9	105.8	106.8	108.0
700	97.8	98.4	99.0	99.8	100.6	101.5	102.4	103.4	104.3	105.3	106.5
660	96.1	96.8	97.4	98.2	98.9	99.8	100.7	101.8	102.7	103.7	104.8
620	94.4	95.0	95.7	96.5	97.2	98.0	99.0	99.9	100.8	101.9	103.0
580	92.6	93.3	93.9	94.6	95.4	96.2	97.1	98.0	99.0	100.0	101.1
540	90.7	91.4	92.0	93.7	93.5	94.2	95.2	96.1	97.1	98.1	99.0
500	88.7	89.4	90.0	90.7	91.4	92.1	93.1	94.1	95.0	96.0	96.7
460	86.5	87.3	87.9	88.5	89.2	90.0	90.9	91.9	92.9	93.9	94.7
420	84.2	84.8	85.5	86.2	86.9	87.6	88.5	89.5	90.5	91.6	92.3
380	81.7	82.3	83.0	83.6	84.3	85.1	86.0	86.9	87.9	89.0	89.8
340	78.9	79.6	80.2	80.8	81.5	82.3	83.2	84.1	85.1	86.1	86.9
320	77.5	78.1	78.7	79.3	80.0	80.8	81.7	82.6	83.5	84.6	85.3
300	75.9	76.5	77.1	77.7	78.4	79.2	80.0	80.9	81.9	82.9	83.6
280	74.3	74.9	75.5	76.1	76.7	77.5	78.3	79.2	80.2	81.2	81.8
260	72.5	73.1	73.7	74.2	74.9	75.8	76.6	77.4	78.4	79.4	79.9
240	70.7	71.2	71.8	72.4	73.0	73.8	74.6	75.5	76.4	77.5	77.9
220	68.7	69.2	69.8	70.3	70.9	71.7	72.5	73.5	74.3	75.4	75.9
200	66.5	67.0	67.6	68.1	68.8	69.6	70.4	71.2	72.2	73.1	73.7
180	64.1	64.7	65.3	65.8	66.4	67.2	67.9	68.8	69.8	70.8	71.2
160	61.6	62.1	62.7	63.2	63.8	64.6	65.3	66.1	67.1	68.1	68.6
140	58.6	59.2	59.8	60.3	60.8	61.5	62.2	63.1	64.1	65.2	65.6
120	55.4	55.8	56.3	56.9	57.5	58.1	58.9	59.8	60.7	61.8	62.2
110	53.6	54.0	54.5	55.1	55.7	56.2	57.0	57.9	58.8	60.0	60.3
100	51.7	52.0	52.5	53.0	53.6	54.3	55.0	55.9	56.8	57.9	58.2



CURVE IV. VAPOR PRESSURE OF SODIUM CHLORIDE AT CERTAIN TEMPERATURES



CURVE V. VAPOR PRESSURE AT VARIOUS TEMPERATURES OF VARIOUS NaCl SOLUTIONS

the temperature of the vapor coming from the previous effect and t_2 is the temperature drop really available to cause transference of heat through the heating surface.

A complete table of values was read from Curve V, these data being given as Table V. This table gives the temperature at which the various solutions have a certain vapor pressure, as the data are most serviceable for evaporator design in this form. A "straight line" interpolation may be used between adjacent values to obtain intermediate values without increasing the error of the results. The plotting was carried out carefully, and to large scale, and it is felt that the values given in Table V are reliable to within certainly 0.2 deg. C. and 3 mm. pressure. All of the erratic results given in the regularly accepted standard tables have been eliminated, and the field from 50 deg. C. to the temperature at which the solutions will boil under one atmosphere pressure is given in much greater detail than hitherto. The values for saturated sodium chloride under diminished pressure are not found in any of the regular published tables. The results given are dependable to an accuracy which is more than sufficient for engineering design.

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Diffusion of Solid Copper in Liquid Aluminum

Details of Experiments Where Copper Rods Were Dipped in Molten Aluminum Under Definite Conditions, and the Resulting Alloy Analyzed—Filiation Experiments Also Were Made in Various Ways, All Giving Nearly the Same Results

BY ROBERT J. ANDERSON*

IN ORDER to obtain figures with regard to the rate of solution of solid copper in liquid aluminum, the following experimental method was employed: Copper cylinders were suspended in liquid aluminum, for various times and at different temperatures, and withdrawn after the desired elapsed time. The resultant alloy was then poured into a button, and analyzed for copper. Strictly speaking, the results of these experiments cannot give a truly quantitative measurement of anything other than the rate of alloying under definite conditions. However, the principles involved in the commercial manufacture of No. 12 alloy are identical with those in the present laboratory experiments, and consequently measurements such as these are of more direct practical worth to foundrymen than calorimetric diffusivity figures.

A foundryman is mainly interested in knowing how long it requires for the copper to go into solution under the conditions of plant practice, and the experiments carried out in this investigation give positive indications of the time required. As above stated, however, the results arrived at are complicated by factors other than time and temperature, because solution, diffusion and convection are all active,[1] and the results give values for the combined effects of these factors. It is possible, however, to obtain useful information from such experiments, and the chemical analysis of the alloy buttons, as well as examinations of the copper cylinders, afford data as to the rate of alloying.

In foundry-melting practice there is always more or less stirring of the melts when heats are made, whereas in the present experiments there was practically no agitation. While it might have been possible to have employed a definite rate of agitation in the case of these experiments, say by rotating the crucible at a constant rate, the net practical result of such a procedure would be simply to increase the rate of alloying.

METHOD OF EXPERIMENT AND MATERIALS

In the experiments with solid copper in liquid aluminum, two sizes of copper cylinders, ½ in. in diameter and 4 in. long, and 5/16 in. in diameter and 4 in. long, were used. (12.7 mm. and 7.9 mm. x 101.6 mm.) These were prepared by melting some copper punchings in a graphite crucible and pouring the liquid copper into cylindrical graphite molds. In experiments 1 to 14 inclusive, the larger cylinders were used, and in experiments 15 to 23 inclusive, the smaller ones were employed. In each experiment, 100 g. of aluminum was melted and brought to the desired temperature in a resistance furnace of the crucible type. When the aluminum was liquid and at the desired temperature, a cylinder was suspended in the liquid aluminum by means of a graphite holder and a bronze clamp. In each experiment, the end of the cylinder was ¼ in. (6 mm.) from the bottom of the crucible, and the same surface area of copper was exposed to the same volume of aluminum. The aluminum was melted in a fireclay crucible of such a size that 100 g. of liquid aluminum filled the crucible about three-quarters full. After a cylinder had been suspended in the liquid aluminum for the desired time, it was withdrawn, and the resultant alloy in the crucible was poured into a button. In each test the alloy was thoroughly stirred before pouring, and the button was analyzed for copper. Temperatures were taken with a base-metal thermocouple. In all the experiments the temperatures given indicate the original temperature of the aluminum at the time of suspending the cold copper cylinder; on introducing the cylinder, a drop of 25 to 40 deg. C. occurred. This chilling was corrected by increasing the power input to the furnace, and thereafter the temperature of the liquid aluminum was maintained within ± 10 deg. C. of the desired.

TABLE I. DIFFUSION EXPERIMENTS WITH ½-IN. COPPER CYLINDERS IN LIQUID ALUMINUM

Experiment	Time, Min.	Temperature, Deg. C.	Per Cent Copper in Button
1	1.0	700	0.17
2	2 5	700	0 18
3	5.0	700	0 26
4	7.5	700	0 77
5	10.0	700	2 26
6	45.0	700	20 50
7	1.0	800	0.20
8	2.5	800	1.35
9	15.0	800	2 80
10	45.0	800	38 82
11	1.0	900	1 92
12	5 0	900	4 27
13	7.5	900	11 14
14	20.0	900	41.01

Where the cylinders were suspended for only one minute or two and one-half minutes, the drop was not recovered in these short periods of time. A summation of the results obtained with the ½-in. diameter cylinders is given in Table I.

Additional similar experiments were carried out, using 5/16-in. diameter cylinders. These cylinders were not suspended in the aluminum, however, but were simply so placed in the liquid metal that practically the same surface area of copper was exposed on each. The cylinders were withdrawn after the desired time; the resultant alloy was thoroughly stirred and poured into a button, and the button was analyzed for copper. In order to ascertain whether the surface condition of the copper influences the rate of solution, some of the small cylinders were freshly cleaned before immersion in the aluminum by boiling in 10.0 per cent sodium hydroxide, followed by washing in water. Those cylinders not cleaned had a slight oxide film on the surface. The results of experiments showed that the condition of the copper surface does not influence the rate of alloy-

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[1]As pointed out in an article entitled "Some Theoretical Principles of Alloying." CHEM. & MET. ENG., vol. 23, No. 8, p. 317 (Aug. 25, 1920).

ing to any practical extent provided the surface is not badly oxidized. Hence, in foundry practice, it is not necessary to clean sheet copper or punchings in the manufacture of No. 12 alloy, provided the copper surface is in reasonably fair condition. Table II gives a summary of the experiments carried out with the small cylinders.

Additional experiments were made with thin copper punchings of circular form, punched from medium gage sheet. Such punchings go into solution in aluminum rapidly even at low temperatures; one 30-g. punching was completely dissolved in five minutes at 700 deg. C. in 175 g. of aluminum with no agitation. The composition of the materials employed in the above experiments was as follows:

TABLE II. DIFFUSION EXPERIMENTS WITH 1/16-IN. COPPER CYLINDERS IN LIQUID ALUMINUM

Experiment	Time, Min	Temperature, Deg C	Per Cent, Copper	Condition of Copper Surface
15	2 0	700	0 60	Oxide film
16	5 0	700	6 63	Freshly cleaned
17	10 0	700	21 94	Freshly cleaned
18	1 0	800	0 16	Freshly cleaned
19	2 0	800	1 78	Oxide film
20	5 0	800	6 58	Freshly cleaned
21	1.0	900	4 26	Oxide film
22	2.5	900	7 75	Freshly cleaned
23	5 0	900	9.45	Freshly cleaned

Material	Elements, per Cent			
	Cu	Fe	Si	Al*
Aluminum	0 23	0 34	0 31	99 12
Copper punchings	99 89			
Large copper cylinders	99 94			
Small copper cylinders	99 86			

* Aluminum, by difference

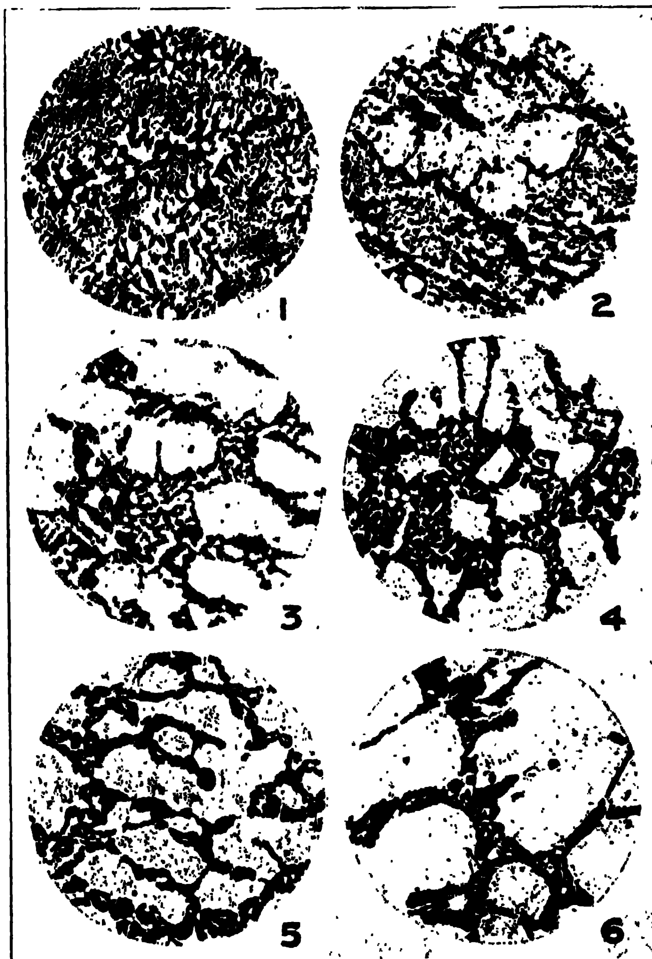
Discussion of the Experiments

The results of the diffusion experiments, summarized in Tables I and II, show that copper readily alloys with aluminum when solid copper is placed in contact with liquid aluminum. The data given in these tables indicate tendencies rather than precise results, and show that copper goes into solution (alloys) with aluminum more rapidly with increasing temperatures, and that small pieces of copper dissolve more rapidly than large ones; in other words, the rate of diffusion is a function of the temperature, of the size and shape of the immersed copper, and of the ratio of the surface area of the solid copper exposed to the liquid aluminum. In preparing alloys of aluminum with copper on a commercial scale, for example No. 12 alloy, by this method, it is advisable to use light-gage punchings and clippings or light sheet scrap.

Filiation Experiments

A few superposition ingots were made in order to show the filiation phenomenon for the aluminum-copper system and also to study this phenomenon in its relation to the subject in hand. These superposition ingots were made in a number of ways, but the results were more or less similar. In experiment 24, the copper was liquefied in a graphite crucible; interior dimensions ¾-in. diameter and 4 in. deep. The crucible was about one-half full of copper. Small pieces of aluminum were then added as fast as they melted until the crucible was full of metal; the aluminum was dropped in, and some agitation resulted. When full of metal, the crucible was removed from the furnace and cooled in air. This experiment was repeated as experiment 25, but a crucible ½ in. diameter and 4 in. deep was employed. In experiment 26, copper was melted in a ¾-in. graphite crucible in one furnace; aluminum was melted in a clay crucible in another furnace; when both metals were thoroughly liquid, the aluminum was poured onto the copper and the whole melt allowed to cool in air. In experiment 27, a cylinder of solid copper was placed in a graphite crucible 0.5 in. diameter and 4.0 in. deep; the cylinder was one which had previously been cast in a crucible of this size, and it fitted the crucible snugly. The cylinder was 2.0 in. long, and its upper surface was planed smooth and flat. A cylinder of aluminum of the same dimensions as the copper cylinder, and with the lower surface smooth, was placed on top of the copper cylinder so that the surfaces were in close contact. The crucible was then placed in a cold furnace, heated to 750 deg. C., held for two hours at that temperature, and cooled in air. The conditions for experiment 28 were the same as for experiment 27, but a crucible ⅜ in. diameter and 4 in. deep was employed; the crucible containing the cylinders was then heated from room temperature to 800 deg. C., and then cooled with the furnace.

After cooling the ingots in experiments 24 to 28 inclusive, they were removed from the molds and examined microscopically. Because of the extreme brittleness of the rich alloy bands formed, the ingots readily broke in two at planes in the ingots corresponding to compositions roughly of 40 to 60 per cent copper. A number of photomicrographs of the typical structures found in the ingots were taken, and some of these are reproduced here.



FIGS. 1 TO 6.
Structure of alloy at distances of 1, 2, 3, 4, 5 and 6 cm., respectively, from the top of copper bar. Etched with NaOH. × 150.

When solid copper is placed in contact with liquid aluminum at a temperature below the melting point of copper. alloying of the two metals takes place. The rate of alloying is dependent upon the temperature. When the metals are placed in contact in the order of their specific gravities (aluminum on top) the copper molecules appear to migrate upward. In experiment 26, where liquid aluminum was poured onto liquid copper, a section 6 cm. from the copper contained about 9 per cent aluminum, the copper content of the aluminum alloy on top being richest nearest the copper and leanest at the top of the ingot. This was shown by microscopic examination of the resultant ingot.

The result of superimposing liquid aluminum on solid copper may be shown by a description of the microscopic results of one of the above experiments. The ingot (made in experiment 26) was polished along one side and points 1, 2, 3, 4, 5 and 6 cm. from the copper in the direction of the upper end of the ingot were photographed. The amount of copper contained in the superposition alloy becomes progressively less as the distance from the copper increases. No aluminum could be detected in the lower extremity (copper end) of the ingot. Micrographs in Figs. 1 to 6 inclusive represent areas located at distances respectively 1, 2, 3, 4, 5 and 6 cm. from the copper in the direction of the upper end of the ingot. The structure shown in Fig. 1 is of practically eutectic composition (about 33 per cent copper), and the copper content of successive areas becomes leaner and leaner until in Fig. 6 it is about 10 per cent copper.

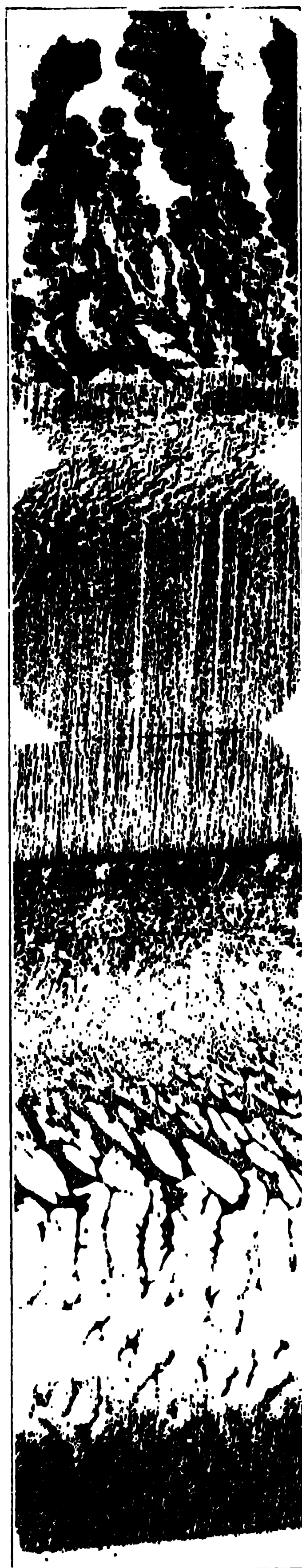


FIG. 7.

Assembled micrographs showing changes from bright copper, below, to a point 6 cm. above. Etched with $NH_4OH + H_2O_2$ × 85.

The microstructure of the area extending from the copper in the direction of the point shown by Fig. 1 is illustrated by a series of micrographs taken at successive points along the section from the copper toward the 1-cm. point. Such a series of micrographs, joined together, are shown in Fig. 7. Considerable difficulty is experienced in securing good photomicrographs of a series of structures in one sample where the composition varies within wide limits, because of the unsuitability of any one etching reagent to a variety of structures. However, the series of micrographs given indicate the changing constitution of successive layers of a superposition ingot fairly well, showing the progressive leanness of successive layers in copper. While interesting, the study of alloys by preparing superposition ingots is not conducive to practical results, and fortunately there are better and more reliable methods.

SUMMARY

It has been shown by laboratory experiments that solid copper goes into solution in liquid aluminum fairly rapidly at relatively low temperatures, and that the rate of solubility and diffusion increases rapidly with rising temperatures. Thus, small pieces of copper go into solution in aluminum fairly rapidly at 700 deg. C., but very rapidly at 900 deg. C. Hence, the commercial method for the manufacture of No. 12 alloy by adding copper directly to aluminum is a rational procedure from the metallurgical standpoint. That it may not be the best method or the one most easily adapted to foundry practice will be discussed later.

Market for American Dyes in Foochow

Evidence of a potential market for American dyes in Foochow is given in a recent report from Consul Ernest B. Price. German dyes, which practically held a monopoly of the market before the war, have been displaced largely by imitation dyes, the labels and packages not showing country of origin. In 1918 the total imports of aniline dyes into Foochow were $10,626; in 1919, $16,064; and in the first quarter of 1920, $11,296. Imports of artificial indigo for 1919 were $20,854, and of vermillion, $15,718. Vermillion imports for the first quarter of 1920 are given as about $4,000. Quite a percentage of the dyes imported is used in the dyeing of paper, scarlet being the color most in demand. Aniline dyes in rose azure, magenta, fast red, indigo blue, orange, green, violet and black are used for dyeing cotton cloth and silk cords.

Lubricating Oil From Asphalt Deposits in Palestine and Syria

A recent report from Consul General Ravndal at Constantinople is to the effect that in order to meet the pressing demand for lubricating oil the directors of the Syrian and Hedjaz railways in 1916 adopted the suggestion of a German geologist to distill the bituminous limestones (asphalt) which are found abundantly in Syria and Palestine. This was done by setting up a special oven and distilling apparatus at a cost of 3.45 piasters per kilo of oil. Between Aleppo and the Red Sea thirty distinct deposits of bituminous schists are known, chief of which are those of Hasbaya, Hadete, Dumar, Mekarine and Nebi Moussa.

Present Status of the Nebraska Potash Industry

Observations on General Conditions and Probable Future of the Industry—Historical Note on the Discovery of Potash in the Nebraska Lakes—Need of Improved Technology in Methods of Operation—Current Fuel and Labor Costs

EDITORIAL CORRESPONDENCE

IT IS conservatively estimated that more than $12,000,000 has been expended in establishing the Nebraska potash industry in the western part of that state, where alkaline lake waters are evaporated for the recovery of mixed salts containing potash in the form of sulphate and carbonate. In spite of the fact that the industry was started during the war and enjoyed high prices for some of its products, the return on the investment has not been adequate. The Nebraska lakes have been our best potash resource for several years past, but for one reason or another the companies as a whole have not prospered.

Considering the attraction which the business held during the early years of the war, when potash could be quickly recovered and sold at high prices, it is not surprising that one or two "wildcats" were promoted and foisted on a gullible public. For the most part, however, the companies which were formed had a legitimate reason for existence and have conducted their operations honestly.

The industry has had its ups and downs, due to various causes, the period of greatest prosperity being due to the shortage of potash caused by the war and the period of greatest depression being due to the change in conditions following the armistice. It seems likely that during the war the Nebraska potash producers became overconfident and felt that their product was so essential that the fertilizer companies or other consumers must take it at any price. It is equally evident that when the armistice was declared the fertilizer companies which had been buying the Nebraska product believed that it would be but a short time before they might again secure foreign potash, and consequently assumed an indifferent attitude toward domestic producers. In fact the fertilizer companies refused to buy and the lack of harmonious co-operation resulted in closing the potash plants in February, 1919, for lack of a market. At that time the producers had on hand about 70,000 tons of salt, containing the equivalent of 25 per cent K_2O. This they were obliged to carry in storage at a considerable expense, refusing to sell at $1.50 per unit material which had cost them from $1.80 to $3 per unit to produce. This conflict of interest between producer and consumer resulted in a cessation of operations until the fall of 1919. In the meantime the accumulation of 70,000 tons was sold gradually at prices varying from $1.75 to $2.25 per unit K_2O.

Contracts for 1920 Production

Importation from foreign sources during 1919 failed to meet the expectations or needs of the fertilizer companies and a market was again afforded for the domestic product. This resulted in placing the Nebraska potash plants in operation about September, 1919. In the meantime the producers had endeavored without success to obtain tariff protection from Congress, and resumed operations in the hope of making a favorable contract with fertilizer companies. This was the subject of negotiations last spring and resulted in an agreement for the disposal of 50,000 tons of mixed salt averaging about 25 per cent K_2O, at $2 per unit. This is practically the production of the district for the summer season and will insure operation at least until fall. If it then appears that foreign potash will still not be sufficient for domestic consumption, a further contract may be made for the winter output. The fertilizer mixing season extends from September to April, and with the close of each season the fertilizer companies have shown a disposition to wait for foreign potash at a low price rather than contract for the domestic product. This policy works very much to the disadvantage of the producers, however, inasmuch as their best season for production is the summer time, and they should begin operations with assurance that they can sell their products, just about the time the fertilizer companies are finishing their mixing and selling campaign. Thus the producer finds himself in a state of uncertainty as to his market just at the time when he should be most actively engaged in production.

Prices of Potash

The price at which the current season's output is contracted for—viz., $2 per unit—is regarded as being about the minimum which ordinarily the companies can accept and make a profit. In fact it is claimed that the price entails a loss in every plant in the district this year. The general sentiment in the district is that the companies should receive about $2.50 per unit in order to return their investment and realize a profit. Some companies even figure as high as $3, while a few are confident that improvement in the technology will permit well designed and operated plants to run possibly at $2 per unit, or less. Certainly a lower cost can be obtained during the summer season when solar evaporation is a great factor in production.

Importance of Nebraska Potash

According to "Mineral Industry," the domestic production of potash in 1918 was almost double that in 1917, and Nebraska brines supplied 55 per cent of the total. At present the district is capable of producing in the summer season from 500 to 600 tons of mixed salt per day, averaging 24 per cent K_2O. During the winter the output is reduced to 300 tons of mixed salt per day. Eight companies are now actively engaged in production, their plants having capacities varying from 150 tons of mixed salt per day down to 25 tons per day. The following companies have survived the difficult months following the armistice and are the

active producers: The Potash Reduction Co., Hoffland; American Potash Co., Western Potash Co., Union Potash Co., Alliance Potash Co., and Nebraska Potash Works, Antioch; Hord Potash Co. and Standard Potash Co., Lakeside.

Historical Note

In view of the important position which the Nebraska potash industry evidently has attained, more than ordinary interest attaches to its early history. The notes here recorded are from personal interviews with Wilson H. Low, late head chemist for the Cudahy Packing Co., Omaha, Neb., and Carl L. Modesitt, of the Potash Reduction Co.

About 1906 a Mr. McCarthy of Alliance, Neb., offered to sell to the Cudahy Packing Co. about thirty tons of alkali which he had scraped from the dried surface of one of the lake beds in the western part of the state. The Cudahy company purchased the lot and used it without further purification for making caustic soda solution. In fact soda was the only salt of interest to either Mr. McCarthy or the Cudahy company, and no one had suggested that potash might be present. The incident resulted in a trip by Mr. Low to examine some of the lakes, and subsequent trips were made in two successive seasons. Conditions were found as represented by Mr. McCarthy and resulted in a careful survey of Jesse Lake, its area, probable depth of mud and amount of alkali on the surface and in the mud. In September, 1908, Mr. Low reported to E. A. Cudahy that on the occasion of his last visit Jesse Lake was largely dry and covered by a thick deposit of crystallized alkaline salt over an area of several hundred acres. A 50-lb. sample of mud was taken from the lake bed and a sample of the salt deposit was scraped from the surface of 25 sq.ft. A laboratory examination of these materials showed that the mud contained about 3 lb. of dry sodium carbonate or its equivalent per cu.ft. The crystal deposit on the surface contained sodium carbonate or its equivalent to the extent of about 10 lb. per 25 sq.ft. Calculated in quantities per acre, these figures showed sixty-five tons of sodium carbonate or its equivalent in the mud and nine tons on the surface, or a total of seventy-four tons per acre in the top foot. As a result of the analyses made by him on this occasion, Mr. Low discovered that the alkali contained appreciable quantities of potash, which made the deposits more valuable than if they contained soda only. Soda ash was then worth about $18 per ton in Omaha, while potassium sulphate or chloride was worth over $100 per ton for mixed fertilizer or other purposes. Accordingly he recommended that Cudahy Packing Co. acquire control of some of these lakes as a source of potash for fertilizer and other purposes, but, owing to other projects which this company had under way at that time, no steps were taken to get hold of the lakes.

The record of Mr. Low's investigation and analyses was available to anyone who was interested, and when the Cudahy company showed no active interest the matter was taken up by John H. Show, head assistant in Mr. Low's laboratory. Mr. Show interested some associates, Carl L. Modesitt, C. C. Denny and V. I. Jeep, who decided to treat the lake waters for the recovery of alkali.

In March, 1910, Mr. Modesitt conducted a rough survey of about twenty ponds and lakes, and analysis was made of about seventy samples of water, mud and crystal. In February, 1912, Mr. Modesitt erected an evaporating tower and made about one ton of crystallized salt which he submitted to different fertilizer companies. A further survey of the alkali lake region was made during 1912-13, and in 1913-14 the refining problems were studied with a view to separating the potash and soda for the purpose of reducing freight cost and securing a higher price for the refined products. By April, 1915, Mr. Show and his associates, who had organized the Potash Products Co., had spent about $17,000. They then got sufficient financial backing to start a plant on a commercial scale, and they assembled and erected a 125-hp. boiler and two evaporating pans with steam coils. Water was pumped from Jesse Lake through a 2½-mile pipe line to the plant. Operations began June 10, 1915, and the first carload of mixed salt was shipped eight days later. The Potash Reduction Co. succeeded the Potash Products Co. in August, 1917, and has continued to be one of the prominent factors in Nebraska potash production.

War Insured Success of Venture

The financial success of this first venture was greatly enhanced by war conditions, which placed a high premium on potash, and the Potash Products Co. sold its early production for as much as $5 per unit K_2O. It was inevitable that others should be attracted to the industry, and as a consequence the Nebraska Potash Co., the American Potash Co., the Hord Potash Co., the National Potash Co., the Western Potash Co., the Alliance Potash Co., the Standard Potash Co. and others came into existence in 1916-17. In addition to these larger concerns, which built the most important plants, there were between twenty-five and thirty companies of minor importance, about half of which produced some potash.

It is evident from this brief sketch that the credit for the original discovery of potash on which the industry subsequently was founded belongs to Mr. Low, while to Mr. Show and his associates is due the credit for the first commercial development.

Methods of Operation

General conditions in the district and a description of the methods of operation have already been published in CHEMICAL & METALLURGICAL ENGINEERING[1] and there have been few changes of importance since that article was published, due largely to the fact that the plants were closed for so long a time. Operations consist in pumping water from the surrounding lakes, often as far as twenty miles; evaporating in multiple-effect evaporators to about 33 per cent solids, and finally drying in rotary kilns which discharge the dry-mixed soda and potash salts. It is considered unprofitable to pump and evaporate water of less than 4 per cent total solids, of which perhaps half is potash salts. During the summer season solar evaporation is a great aid to production and it is customary to "farm" the lakes by pumping from one to another. If water from one lake is pumped onto the dry bed of another, and taken out again at the opposite side, solar evaporation will have concentrated the water to several times its original salt content. Mr. Low has made some calculations of the value of solar evaporation, based on the fact

[1] "The Nebraska Potash Industry," by Ernest E. Thum, vol. 17, No. 12, Dec. 15, 1917.

that in hot weather in western Nebraska evaporation will amount to from ¼ in. to ½ in. per day. At the lower figure the evaporation from an acre of water would amount to twenty-five tons per day, so that from a 100-acre lake it would be possible to evaporate 2,500 tons of water per day, due to solar effect alone. By suitably handling the lower-grade lake water it is possible to deliver to the plant a brine of high specific gravity practically ready for final evaporation.

Wooden pipe lines have been largely substituted for iron for the transportation of water from lakes to plant. Some companies have as high as 100 miles of pipe, which involves a large expenditure. It is necessary to lay the pipe below the surface, and 8-in. pipe costs about $5,000 per mile laid and 6-in. pipe about $3,500 per mile.

Evaporator Practice

Evaporator practice has been much improved since the early days of the district and the equipment of the later plants is superior to that of those first built. The kilns are oil fired, but experiments have been made with powdered coal which indicate that economies can be effected by the latter fuel. According to the best practice in the district it now requires about 55 gal. of oil to produce one ton of dry salt when the kiln feed contains about 33 per cent solids. Preliminary experiments by the Hord Potash Co. with powdered coal indicated that the same work could be done with 1,000 lb. of coal; and since oil costs 8c. per gal. and coal over $4 per ton at the plant, there would be a decided advantage in the use of coal if it could be satisfactorily applied without requiring too much plant equipment. Recent information is to the effect that the Hord company has adopted and installed Aëro size B and D pulverizers and that a saving is being made of $1.50 and $2 per ton of dried salt.

The cost of all operation has increased greatly since the plants were first built and started. In the beginning it was possible to get coal from Sheridan, Wyo., at 35c. per ton f.o.b. mines and a freight charge of $2 per ton. In April, 1920, the same coal was costing $1.70, and in August, 1920, $1.95, f.o.b. mines, with a freight charge of $2.30 per ton. Labor originally cost the companies from 15c. to 20c. per hour with meals and lodging, the latter amounting to about $1 per day. In April, 1920, the charges were from 50c. to $1 per hour with an average of 62½c., the men paying for their bed and board. Freight on potash from the district to southern points was $10.80 per ton last spring, but of course this will be notably advanced if it has not already been advanced.

Improved Technology Necessary

There is a tendency throughout the district to get more and better technical advice than was customary in the early history of the region. This may be regarded as one of the most hopeful signs for the future of the industry, inasmuch as it is quite evident that improved technology must be relied upon to reduce the cost of production and enable the companies to meet foreign competition when it becomes active.

In addition to obvious economies in boiler and evaporator practice, probably one of the best lines of improvement will be in the separation of sodium from potassium salt. At the present time the product of the district contains about as much soda as potash. The former is without value to the fertilizer companies and serves merely to dilute the potash and increase the expense for freight. By making a separation of the salts it would be possible to produce several materials of value instead of one. A number of processes are now under experiment and it would seem as though the present season should witness the development of methods that can be put into active use next year. One of the processes involves causticizing the concentrated brine with CaO, the subsequent conversion of caustic potash to sulphate by the addition of sodium sulphate, with final evaporation and salting out of the potassium sulphate, the caustic soda remaining. Other processes under experimentation involve fractional crystallization of the different salts and production of soda ash.

A radical departure from general practice in the district was made last spring by the Merriman Potash Products Co. in an effort to make a product approximating a mixed fertilizer. It was claimed that by treating phosphate rock with brine in the drying kilns, a conversion takes place which renders the phosphoric acid soluble and therefore available. The reaction is not clear, although it is known that the so-called calcined phosphate produced by mixing phosphate rock, sodium sulphate and carbon, and subjecting the mixture to the heat, will render phosphoric acid available. It is doubtful if enough work has been done to determine the value of this procedure, but if it meets the claims of the company it is possible to secure plenty of phosphate rock from Idaho and Montana, treat it in transit and forward the product to the fertilizer companies. The company has since gone into the hands of a receiver and none of the other plants in the district is attempting to make this kind of product. It is doubtful, therefore, if there will be any further developments in the near future.

Future of the Industry

The future of the Nebraska potash industry cannot be determined with any degree of finality at this time, although there is ample reason to believe that the industry can exist profitably for a long time. There will be the inevitable dropping out of the smaller and weaker concerns, and the strengthening of the larger companies by better technology and business methods. A greater study of the lake areas and of methods of concentrating the brine will undoubtedly reveal tremendous resources. Solar evaporation and systematic "farming" of the lake waters will also play a large part, and in fact the industry may develop into a seasonal one. Sooner or later the industry must meet foreign competition, because potash from abroad is being imported in increasingly large quantities, and will continue to come in the future. There is reason to believe, however, that the domestic industry will be able to meet this competition and continue to operate at a profit. In this connection it is quite evident that harmonious relations between the producers and the large consumers will do much toward stabilizing the industry.

Profits of Swedish Government Water-Power Administration

The Swedish Government operation of water-power sites reports a gross income for 1919 amounting to 13,897,649 crowns and expenditures of 7,622,750 crowns. Nearly all the water-power plants now in operation show a profit to the government, and most of the expenditures are for additions and new construction work on power sites that have not yet been completed.

Properties and Industrial Uses of Cellulose Acetate*

A Summarized Outline of the Properties of the Normal Acetate and of Its Uses in the Manufacture Especially of Dope, Celluloid, Impermeable Fabrics, Artificial Leather, Artificial Silk and Electric Insulation

BY MAURICE DESCHIENS

THE normal cellulose acetate or tri-acetate, more or less mixed with di-acetate, appears in the form of a coarse powder or as rough amorphous filaments whose structure varies with the cellulose used, the method of preparation, the ripening and the conditions of precipitation. Thus cellulose acetates prepared from wood cellulose are in general coarser, rougher and more viscous in acetone solution than those obtained from cotton.

The average density of cellulose tri-acetate is 1.2. When distilled or volatilized it is decomposed at about 210 deg. C. The higher acetates, unless perfectly washed and stabilized, have a tendency to decompose into simpler esters with the formation of free acetic acid, a decrease in solubility and increase in viscosity. The tri-acetate is less flammable and less combustible than the nitrocellulose.

SOLUBILITY

The commercial cellulose tri-acetate is completely insoluble in water, pure methanol, ethyl alcohol, butyl alcohol, ether, benzene, methylacetone, pure ethyl acetate, amyl acetate, tetrachlorethane, butyl formate, carbon tetrachloride, toluene and triphenyl phosphate. It has the property of swelling in contact with water, alcohols, benzene, butyl formate and methylethylketone. This property of swelling is the more marked when in contact with water at ordinary temperature and with a mixture of equal parts of methanol and ethyl alcohol and benzene at about the boiling temperature. When thus swollen the acetate is much more sensitive to the action of certain solvents such as acetic acid, is completely saponified at ordinary temperature in a few hours by N/2 potash, and absorbs with great rapidity and in proportion with its degree of swelling dyes such as methylene blue. This last property is used industrially.

The cellulose tri-acetate is soluble in the cold in a great number of organic solvents such as acetaldehyde, acetal, acetone, formic acid, acetic acid, methyl formate, ethyl formate, methyl acetate, aniline, phenols, cresols, benzyl and oxybenzyl alcohols, pyridine, quinoline, tri-acetine, cyclohexanone, amyl and butyl tartrates and citrates, benzyl aldehyde, acetylacetic ester, ethyl oxalate, ethyl lactate, acid oxalates and lactates, mesityl oxide, glycol di-acetine, carvacrol, carvol, eugenol, isoeugenol, safrol, isosafrol, phthalic esters, guaiacol, creosote, acetamide, anethol and terpinol. It is more soluble in warm eugenol, furfurol, triacetine and chloroform. Its solubility at boiling temperature in a mixture of equal parts of methanol or ethyl alcohol and benzene is used in the manufacture of cellulose acetate in sheets and in plastic masses.

A fact which deserves special attention is that substances which may be called auxiliary solvents, when alone, do not dissolve cellulose acetate, but when these substances are mixed with non-solvents of acetates, such as ethyl alcohol, methanol and benzene, which may be called diluents, the mixture becomes a cellulose acetate solvent even with small quantities of the diluent. This is the case with methylethylketone, ethyl acetate, tetrachlorethane, cold chloroform and butyl formate. For example, when ethyl acetate, a non-solvent of cellulose acetate, is mixed with 4 to 5 per cent of ethyl alcohol the mixture dissolves the cellulose acetate in the proportion of 1 g. acetate per 9 g. of the mixture.

INDUSTRIAL USES

Aëronautics Industry.—Prior to the development of aëronautics, cellulose acetate dope has been used to coat balloon fabrics, making them impermeable to gases. A typical composition was:

	Grams
Cellulose acetate	15
Rubber	2
Tetrachlorethane	100

The considerable progress realized during the last few years in heavier-than-air aëronautics, with the resulting need to impart to the planes certain qualities, contributed greatly to the development of the industry of dopes having cellulose acetate as base.

These dopes are obtained by dissolving cellulose tri-acetate in a mixture of more or less volatile solvents. This mixture consists of light solvents (acetone, methyl-acetate, ethyl formate) having a boiling point as low as 50 to 60 deg. C., to which is added diluents such as ethyl alcohol or methanol, benzene, with a boiling point of 80 to 115 deg. C., and heavy gloss-retaining solvents such as benzyl alcohol and phenol, which vaporize very slowly and only partly, their boiling point being 130 to 200 deg. C.

By evaporating the solvents there is left an elastic film of variable thickness which has to have the following qualities: Homogeneity, transparency, retractibility at the time of its formation, elasticity, suppleness, tenacity, impermeability to water, castor oil and volatile oil, and ability to increase the tension and tearing resistance of the coated fabrics and make the surface of the coated fabrics polished in contact with the air so as to reduce the coefficient of friction of the air on the planes, and thus insure a greater velocity of the airplanes.

STANDARD DOPE FORMULAS

During the war extensive tests were carried out by the Allies on a formula for a dope which resulted in the adoption of the following standards which have given excellent results:

Cellulose acetate	80	80	
Diluents and light solvents	860	890	880
Heavy solvents (benzyl alcohol or phenol)	30	40	
	(summer)	(winter	

*Abstracted and translated from *Chimie et Industrie*, May, 1920, pp. 591-607; see CHEM. & MET. ENG., vol. 23, No. 11, p. 533.

or:

Cellulose acetate	80
Diluents and light solvents	800
Furfurol	60

The relative quantities of diluents and light solvents, the products being pure, are:

Acetone (light solvent)	410
Benzene } diluents	250
Alcohol }	230-220

or:

Methyl acetate (light solvent)	513
Benzene } diluents	250
Alcohol }	117-127

or:

Ethyl formate (light solvent)	455
Benzene } diluents	250
Alcoho }	125-175

The light solvents may be replaced in the above formulas in the proportion of 3: 8 by the following light auxiliary solvents: ethyl acetate, methyethylketone, and butyl formate.

The dope is applied in three layers on the linen fabrics after these are already fixed on the wings of the plane. The total thickness of these layers is such as to represent 70 to 80 g. per sq.m.

Tests of the Coated Linen Fabrics

Tensile Strength.—The tensile strength of the linen is determined by an apparatus called aërotensiometer, represented in Fig. 1, which measures the deflection produced in the stretched non-coated or coated fabrics by the application in the center of a known weight. The apparatus consists of the following essential parts: A metallic disk *B* having a rim *R* which is applied to the fabric to be tested. The plate *P* presses on the fabrics under the action of the spring *S*. The deflection is indicated on *D* to the tenth of a millimeter.

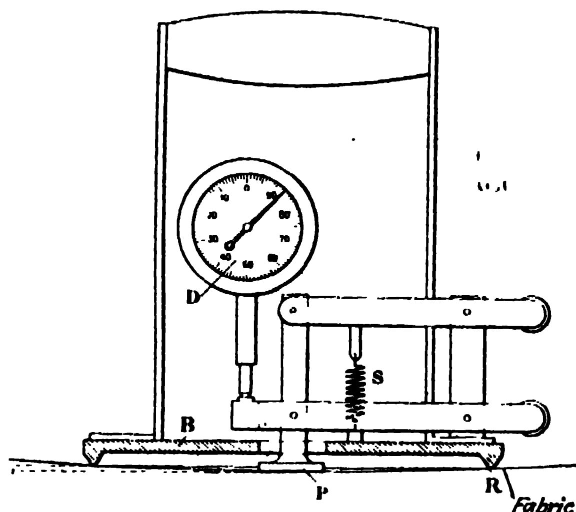


FIG. 1. AEROTENSIOMETER

Tests made with this apparatus gave the following deflection values for non-coated and coated fabrics:

	Deflection Mm.
Stretched non-coated linen fabrics	13.7
Same quality of linen stretched and coated with:	
1. Layer of standard acetone and benzyl alcohol dope, the thickness of the film being 36 g. per sq.m	6.0
2. Layer of same dope, thickness of film being 56 g. per sq.m	4.9
3. Layers of same dope, thickness of film being 74 g. per sq.m	4.3

The minimum deflection is obtained when the thickness of the film corresponds to 80 to 85 g. per sq.m.

Impermeability.—This is measured by noting the number of days required for water to permeate through the film.

Resistance to Rupture.—When tested with the warp or with the woof the non-coated linen fabric presents a resistance to rupture of 1,500 kg. per lineal meter; when coated with three layers of dope, the thickness of the film corresponding to 70 to 80 g. per sq.m., the resistance to rupture is increased from 25 to 50 per cent. The average resistance to rupture is 1,812 kg. per lineal meter with the warp and 2,175 kg. per lineal meter with the woof.

According to A. de Guiche, for an airplane traveling at a speed of 250 km. per hour (150 miles per hour) the pressure exerted on the plane is 180 kg. per sq.m., which corresponds to a tension of only 150 kg. per lineal meter. This figure indicates that coated fabrics present a high safety coefficient.

Industry of Celluloid, Plastics, Films

Cellulose acetate, being less flammable than nitrocellulose, is used now extensively in the preparation of celluloid.

A typical example of the composition of such a celluloid is that of Ernst Zühl (American patent 729,990, 1903): 70 parts nitrocellulose, 30 parts cellulose acetate, 50 parts camphor.

There is now a great variety of formulas used for the manufacture of non-flammable celluloids. They may or may not contain camphor. They also may contain cellulose esters, various solvents, oils, casein, mineral pigments, etc.

The manufacture of acetic cellulosic plastics may be considered as a branch of the celluloid industry. The principle on which is based the production of these plastics is that the cellulose tri-acetate, which is soluble in acetone and totally insoluble in alcohol and benzene or their mixture, can be dissolved by a mixture of equal parts of acetone with alcohol or benzene at about boiling point, from which it is re-precipitated as a gelatinous mass when the temperature is lowered.

The entire process of the manufacture of cellulose acetate plastics consists first in the realization of the above-described solution and precipitation. The liquid is now decanted, camphor or another plasticizing mass is added to the gelatinous precipitate and heated to 50 to 60 deg. C. until a homogeneous mass which can be molded, cut and pressed is obtained. This mass may also be squeezed through dies for making bars, threads, etc. (Société Industrielle de Celluloid-Sicoid, etc.)

These plastics are used for the manufacture of imitation amber, scales, combs, artificial flowers, etc.

Cellulose acetate sheets used for guards, transparent plates for automobiles and airplanes, windows, etc., are manufactured by mixing cellulose acetate pastes with plasticizing products and with other substances as desired. These mixtures are then rolled, compressed in block presses, cut with special cutters, some of which are automatic, and straightened when hot by appropriate presses.

Reinforced acetate sheets are manufactured by the same process, but with the use of special mechanical apparatus for the incorporation of metallic reinforcing.

The plastic plates resist well the action of rain, snow and other atmospheric agents, when they contain a sufficient proportion of plasticizing products and heavy solvents.

The principle of the manufacture of photographic plates and sheets is the same as that for plastic sheets, but special care has to be exercised in the mechanical regulation of the thickness of films, the plasticizing material used and the application of a sensitized gelatine coating.

Impermeable Fabrics—Washable Linen

Impermeable fabrics may be obtained by impregnating the fibers with cellulose acetate solutions. Similarly washable linen is obtained either by treating the linen with a 20 per cent solution of cellulose acetate in an appropriate solvent and applying to the treated linen a nitrocellulose varnish, or by the application of a basic aluminum acetate, drying and coating with cellulose acetate.

Artificial Leather—Patent Leather

Artificial leather is manufactured from the cellulose acetate of old films. Cloth imitating the grain of leather is coated with a mixture of cellulose acetate, appropriate solvents such as chinawood oil, linseed oil, castor oil, pigments, fillers such as chalk, kaolin, cork and other substances such as gutta percha, oils and glycerine.

Patent leather is obtained by coating the leather with any of the above mixtures or with a mixture having a nitrocellulose base. (U. S. patents 627,493—1899; 848,357—1907, etc.)

Artificial Silk

A great number of patents have been granted for the manufacture of artificial textiles having cellulose acetate as base, but practically all of these patents follow the same principle, namely:

Cellulose acetate thread is obtained by passing its solution through orifices into another solution which precipitates the acetate. The thread is used for artificial textiles, filaments for incandescent lamps, gas mantles (Welsbach system), artificial horsehair, artificial silk, etc.

Of these the most important is the manufacture of artificial silk. The production of artificial silk with a cellulose acetate base is progressing rapidly, especially in the United States, Great Britain and Belgium. The consumption, which in 1914 was 11,000,000 kg., is now greatly increased.



FIG. 2. CELLULOID CUTTING MACHINE

There are two distinct methods of manufacture—namely, the wet process and the dry process. [This is also the case for the manufacture of artificial silk with nitrocellulose base (Chardonnet) or by dissolving cellulose and hydrocellulose in ammoniacal copper oxide solutions (Parisian silks, Pauly-Glauzstoff) or with xantate silk (viscose).]

Wet Process.—The cellulose acetate in the form of a very viscous paste with appropriate solvents and plasticizing agents which makes it supple is forced through capillary orifices of glass, crystal, or even platinum. The thread is led into a bath containing a solution which precipitates the cellulose acetate and eliminates almost all of the solvents. A number of these fine threads are twisted together by means of spools rotating at very high speed; this multiple thread constitutes the artificial silk which can be woven.

The volatile solvents used in this method are recovered, thus lowering the cost price.

Dry Method.—A viscous solution of cellulose acetate is passed in a steady stream through fine orifices into an airtight chamber heated to about the boiling temperature of the solvents used. The semi-solid thread is wound around rapidly rotating drums placed in the interior of the chamber. The solvents are gradually eliminated and the threads solidify. Here also a number of these fine threads are twisted into one thread which constitutes the artificial silk.

The recovery of the solvent is very easy in this case. It is sufficient to recover it from the hot air which is saturated with solvent vapors by any one of the known modern methods.

The artificial silk with a cellulose acetate base is non-flammable, very brilliant, very supple, its specific resistance to moisture is greater than that of any other kind of artificial silk, it washes very well without deterioration and constitutes the best washable silk. It is easily distinguished from the other kinds of artificial silks by its density, which is 1.250, solubility in acetic acid, insolubility in a cupro-ammoniacal solution and by its becoming yellow when treated with iodine and sulphuric acid.

Artificial Sponges

The product obtained by incorporating fibrous materials and sodium chloride or sugar with a cellulose acetate paste and washing with water constitutes artificial sponges. (British patent 21,524—1914.)

Electric Insulators

The use of cellulose acetate as insulator for electric wires and cables becomes more and more generalized, especially in America and Great Britain. The acetate is used in the form of threads which are wound around the cables or in the form of a solution in a volatile solvent which when evaporated leaves an insulating coating of cellulose acetate.

Miscellaneous Uses

Cellulose acetate is also used in the composition of certain explosives, in the manufacture of phonograph records, bayko thread, capsules, lacquered paintings, certain adhesives, and special cements, artificial pearls, and as a gelatinizer associated with gelatine for the manufacture of solidified alcohol.

The Value of Patents

By Chesla C. Sherlock

It is very seldom, even in this country, where thousands of patents are granted annually, that we pause to consider just what a patent is worth. Many persons are discouraged, when they come to seek a patent, because they think it is too much of an effort, too hard to obtain to be worth while for a trivial invention or improvement.

A patent is worth all the effort necessary to obtain it. The very fact that it is hard to obtain the grant, that it is given only after the most painstaking search of the records of the Patent Office, should in itself signify that it is something more than a "mere scrap of paper."

Just what does a patent grant to the patentee? The rights and privileges which he obtains have been reduced to a few simple statements gleaned from the statutes and the opinions of the courts.

1. Exclusive right to make the invention for seventeen years.
2. Exclusive right to use the invention for seventeen years.
3. Exclusive right to sell the invention for seventeen years.

This exclusive right to the manufacture, use and sale of the patented article is termed three rights of monopoly, and they apply to the entire territorial jurisdiction of the United States. They survive to the heirs and assigns of the patentee.

As expressive of these rights of monopoly in the patented article, the courts have held that the following additional rights repose in the patentee:

1. To exclude all others from making, using or selling same.
2. Right to an injunction against further infringement and to recover all profit lost by wrongful infringement of patentee's rights.
3. Right to restrict making, using or selling in any manner desired.

In order to comprehend the vast rights which a patent confers upon an inventor, one has only to recall the fact that all monopoly is ordinarily odious to the law and that the law seeks at every turn possible to destroy it.

Patentee's Monopoly Protected by Law

But in the case of a patent, we find the law not only sanctioning a monopoly but in fact creating that monopoly and conferring it upon one citizen or other person to the exclusion of all others. But that is not all. The fact is that the law not only creates the monopoly, but is bound to protect the patentee in that monopoly during the life of the patent. Such, then, is only one of the rare privileges which accrue to a patentee under our patent laws.

Any effort to restrict or control sale prices of a manufactured product under our laws has met with instant prosecution on the part of the Government. The Government has ever declared itself to be in direct conflict with all who seek in any way to limit the price at which their products may sell.

Is this true in the case of patented articles? Strange to say, most strange indeed it will appear to business men, the courts have not only kept their hands off, but the prosecuting branch of the Government has also remained passive, for it was long ago determined that patent owners have the right to restrict selling prices. The Gillette Safety Razor case or the Victor Talking Machine agreements are instances in point with which most of us are familiar. The patentee in these cases has not only fixed the resale price of his product, but he has further specified the uses to which his product may be placed, and if the purchaser fails to use the products as specified, he becomes an infringer under the patent laws and may be sued for damages by the patentee. In the case of the Gillette razor the mere resharpening of the blades is an infringement, or in the case of the Victrola, to play records of another make upon the Victrola amounts to infringement.

Limitations to Patent Monopoly

It is, however, coming to be recognized that some limitation or curb must be placed upon the right to control resale prices, else the whole structure of our anti-trust laws would, in some instances, come tumbling down. In the famous O'Donnell case, it was held that the resale price cannot be controlled by the patentee or owner where the patented article passes through another's hands. In this case it was said that the retailers can, in that event, no longer be held as infringers if they cut prices. But if the manufacturer or owner of the patent uses his own selling organization and eliminates all middlemen, selling direct to the dealers, he can still regulate his prices to retailers, and this is just the method that the Victor people and others use to control the resale price of their product.

One court has said: "Within his domain the patentee is czar. The people must take the invention on the terms he dictates or let it alone for seventeen years. This is a necessity from the nature of the grant. Cries of restraint of trade and of the impairment of the freedom of sales are unavailing, because for the promotion of the useful arts the Constitution and the statutes authorize this very monopoly."

Patents Are Personal Property of Patentees

It should also be kept in mind that a patent is personal property and cannot be taken away except by due process of law, which includes only constitutional decrees of competent courts. It does not include legislative acts either of Congress or of the Legislature. It cannot be seized under a writ or other execution of the common law, but it may be attached by a creditor's bill in equity, in default of the payment of a judgment.

The law provides that all patented articles must be plainly marked so that all may know the facts. But if one marks an article so as to give an impression that it is patented when, as a matter of fact, such is not the case, it is a criminal offense, punishable by a $100 fine, one-half of which goes to the person bringing the action.

Patents are not merely a trivial right which one may obtain at a great deal of effort. They are among the most valuable property rights which an individual can possess. The law has done everything possible, even to overturning well-established rules of public policy, to make the patents as valuable and as effective as possible.

No business right enjoyed can be greater than a monopoly. A patent is not only a monopoly in one particular, but in several. It goes without saying that it is worth while for anyone to obtain a patent on his inventions or improvements, for the law intends that he should have it and the fruits thereof. It is only a partial recompense for the service rendered all the people in the improvements made as a result of the patentee's skill, genius or craftsmanship.

Synopsis of Recent Chemical & Metallurgical Literature

Humic Acids.—In the July 24, 1920, issue of *Chemiker Zeitung*, Dr. FRIEDRICH FUCHS describe the result of his work on the humic acid obtained from peat by the action of alkalis. He found that humic acid is a true acid and not a colloidal substance. It gives simple (not double) salts with bases following the stoichiometric laws. The analysis of the free acid gives C = 57.4 and H = 4.6 per cent, with little N and less than 1 per cent S. Humic acid from non-purified peat contains greater amounts of sulphur. Humic acid treated with organic or inorganic acids always gives a precipitate. Alkaline humates are only partly precipitated by a solution of sodium chloride but are completely precipitated by hydrochloric acid. The latter precipitate when dried gives a brown powder easily soluble in soda, whereas the former dried precipitate is darker and insoluble or only slightly soluble in soda. Humic acid treated with Na_2SO_3 gives a soluble sulphite which reacts with aniline and other organic bases.

Curative Effect of Acids in Breathed Air.—It is reported by Dr. VON KAPFF in *Die Umschau* (vol. 24, pp. 45-8, 1920) that the presence of a small quantity of a gaseous acid in the atmosphere if not breathed to excess is not only not injurious but tends to prevent and even to exert a curative effect on diseases of the air passages. The amount should not exceed 0.1 to 0.2 g. per cu.m. and the breathing was continued in his tests for two or more hours daily. The acids employed were hydrochloric, hydrofluoric, sulphurous (SO_2), formic and acetic, and he found the stronger inorganic acids the better curative agents. He claims that the reaction of the mucous membrane is kept acid by the inhalations and that as a result pathogenic organisms cannot grow there. The curative effect is said to be due to the production of hyperemia and possibly the consequent stimulation of the body cells to increase the alkalinity of the blood. The conclusions are reached from experiments made by the author and also from experience with workmen in various industries.

Relative Action of Acids on Enamels.—The progress report of the Sub-Committee on Enamels as printed in the July, 1920, issue of the *Journal* of the American Ceramic Society represents a very large amount of carefully executed experimental work and discloses material progress in arriving at the desired result, to the profit of manufacturers of enameled ware.

It was found that citric acid offers a fairer means of testing enameled coatings than does tartaric acid. Using two different frits and plotting curves, it was noted that there is a reasonable uniformity of action around 15 per cent acid, small variations of concentration in either direction making but slight effect in the total activity. This figure was therefore decided upon. Temperature variations were then studied with a 15 per cent solution of citric acid. Range of 15 to 35 deg. C. was found to materially affect the results. Commercial citric acid was found to be of sufficient purity to give uniform results. Six ounces of acid in one quart of water gives a 15.73 per cent solution and was used for the tests.

Tests were made over 24-hr. periods under temperatures ranging from 12 to 20 deg. C. The etching by acid was determined by rubbing finely-ground charcoal on the surface of the ware, producing definite discoloration in the etched portions below the liquor line and none above. A 3 g.p.l. solution of malachite green was also used, being allowed to stand five minutes and the dishes being rinsed out. The resultant discoloration of etched portions gave more uniform results with varying strengths of acid than in the case of charcoal. The experimental work is still under way.

The Concentration of Graphite Ores, Past and Present.—The first graphite mill in Canada began operations about fifty years ago, using a buddle as a concentrating device. Ore was broken in crushers and stamps and roughly classified, the products being fed to buddles which produced concentrates, middlings and tailings. Middlings were re-treated in buddles. The concentrate was treated by the buhr stones and screens. The latest mills use flotation as an essential step in the process, the concentrate being treated by buhr stones and screens, or, in some cases, rolls may be substituted for the buhr stones. In the Aug. 20 issue of the *Canadian Mining Journal* is published an article by R. C. ROWE describing the development in the processes, together with a brief discussion of the limitations of the flotation process as applied to graphite ores, from which the following is abstracted.

Canadian graphite occurs principally in more or less flat flakes ranging in size from ½ in. in diameter to microscopic dimensions and disseminated throughout the accompanying rocks. The specific gravity is about 2.2 for the graphite and 2.6 for the gangue. As the chief use of graphite is in the manufacture of crucibles and as only the larger flakes can be used for this purpose, the efficiency of any process of concentration is determined to some extent by the quantity of crucible flake recovered.

As the graphite and gangue are of about the same specific gravity, it is difficult to obtain efficient recovery using gravity methods of concentration only, and all efforts in concentrating previous to the use of flotation may be considered commercial failures, although used extensively previous to the introduction of flotation processes. The use of buddles in a wet process of concentration has been noted. A dry process has been used for some time which consisted of drying the ore in rotary kilns or driers, grinding to produce a minus 20-mesh product which was fed to high-speed flour rolls. The principle of the process was that the flake, being flat and tough, would pass through the rolls uninjured, while the gangue, being friable and granular, would be pulverized and could subsequently be removed from the flake by screening. The roll product was screened over 40-mesh and the fine material re-treated by rolls and finer screens. The most recent mills use rolls and screens for treating high-grade concentrate, but this method when used on 10 to 12 per cent ore was not efficient, due to excessive destruction of the flake graphite, to excessive wear of both rolls and screens and to low recovery. A plant using wet crushing, grinding, classifying and tabling was next built, and although the small difference in specific gravity between the graphite and gangue caused difficulty the plant was the most successful working on disseminated ores previous to the adoption of flotation.

The use of gravity methods for concentration brought out the fact that the graphite is intimately

intercrystallized with the gangue material and requires fine grinding in order to liberate the graphite. This is an important point to be considered in the application of flotation processes to graphite ores and emphasizes the problem of proper grinding in order to obtain satisfactory recovery. It has been found that the flake graphite is freed more easily from decomposed than from undecomposed ores and that decomposition appears to free the flake graphite in a manner impossible to duplicate mechanically.

Mechanical and pneumatic flotation machines give practically the same result, the former giving a slightly lower tailing product and the latter a slightly higher grade concentrate. The concentrate from the rougher cells will contain from 30 to 45 per cent carbon.

Three methods may be used to increase the grade of the rough concentrate: (1) Successive flotation, the tailing product being re-treated. (2) Stage grinding followed by flotation. (3) The use of concentrating tables. The first method is the simplest, but it is doubtful whether a high-grade concentrate can be produced. By the second method a high-grade concentrate can be produced, but the successive grinding of the tailing products causes the destruction of a large amount of flake graphite. The use of concentrating tables appears best suited to general requirements, as theoretically the free flake can be removed and is therefore not destroyed in the regrinding of the tailing product from the tables. In practice, however, it is found to be difficult to completely break down the primary froth, and an oil streak which passes down the table with the head water results, which lowers the grade of the table concentrate. A careful selection of the flotation oil may help reduce the loss.

By means of any of the above methods a concentrate containing from 65 to 85 per cent graphite carbon may be obtained, with 75 per cent a fair average grade. The first method is applicable to soft friable ores. With undecomposed gneissic ores the second and third, either separately or in combination, may be used with good results. The first and the third methods yield a higher proportion of No. 1 flake, while the second probably results in a higher grade combined concentrate.

The results that may be obtained by the use of the flotation process have resulted in a distinctly optimistic trend of thought regarding the graphite industry, but it must be pointed out that the industry on this continent has suffered through the acceptance of theory alone as a basis of mill design. The application of the flotation process to graphite ores is not a simple thing and the easy acceptance of theory may result in failure. Each step in the process should be proved to be satisfactory by mill-scale tests, and the advisability of testing cannot be too strongly emphasized.

Easton, Pa., Sewage Disposal Plant.—Bulletin 200 of the National Lime Association contains a description of a sewage disposal plant at Easton, Pa., which has been in successful operation for two years. The raw sewage is first screened, and then passed into an inclosed cypress tank in which are placed electrodes made of mild steel plates 10 x 16 x 1/8 in. arranged in banks of forty-eight with revolving paddles between the successive pairs of plates. The tank is provided with vents to remove gaseous products, and lime is added to keep the electrodes in a "passive condition" to conduct the current, making possible the liberation of nascent oxygen, and to aid in precipitating the organic material. The advantages claimed are direct, positive and controlled operation of the process, efficiency in the destruction of solid organic material and that the disinfection and purification of the effluent are high. The plant may be located in a vacant lot within the city limits, thus avoiding the need of long trunk sewers and the attendant expense and debt. The Easton plant is said to be on a residence street within the city, and to give no offense to adjoining property owners.

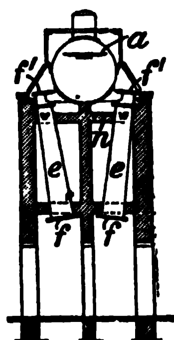
Recent Chemical & Metallurgical Patents

British Patents

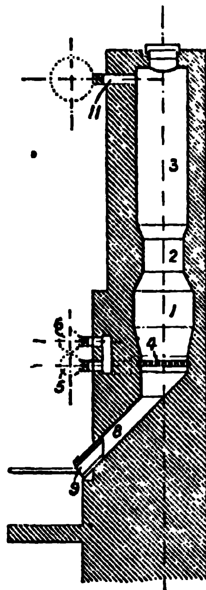
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Refining Lead.—A process for dezinking lead consists in heating the molten lead with a molten mixture of an alkali chloride and a substance which lowers the melting point of the alkali chloride, e.g. a caustic alkali, or zinc chloride in the presence of a source of oxygen such as air or litharge. The treatment of lead with a mixture of zinc chloride and litharge is also referred to. (Br. Pat. 142,315—1919. H. HARRIS, London, June 30, 1920.)

Apparatus for Distilling Heavy Hydrocarbons.—In an apparatus for distilling heavy hydrocarbons such as petroleum, lignite tar and coal tar, and for producing coke, a boiler which is not exposed to the greatest heat of the flue gases is formed with a number of extensions forming retorts on which the fire gases play, the dimensions of the boiler and retorts being such that the solid residue to be coked resulting from the distillation of a charge which fits the whole apparatus is just sufficient to fill the retorts. In the arrangement shown in the accompanying figure the retorts *e*, which are preferably of conical form as shown, are attached to the bottom of the boiler *a* by horizontal branches and are furnished with cleaning doors f^1 above and discharge doors *f* below. In another form the retorts are attached directly to the boiler and cleaned from within it. Brickwork *n* shields the boiler from the direct heat of the fire gases, but it may be heated by gases escaping to the main flue. The portions of the retorts *e* in the fire-gas chamber are preferably connected to the upper part by flanges, so as to be easily detached for repair. In a modification each retort is connected to a separate boiler chamber with pipes and valves for filling and leading away gas, an arrangement of dampers being provided for regulating the supply of heat to the various retorts. Steam may be injected into the bottom of the retorts to equalize the heating of the liquid. (Br. Pat. 142,376—1919. L. STEINSCHNEIDER, Brunn-Königsfeld, Czechoslovakia, June 30, 1920.)



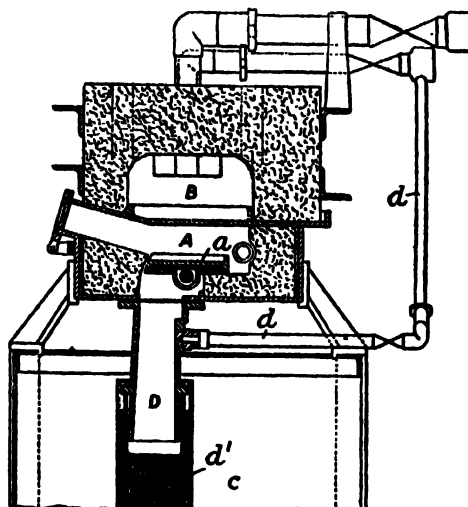
Destructive Distillation Furnace.—Relates to a vertical shaft furnace for the distillation of asphalt rock, bituminous slate, etc., for producing oil, of the kind in which the distillation is carried out in part of the same chamber as that in which combustion of a part of the material takes place. The furnace comprises a vertical channel 3 having a restricted cross-sectional area 2 at or near the center part for a combustion zone and a lower heat recovery zone 1 of comparatively large depth and diameter. Tuyeres 4 are provided at the bottom of the lower zone which communicate with two channels 5, 6 to supply air for combustion and steam or gas respectively. The heat recovery zone 1 narrows downwardly to the shoot 8, which is closed by a shutter 9. The gases from distillation and combustion are withdrawn through a pipe 11. (Br. Pat. 142,541—1919. A. LA PORTA, Rome, and R. BARTOLOMEIS, Milan, Italy. July 7, 1920.)



Aircraft Fabrics.—A process for preparing impervious fabric for airships consists in treating a fabric of cotton or other fabric having cellulose as its principal constituent by suitable chemical means to convert the cellulose partly or wholly into cellulose acetate, then treating with softening agents, such as triacetine or castor oil, and finally calendering. Any ordinary method of acetylation may be used. For example, the fabric is treated for several hours, at a temperature below 50 deg. C., with double its weight of mixture consisting of 5 to 6 parts acetic anhydride, 4 to 5 parts glacial acetic acid, and 1 part fused zinc chloride. After treatment with the softening-agent and calendering, the fabric may be coated with cellulose-acetate or like dope, and varnished. (Br. Pat. 142,615—1919. VICKERS, LTD., and Sir J. MCKECHNIE, Westminster, and A. RYAN, Oldham, Lancashire, July 7, 1920.)

Monoazo and Primary Disazo Dyes.—Monoazo and primary disazo dyes are obtained by coupling one or two molecular parts of a diazotized *o*-aminooxyarylsulphonamide of the formula $(OH)(NH_2)R—SO_2NHX$ (R = aryl or substituted aryl, X = hydrogen or aryl), or one molecular part of such a diazo compound and one molecular part of an aromatic *o*-oxydiazo compound, with one molecular part of an N-substituted derivative of 2 : 5 : 7-aminonaphthol sulphonic acid, such as phenyl-2 : 5 : 7-acid, benzoyl-2 : 5 : 7-acid, *m*-aminobenzoyl-2 : 5 : 7-acid, the urea of 2 : 5 : 7-acid, 5 : 5'-dioxy-2 : 2'-dinaphthylamine-7 : 7'-disulphonic acid, or the urea of *m*-aminobenzoyl-2 : 5 : 7-acid. The products are substantive cotton dyes, and may be converted in substance into copper compounds by treating the solutions of dyes with copper or copper compounds, or by coupling the dye components in the presence of copper or its compounds; the copper compounds may also be produced on the fiber by after-treatment with copper salts of the direct dyeings or prints of the dyes, or by dyeing or printing with the dyes in the presence of a copper salt; the copper compounds give bordeaux to violet shades on cotton. Examples are given of the preparation of: a monoazo dye from 6-nitro-2-amino-1-oxybenzene-4-sulphonamide and phenyl-2 : 5 : 7-acid; a disazo dye from two molecular parts of 2-amino-1-oxybenzene-4-sulphonamide and 5 : 5'-dioxy-2 : 2'-dinaphthylamine-7 : 7'-disulphonic acid; a disazo dye from two molecular parts of 2-amino-1-oxybenzene-4-sulphonamide and the urea of 2 : 5 : 7-acid; a disazo dye from two molecular parts of 2-amine-1-oxybenzene-4-sulphonanilide and the urea of 2 : 5 : 7-acid; a disazo dye from 2-amino-1-oxybenzene-4-sulphonamide, 2-amino-1-oxybenzene-4-sulphonic acid, and 5 : 5'-dioxy-2 : 2'-dinapthylamine-7 : 7'-disulphonic acid. (Br. Pat. 142,448—1919. GES FÜR CHEMISCHE INDUSTRIE IN BASEL, Basel, Switzerland, July 7, 1920.)

Metal Heating Furnace.—A furnace for hardening or tempering small metal articles in a non-oxidizing atmosphere comprises a heating-chamber *A* separated from the combustion chamber *B* and having beneath it a chute *D* through which articles tipped or dislodged from the hearth will fall into the quenching-bath *C* without being exposed to the air. The hearth *a* is preferably pivoted as shown, or it may be mounted to slide, the articles being dislodged by a fixed rake; or where the hearth is fixed, a movable rake may be used to discharge the articles into the quenching-bath. Combustible gas is supplied to the chute *D* and heating-chamber *A* through the connection *d*, and openings may be formed in the roof of the heating-chamber through which part of the gas may enter the combustion chamber.



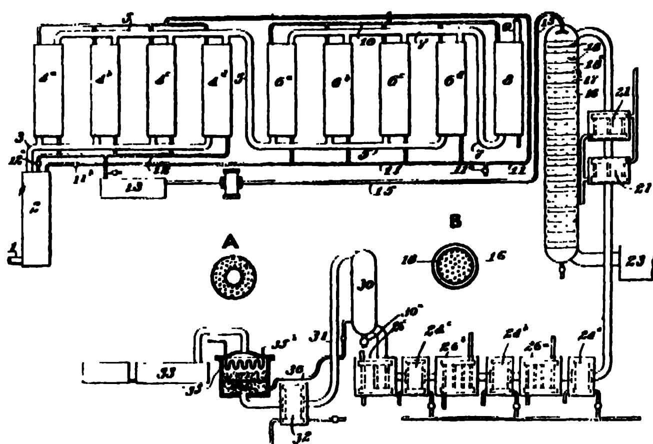
A basket *d'* supported by the chute is provided to receive the discharged articles, and a screw pump may be fitted to maintain circulation of the liquid in the quenching-bath. The furnace is gas-fired, preferably by a burner of the kind described in Specification 110,960. (Br. Pat. 142,671—1919. H. W. YATES, Birmingham, and S. N. BRAYSHAW and E. R. BRAYSHAW, Manchester, July 7, 1920.)

Enamels.—Enamels are made, without boron, lead, arsenic, milk glass or opal glass, from a mixture of silicates of alumina, soda, and lime and fluorides, fused and ground, coloring matter such as metallic oxides being added during the grinding process. Carbonate of ammonia may be added if desired, and the composition so obtained is applied to articles and heated to temperatures ranging between 800 and 1,050 deg. C. The limits between which the proportions of the ingredients may be varied are given. (Br. Pat. 142,688—1919. C. MUSIOL, Brussels, July 7, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Recovery of Sulphur Dioxide From Furnace Gases.—A. H. EUSTIS, of Milton, Mass., has been granted two patents covering a method and an apparatus for the recovery of sulphur dioxide from smelter smoke and other gases. The method consists essentially of absorbing the sulphur dioxide from the gases in water, from which it is liberated by heating the solution. The sulphur dioxide is then condensed by pressure and cooling. The principal objects of the invention are to protect from corrosion the pumps by which the gases are handled; to utilize a portion of the liquid SO_2; to remove substantially the last traces of moisture from the gases, thereby eliminating dessicators for drying the gas, and to combine in a vacuum chamber the functions of a gas extractor and a condenser for the steam engine of a power plant, thus eliminating the usual heat exchanger. The apparatus is illustrated in the sketch. Gases containing SO_2 are led through flue 1



to the hot tower 2, the principal function of which is to cool, clean and enrich the gases. From the tower 2 the gases pass through flue 3 into scrubbing towers 4a to 4d in parallel, thence by flue 5 to scrubbing towers 6a to 6d in parallel, thence by flue 7 to lime tower 8, and thence by flue 9 to the atmosphere. The towers are all of similar construction and all except tower 8 are filled with coke or other insoluble material. The limestone or other soluble material in tower 8 increases the capacity of the liquid to absorb SO_2.

Water is fed to the scrubbing towers of the 6 group and to the tower 8 through pipe 10. The water from tower 8 may be wasted or fed to scrubbers of the 4 or the 6 group. The water from the towers of the 6 group is disposed of in three ways; part of it may be delivered through valve 11b to the top of the hot tower 2, when it will be heated by the incoming gases and give up its SO_2; part will be used to supply the towers of the 4 group and part wasted through valve 11a. The solution from the 4 group is collected in pipe 12, part being delivered through valve 12a to the hot tower 2, the remainder being delivered to a storage tank 13.

From the tank 13 the solution is pumped through the pipe 15 to the top of the chamber 16, the upper part of which constitutes a douche tank to cool the gases and the lower part of which constitutes a vacuum extractor. The tank is provided with a series of perforated shelves, 17 and 18, designed as shown at *A* and *B*. The descending solutions are subjected in the lower part of the tank 16 to the combined effect of heat and vacuum by which the SO_2 gas is liberated from the liquor. The heat is supplied by exhaust steam from the steam engine 23, the vacuum being produced by pumps 24a, 24b and 24c. The concentrated SO_2 gas passes through the coolers 21, to the pump 24a, through cooler 26a, to pump 24b, through cooler 26b, to pump 24c, and through cooler 26c to the cooling chamber 30. The repeated compression and cooling of the gases progressively removes the moisture and effects a saving of power. A further advantage is that it is possible to keep the temperature of the pump above the dew point of the gases and thereby prevent damage to the pump. If a single stage compression be used instead enough heat is generated by the compression to necessitate water cooling of the pump and this cooling is liable to cause condensation of SO_2 on the walls of the pump with resultant damage thereto.

The cooled and dried gases from cooler 30 pass through pipe 31 to pump 32 and are delivered to condenser 33 through the trap 35, which contains liquid SO_2 and acts as a dessicator to absorb the last traces of moisture from the gas. The trap is filled with coke and is cooled by the water coil 35b to such temperature that a portion of the SO_2 is liquefied. The liquid SO_2 from the trap is blown into cooling chamber 30 through pipe 36, when by expansion it refrigerates the cooler and gives up at least a portion of the moisture, which is removed through valve 30a. The pumps are provided with jackets for the purpose of keeping the walls above the dew point temperature and thus prevent corrosion. (1,341,114; May 25, 1920.)

Use of Oil in Drying Ores.—Certain iron ores found in parts of the Mesaba region and in other parts of the country contain a high percentage of moisture and are so lean that practically all of the moisture must be removed to raise the iron content of the ore to a commercially workable percentage. In drying these ores it has been found that at about 7 per cent of moisture the ores become so dusty that they cannot be transported or used in a blast furnace without undesirable loss. GEORGE L. COLLORD has found that if an oleaginous material such as tar or some form of petroleum be added to the moist ores, either before or while drying, such oil will spread over the ore particles and form a protective coating on all of the particles of the ore, and when so coated the percentage of moisture can be reduced to 3 per cent without the ore disintergrating in the process of drying. It has been found that 2½ to 3 per cent of oil or tar will be sufficient to coat all particles and that when the oil treated ore is dried to about 2 to 3 per cent of moisture the film coated materials will assume a granular form and will be entirely free from dust. (1,343,249; June 15, 1920.)

High-Speed Cutting-Tool Alloy.—Various combinations of elements may be made to produce alloys useful for specific purposes, and one invented by HUGH S. COOPER of Cleveland illustrates the possibilities in this direction. A high-speed cutting-tool that gives satisfactory service may be made by alloying zirconium, silicon and aluminum with nickel in the following proportions: Zr, 0.5 to 2 per cent; Si + Al, 2 to 8 per cent; the remainder of the alloy being Ni with small incidental amounts of iron, and, if desirable, tungsten. (1,350,359, assigned to the Zircon Tool & Alloy Corp.; Aug. 24, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Chemical Exposition Opens in New York

Larger and more inclusive as to exhibits and more interesting as to program and entertainment than any of its five predecessors, the Sixth National Exposition of Chemical Industries was formally opened in Grand Central Palace, New York, on Monday, Sept. 20, with an address by Dr. Charles H. Herty. He was followed by Dr. Charles L. Reese, chief chemist for the du Pont company, who spoke on "Co-operation in the Industries." Dr. Reese drew attention to the paramount importance of co-operation among all interests concerned in the chemical industry. He pointed out as an example the fact that although exact measurements are the very foundation of chemical science, yet these measurements are made by physical instruments prepared by those who are not chemists. As a consequence co-operation between chemists and manufacturers of physical apparatus for controlling chemical processes is an outstanding necessity. The mutual benefit to be derived would be welcomed by both the chemist and the equipment maker. Dr. Reese stated that a beginning had been made in this direction by the association of some of the large chemical manufacturers of the country for the purpose of deciding upon standard specifications for certain chemical equipment, particularly thermometers.

The speaker also pointed out the value of co-operation among chemists in exchanging information and in concentrating on the solution of fundamental problems which are of interest to the entire profession. As an example he cited the need for material which resists aqueous hydrochloric acid at high temperatures. This is but one of the many problems which he thought would be solved if there were closer co-operation.

Problems confronting the American exporter were discussed by Erastus Hopkins of Gaston, Williams & Wigmore, Inc. Mr. Hopkins' paper dealt generally with a few fundamental suggestions which relate not only to chemical export trade but to American trade in general. He criticized the American selling organization for not studying the successful methods of other countries, such as England and Germany. This is believed to be necessary because Americans are not in any sense colonists nor do they have the foreign outlook as do the English and the Germans. He emphasized the necessity of shipping goods which meet exactly the specifications of the buyer, this being one phase of the service which must be rendered. Another phase is promptness in delivery. The speaker touched upon the matter of packing goods for export and contrasted the methods of English and American manufacturers in this respect. In the matter of financing the American exporter still has much to learn. Business cannot be done on a cash basis and the manufacturer must bear his share of the burden of financing his export business.

The fuel symposium, which was held Tuesday afternoon, Sept. 21, was devoted to the subject of fuel conservation and methods of getting additional energy out of the country's fuel supply. A full report of this symposium will be given later.

The motion picture programs are an excellent feature of the Exposition and will do much toward giving the public a sense of the importance of the chemical industry in the United States. Such films as modern packaging methods, the production of salt, the story of sulphuric acid and others are proving very attractive. Advantage is being taken of Exposition week for the gathering of several organizations, among them being the Chemical Warfare Post of the American Legion, the chemical fraternity Alpha Chi Sigma, and the American Institute of Chemical Engineers. The complete story of the Exposition and report of the technical sessions will be given in our issue for Oct. 6.

American Foundrymen's Association Meeting

The 1920 convention and exhibition of the American Foundrymen's Association, together with the Institute of Metals Division of the A.I.M.E., will be held at Columbus, Ohio, during the week of Oct. 4.

The tentative program contains many interesting and important papers to be presented on various aspects of Gray Iron, Non-Ferrous Practice, Steel, Industrial Relations, Metallography and Malleable Iron. Among these are "A Note on the Electric Furnace and the Problem of Sulphur in Cast Iron," by George K. Elliott; "Steel Making," by James W. Galvin; "The Triplex Process of Making Malleable Iron," by H. A. Schwartz, and "Approved Methods of Testing Molding Sand," by S. W. Stratton.

The convention will close Friday, Oct. 8, with an important exhibition by about 200 exhibitors of equipment and products, and a big meeting with the Electric Furnace Association.

Minerals Separation, Ltd., Appeals Case

Minerals Separation, Ltd., has appealed from the recent decision of Judge Morris, of the U. S. District Court of Delaware—the decision upon which that judge had based his various orders dismissing the different contempt proceedings through which Minerals Separation has unsuccessfully attempted to have Miami Copper Co. declared in contempt of court for continuing the use of its flotation process. By this new proceeding Minerals Separation now seeks to bring its assertion of contempt before the U. S. Circuit Court of Appeals in Philadelphia.

American Tar Products Co. Sold

The Koppers Co. and the Aluminum Co. of America, both of Pittsburgh, have jointly purchased the American Tar Products Co. and will operate it together. It is planned that operations shall include manufacture of electrodes for the use of the Aluminum Co., as well as a continuance of the general tar-refining work.

Cleveland Meeting of the American Electrochemical Society

The thirtieth general meeting of the American Electrochemical Society will be held in Cleveland Sept. 30, Oct. 1 and 2, 1920, under the auspices of the local members and the courteous co-operation of the Cleveland Engineering Society and the Cleveland Section of the American Chemical Society. Headquarters will be at the Hotel Statler. The morning sessions of Thursday, Sept. 30, and Saturday, Oct. 2, will be held in the ballroom of the hotel, but the session of Friday morning, Oct. 1, will be held in the physics lecture room of the Case School of Applied Science. An excellent technical program has been arranged as well as visits to plants of the Cleveland Instrument Co., U. S. Malleable Castings Co., Ohio Chemical Co., Cleveland Metal Products Co., Guide Motor Lamp Co. and Western Reserve Chemical Co. The social features will comprise a complimentary smoker in the ballroom of the Hotel Statler Thursday evening, Sept. 30, and an informal subscription dinner and dance in the ballroom of the hotel Friday evening, Oct. 1. Special arrangements have been made for the entertainment of visiting ladies. A feature of the meeting will be a visit to the Nela Park laboratories of the General Electric Co., where a special program will be arranged.

Lemon Growers Utilize Byproducts of the Lemon Industry

Another example of the way the chemists are conserving and economizing nature's resources is the work done at Corona, Cal., by the Exchange By-Products Co., which is owned and operated by the lemon growers of the California Fruit Growers Exchange. Large quantities of lemons which, because of their small size or some other good reason, would not be marketable and ordinarily a total loss have been salvaged and turned into profit. This byproducts plant is reported to have utilized ninety-four tons of lemons a day during the month of July and to have prepared and made use of 15,000 gal. of lemon juice per day during this time.

United States Not to Buy German Drugs

No German chemical drugs manufactured during the first half of the current year are to be purchased by the United States from stocks impounded in Germany. This applies to the synthetic organics of commerce and to practically all of the German patented products. The United States retains its right to make purchases during the next four and one-half years on the possibility that the present sufficiency of chemical drugs might not be obtainable from domestic sources. The statement in this connection issued by the War Trade Board Section of the Department of State follows in its entirety:

> The Reparation Commission has offered to this Government the right to participate in the purchase of certain chemical drugs from stocks impounded in Germany as well as from subsequent production of German manufacturers, rendered available to the commission by the Treaty of Versailles.
>
> From the records in possession of the War Trade Board Section it would appear that practically all these chemical drugs are now being manufactured in this country. They are available to the American consumer on reasonable terms as to price, quality and production. Reliable reports indicate the domestic product is equal to the German in quality; that the average price is substantially the same as that asked by the German manufacturers for stocks of current production, and that these drugs are manufactured in this country in quantity sufficient to meet all indicated domestic demand. The foregoing covers not only synthetic organics of commerce but likewise practically all of the German patented products.
>
> From the foregoing it would seem that there is no present need or demand in this country for these chemical drugs of German manufacture. For this reason this Government does not feel it advisable to take active steps to place upon the market foreign-made drugs which would compete with those of domestic manufacture and therefore will not exercise its option upon impounded stocks of chemical drugs of German manufacture or upon stocks of chemical drugs manufactured during the months of January, 1920, to June, 1920, inclusive.
>
> This Government will, however, retain its right to participate in allotments from future daily production of chemical drugs which may be manufactured by Germany during the next four and one-half years, in view of the possibility that a need in this country may arise at some future time for certain chemical drugs which may at that period be unobtainable from domestic

Pulp Situation at Holyoke Mills Easier

The general improvement in traffic conditions has eased the pulp situation in the Holyoke district. As there is but one pulp mill in the immediate vicinity, the mills are absolutely dependent on the railroads and consequently any impairment in service is felt immediately. Shutdowns of a day or two at a time caused by lack of pulp were common through the early part of the summer. The larger companies, by rationing each car of pulp consigned to them, were able to keep their divisions operating.

In common with the rest of New England, Holyoke has suffered from the coal shortage. The mills are for the most part operated on water power but of course depend on coal for raising what steam is needed, and supplies have been very short. The local gas and electric company has barely been able to keep going by borrowing needed coal from the local mills fortunate enough to have a surplus and from nearby cities where a carload or so at a time could be picked up.

Conference of Color Committee of Cottonseed Oil Chemists

A conference dealing with the color standardization of oils was held at the Bureau of Standards on July 30 and 31. The entire subject was discussed in detail, including the use of technical terms, the present difficulty in getting instrument makers to turn out the required apparatus, and a demonstration of the methods used in color grading oils by the optical division of the Bureau. The new apparatus recently designed for this purpose was demonstrated and a great deal of time spent in familiarizing the committee with the use of the instrument. Data secured were compared with the results obtained from the Arons chromoscope in terms of Lovibond numbers. Data were also secured on some of the samples by means of the Koenig-Martens spectrophotometer.

Memorial to Lord Rayleigh

The Rayleigh Memorial Committee has decided that the mural tablet to the late Lord Rayleigh, which is to be placed in Westminster Abbey, shall be erected in close proximity to the memorial to Sir Humphry Davy. As there will be a balance remaining after all expenses have been met, it is proposed that this shall be used to establish a library fund at the Cavendish Laboratory, Cambridge.

Philadelphia Section Meeting, A. C. S.

The first meeting of the Philadelphia Section, American Chemical Society, for the 1920-21 season, was held at the Engineers' Club Thursday evening, Sept. 16.

For the benefit of those members who were unable to attend the sixtieth meeting of the Society at Chicago, Dr. R. P. Fischelis outlined the general features of the meeting, devoting particular attention to matters discussed at the Council meeting. An item of local interest was the change in name of the Carney's Point Section to the South Jersey Section.

Dr. W. A. Pearson announced that Sydney Davis has found it impossible to continue as editor of the *Catalyst,* owing to business interests which require his full time outside of Philadelphia. A vote of thanks was tendered Mr. Davis and Dr. Fischelis, managing editor of the *Catalyst,* who is to leave Philadelphia in the near future. In order to fill these vacancies, Dr. Henry Leffmann will be asked to accept the position of editor and Dr. Joseph S. Hepburn that of associate editor.

Nitrocellulose

Hugo Schlatter, chief of the Chemical Products Division, Hercules Powder Co., reviewed the development of the nitrocellulose industry, which dates from Schönbein's discoveries in 1846, and then discussed the chemistry, manufacture and uses of nitrocellulose.

Chemistry of Cellulose

The product obtained by treating cellulose with mixed acid is a true ester and not a nitro compound, so that we should speak of cellulose nitrate and not nitrocellulose. The products obtained are not definite compounds since the raw material—cellulose—is complex. In nitrocellulose work, n in the formula $(C_6H_{10}O_5)_n$ is taken as 4. Of the structural formulas, that of Green best explains the formation of dextrose and brom-methyl-furfural. Hibbert's formula consists of a 5- and a 6-membered ring (instead of the 5- and 7-membered ring of Green) and explains polymerization. Our knowledge of the cellulose molecule is, however, still very meager.

Manufacture of Nitrocellulose

The chief source of cellulose for nitration is cotton linters. These are cleaned, freed from oil by boiling under pressure with 2 per cent NaOH solution (in the absence of air, which would form oxycellulose), dried to less than 1 per cent moisture and then treated with mixed acid, the composition of which varies according to the product desired. The nitrated products have the formula $C_{24}H_{40-n}O_{20-n}(ONO_2)_n$, where n may vary from 1 to 12, although only those nitrocelluloses in which n is 7 or over are of commercial importance. As a general rule, nitrocellulose containing over 12 per cent N is insoluble in ether-alcohol and is used as guncotton, while when the nitrogen content is below 12 per cent the product is suitable for the manufacture of pyroxylin plastics.

The modern system of manufacture consists in treating the cellulose in small batches in dipping pots which discharge to centrifugals on the floor below. These in turn discharge into washing bowls provided with a tangential flow of water. It has been found that instability of the product was due to the presence of nitration products of impurities in the raw cellulose. These are broken up by boiling with water containing a little acid. The material is next passed through beating engines, which reduce the fibers so that they will pass through 0.01-in. slits. A final boiling or "poaching" serves to remove the last traces of acid from the capillary fibers. After drying to 30 per cent moisture in centrifugals, the nitrocellulose is placed in hydraulic presses having a perforated plate through which alcohol is forced, to displace the water in the nitrocellulose. The alcohol is then removed by a pressure of 3,500 lb. per sq.in.

The speaker concluded with a summary of the varied uses of nitrocellulose for military and industrial purposes.

Discussion

In reply to a question by Dr. E. E. Marbaker as to the difference between high and low viscosity cottons, Mr. Schlatter said that the viscosity could be varied over a wide range through the proper choice of solvents coupled with the use of diluents or non-solvents. Solutions of very high viscosity are obtained when nonsolvents are added in amounts just insufficient to cause precipitation. This phenomenon is the basis of one of the methods for preparing solid alcohol. Viscosity is determined with sufficient accuracy for practical purposes by noting the time required for a steel ball to fall 10 in. in a vertical tube filled with the solution to be tested. This time may vary from 5 to 1,200 sec.

Dr. Marbaker also inquired as to the cause of "blushing" or the appearance of opaque, poorly-adherent spots in the coating of split leather when dopes containing highly volatile solvents are used. Mr. Schlatter said that this was due to the relatively greater hygroscopicity of such dopes and to the fact that the rapid evaporation of the solvent often cools the surface below the dew-point of the surrounding atmosphere so that moisture condenses on the coating, causing precipitation of the nitrocellulose.

Ceramic Day at the Chemical Exposition

The American Ceramic Society is occupying Booth 750, on the fourth floor, at the Sixth National Exposition of Chemical Industries, Grand Central Palace, New York City. A program of diversified interest will be given on Ceramic Day, Friday, Sept. 24, at 2 p.m. In the evening of the same day moving pictures will be shown of different phases of the ceramic industry. Members and persons interested are invited to register at the booth, where the Society's literature may be examined, orders left, application blanks obtained, etc. The assistant secretary will be in attendance each day to give information and to receive registrations and memberships.

Another Platinum Theft

The following pieces of platinum were recently stolen from the chemical laboratory of the United States Smelting, Refining & Mining Co., at Midvale, Utah:

Cylinders	No. on Cyl.	Size of No on Cyl. In.	Wt. of Platinum, G.	Size of Cylinders
1 (B & Co. on stem)	6	¼	17.0008	4½ in. x 2 in —5½ in. stem
1 (B & Co. on stem)	31	¼	15.6975	4½ in. x 2 in.—5½ in. stem
1 (B & Co. on stem)	25	¼	15 4663	4½ in. x 2 in.—5½ in. stem
1 (B & Co. on stem)	29	¼	15 6608	4½ in. x 2 in.—5½ in. stem
1 (B & Co. on stem)	1	3/16	11.50	3½ in. x 2 in.—4 in stem
1 (B & Co. on stem)	3	3/16	11 50	3½ in. x 2 in.—4 in. stem
1 (B & Co. on stem)	5	3/16	11 50	3½ in. x 2 in.—4 in stem
1 (B & Co. on stem)	6	3/16	11 50	3½ in. x 2 in.— 4 in. stem
1 (B & Co. on stem)	7	3/16	11.50	3½ in. x 2 in.—4 in. stem
1 (B & Co. on stem)	9	3/16	11 50	3½ in. x 2 in.— 4 in. stem
9 Spirals			about 6 g each	4½ in. long —¾ in. flat coil
2 Crucibles			about 20 g. each	
2 Crucible covers			about 5 g. each	
3 Filtering cones			about 2 g. each	

Imports and Exports of Chemicals

Exports of chemicals during the seven months ended with July ran well ahead of the corresponding period of 1919. The value of chemicals exported during the first seven months of 1920 was $106,633,166, as compared with $75,299,068 for the first seven months of 1919. These figures are taken from the returns to the Bureau of Foreign and Domestic Commerce, which has just completed the compilation of the July returns.

In July, the value of chemicals exported was $13,-775,972, as compared with $7,642,735 in July of 1919. The sodas contributed greatly to the increase. Sodas were exported in July, 1920, to the value of $2,133,239. The principal increase was in caustic soda exports. Dyes and dyestuffs also increased markedly. Exports in July, 1920, were valued at $3,018,188, as compared with $872,091 in July of 1919. France, Italy, the United Kingdom, Canada, China and Japan were the destinations of greatly increased quantities of dyes.

While the exports of acids were light, valued at $426,340, there was a very marked increase in exports of sulphuric acid. The exports of extracts for tanning fell off slightly, totaling for July, 1920, $234,310.

Imports of chemicals more than doubled in July, 1920, as compared with those of July, 1919. The total value of chemicals imported without the payment of duty in July, 1920, was $11,249,624, compared with $3,816,142 in July of 1919. The value of the dutiable chemicals imported in July, 1920, was $6,640,706. In July, 1919, the imports of dutiable chemicals were valued at $4,696,731. Of particular significance were the imports of gums. In July, 1920, gum arabic, camphor, chicle, copal, gambier, shellac and other gums were imported to the extent of 18,162,380 lb. Potash imports also were heavy, aggregating 3,394,208 lb. The principal item making up the total was cyanide of potash.

Figures covering chemicals of lesser importance are as follows:

IMPORTS OF CERTAIN CHEMICALS

	July, 1919 Lb.	July, 1920 Lb.
Arsenic, and sulphide of	398,291	993,558
Indigo:		
Natural	1,736	none
Synthetic	9,311	164,676
Iodine	83,257	none
Lime, chloride of	101,378	140,562
Lime, citrate of	220,815	781,933
Potash, carbonate of	71,627	794,909

EXPORTS OF CERTAIN CHEMICALS

	July, 1919 Lb.	July, 1920 Lb.
Glycerine	67,980	113,636
Lime:		
Acetate of	908,546	1,388,972
Chloride of	652,226	3,656,024

Appropriations for Chemical Work

No great difficulty is expected in convincing Congress at the next session that more appropriations must be forthcoming for work of interest to the chemical industry. While it is expected that the next Congress will be more generous than the last, information reaching Washington is that the chemical industries are prepared to present such convincing facts and figures as to make a favorable decision in the matter by the Appropriations Committee practically certain. The Appropriations Committee will be shown that from 1914 to 1917 there was an increase of 182 per cent in the volume of business done by the chemical industries. In 1910 the value of exports of thirty-six classes of chemicals aggregated $21,500,000. In 1917 the exports of these same classes of chemicals aggregated $193,-000,000. In 1910 imports of seventy-six different groups of chemicals aggregated $76,500,000. This amount was increased to $144,000,000 in 1917. In 1910 the United States imported $55,000,000 worth of chemicals more than were exported. In 1917 the exports exceeded the imports by $49,000,000.

It also will be pointed out at the next session that the expansion of the chemical industries antedated the war. During the period from 1904 to 1914 the average increase in the value of products of fourteen leading industries was 63.9 per cent. During the same period the value of the products of the chemical industries increased 86.1 per cent. Among the fourteen industries the expansion in the chemical industry was exceeded only by that in the vehicle industry.

It is believed that it will not be difficult to impress upon Congress the enormity of the achievement of the chemical industry in meeting the chemical needs of the country throughout the war, when it was called upon almost over night to take care of needs which previously had been supplied from abroad. This was done in spite of the intricate character of most chemical manufacturing processes.

It is taken for granted that Congress is unanimous in the desire to prevent the decadence of this new industry, but the Appropriations Committee will scrutinize closely any proposed expenditures to assist the industry in holding its own. It will be pointed out to the committee, however, that the maintenance of these great business enterprises, when subject to peace-time competition, will depend to a considerable degree on their efficiency, and that a great number of problems will have to be met if the various advantages held abroad are equalized. There is reason to think that Congress will be ready to lend its aid to end the old practice of exporting the raw materials from which chemicals are made and buying back the finished products at greatly enhanced prices.

Chicago Meeting of the National Association of Purchasing Agents

The National Association of Purchasing Agents will hold its annual convention at the Congress Hotel, Chicago, Oct. 11, 12 and 13. Business sessions will be held on each of those days, the convention being open to all industrial purchasing agents.

At the morning session on Oct. 11 the work of the association in establishing standards of business practice and in national legislative matters will be reviewed. At all other sessions there will be addresses and discussion. Some of the speakers on the program are Russell A. Pettengill, of the Russell A. Pettengill Co., Chicago, on "Buying Through Specifications"; Prof. Irving Fisher, of Yale University, on "Stabilizing the Dollar"; Dr. F. W. Russe, of Mallinckrodt Chemical Works, St. Louis, on "Safeguarding the Purchase of Chemicals."

Visits of inspection will be paid by the delegates to the packing houses of Chicago and to the Great Lakes Naval Training Station.

On the evening of Oct. 11 the annual banquet of the association will be held, featuring speakers of national prominence.

The National Association of Purchasing Agents has a membership of 3,500.

American Engineering Council of the Federated American Engineering Societies to Meet

The first meeting of American Engineering Council of the Federated American Engineering Societies will be held in Washington, D. C., Nov. 18 and 19, 1920, with headquarters at the New Willard Hotel. All sessions will be held in the small ballroom.

Registration will begin at 8:30 a.m. Thursday, Nov. 18, and at 10 o'clock the opening session will be called to order by Richard L. Humphrey, chairman of the Joint Conference Committee. A temporary chairman and secretary will be elected and committees will be appointed on program, credentials, constitution and bylaws, nominations, plan and scope, budget, and resolutions. At the afternoon session J. Parke Channing, chairman of Engineering Council, will address the gathering on the work of that organization. This will be followed by a discussion of the field of activity for the Federated American Engineering Societies.

At 9 o'clock Friday, Nov. 19, the morning session will consider the report on the committee on nominations, election of permanent officers, report of committee on constitution and bylaws, formal ratification of same, and report of committee on plan and scope. At the afternoon session at 2 o'clock the committees on budget and on resolutions will make their reports. The evening session will meet at 8:30 to hear an address by Herbert Hoover, president of the American Institute of Mining and Metallurgical Engineers. This will be followed by an informal reception and smoker.

At 9 a.m. Saturday, Nov. 20, there will be an organization meeting of the executive board, American Engineering Council, of the Federated American Engineering Societies.

Personal

Dr. ARTHUR M. BUSWELL, who was formerly in the department of sanitary engineering at Columbia University, is now chief of the Illinois State Water Survey, Urbana, Ill., having succeeded Prof. Edward Bartow, who is now head of the chemical department of the University of Iowa, Iowa City, Iowa.

Dr. FARRINGTON DANIELS has resigned from the Fixed Nitrogen Research Laboratories, American University, Washington, D. C., to become assistant professor of physical chemistry at the University of Wisconsin.

Dr. J. E. DAY has resigned as assistant professor in Ohio University to accept a similar position with the University of Wisconsin, where he will teach inorganic chemistry.

HARMON E. KEYE, who was with the Consolidated Mining & Smelting Co. of Canada, is now chemist with the Electrolytic Zinc Works, Martinez, Cal.

Dr. R. E. RINDFUSZ has been appointed assistant to the president of the American Writing Paper Co., of Holyoke, Mass. Dr. Rindfusz has been chief of the research section of the company's department of technical control. Previous to his association with this company he was associate in organic chemistry in the University of Illinois and was identified with that institution's war work in the manufacture of rare organic chemicals.

H. H. STOEK has recently received the honorary degree of D.Sc. from the University of Pittsburgh.

A. E. WELLS, chief metallurgical engineer of the Bureau of Mines, has resigned to handle the mining and metallurgical problems of a large development company. His headquarters will be in New York.

Obituary

GEORGE A. BREWSTER, who had been chief chemist and metallurgist with the American Steel Foundries Co., Chicago, Ill., and the American Radiator Co., Buffalo, N. Y., and who had also held other positions in connection with the chemical industry, died on Aug. 17, 1920. Mr. Brewster was an active member of the American Chemical Society, the American Steel Treaters Society and the American Institute of Mining and Metallurgical Engineers, and had accomplished much in the way of development of special steels. He is survived by his wife and two sons.

JOHN R. COOPER, of Degolia, N. Y., who was part owner of the Newton Chemical Co., died on Sept. 3 following an operation.

Dr. WILLIAM HODGSON ELLIS, former dean of the faculty of applied science, Toronto University, died at Lake Joseph, Muskoka, Canada, on Aug. 23, 1920. Although Dr. Ellis was in his seventy-fifth year and had not been as active for the past year as his friends would have wished, his death came as a distinct shock to his colleagues of the university and to a host of graduates throughout Canada. For more than forty years Dr. Ellis had been on the teaching staff of Toronto University. He held various lectureships until 1887, when he became professor of applied chemistry at the school of practical science. He was later made dean of the faculty of applied science, from which he retired in May, 1919.

CHARLES WARREN MCCLURE, vice-president and general manager of the William B. Pollock Co., Youngstown, Ohio, died on Aug. 11, 1920.

Book Reviews

THE OIL-SHALE INDUSTRY. By *Victor C. Alderson*. 170 pp., illus. New York: F. A. Stokes & Co. Price, $4.

This book, gotten out "to meet the widespread demand for information of a comprehensive nature," contains a miscellaneous collection of facts, figures and views anent oil shale and the oil-shale industry. It comprises an elaboration and revision of material presented in the *Quarterly of the Colorado School of Mines* for October, 1919. Essentially popular in its nature, it adds nothing to present knowledge of oil shale of value to the engineer or chemist, but much of the information and many of the views presented will be of interest. The book should be in the hands of every person interested in the promotion of an oil-shale project.

After reviewing the critical petroleum situation, which points to the eventual utilization of oil shales, the extent of the world's deposits of oil shale and the history of the shale industry abroad are popularized and presented in pellet form. Many statements in the book are of doubtful accuracy. Chapters on "Retorting and Reduction" and on "Experimental Work" are included, which seem to have been hastily compiled from the popular press. For example, on page 52, we learn that all petroleum consists of hydrocarbons which "belong to one of two series—the parrafine or the olefine series." On page 54, we are told that a hydrocarbon "is primarily a compound of the elements carbon and hydrogen, but combinations of these two with other elements are not excluded." On page 93, experimental work of the United States Geological Survey is quoted, showing that the yield of ammonia obtained by steam distillation was approximately two and one-half times that obtained by dry distillation, while on page 61 we learn that "It is difficult to see how steam can aid in the formation of ammonia during the distillation of the oil by any chemical interaction."

While the possibilities of the oil-shale industry could hardly be exaggerated and indeed are not exaggerated by Dr. Alderson, his views as to the present status of the industry seem optimistic in view of the fact that all work done up to the present time, however valuable, has been confined strictly to pioneering on a small scale. A number of favorable reports upon the quality of shale oil have been included, and, however authentic these may be, due mention is not made of adverse reports. A method for the determination of oil and ammonia yields from oil shale is included which seems to have many excellent features. A very good bibliography is appended.

The difficulties of presenting information bearing on an industry so embryonic as the American shale-oil industry are, of course, great, and much should be excused in an attempt to describe such an industry. At the same time it seems ill advised to offer to the public a work purporting to convey "comprehensive information" upon a nonexistent industry. Especially is this true at a time when governmental agencies are investigating the subject, when many private agencies with conflicting interests and opinions are putting forth conflicting claims and when no technology exists to be described except the Scotch practice, which is presented in this work only in a very general and somewhat fragmentary manner. CHARLES L. JONES.

Current Market Reports

The Iron and Steel Market

Pittsburgh, September 17, 1920.

Demand for steel products, whether for prompt or for late delivery, continues notably light, and the situation is the more impressive from the fact that more than half of September has been passed, so that the dullness can no longer be ascribed to its being the midsummer period, which is always dull in the steel trade, but which the trade limits in its market analysis to the two months July and August.

As to forward commitments the dullness is ascribed to uncertainties both as to general business and as to prices of steel in particular. As a rule in steel, only a scarcity of material or the certainty that prices are going to be higher will bring the buyer into the market for forward commitments. As to prompt buying, the loosening up in the rail transportation situation is easily sufficient to account for the dullness. Production of steel has increased and the mills are now shipping more than they currently make, instead of less, as was the case in July and three months preceding. The stocks at mills are not cleaned up yet, but are probably reduced to not over one-half the maximum, which fell at about the end of July. Thus there has been a very material increase in receipts of steel by jobbers and manufacturing consumers. The prompt buying that occurred some time ago was not of regular character, but was largely by consumers who had steel due them on regular contracts but who were not receiving full deliveries. Accordingly they doubled up on purchases, buying prompt deliveries to eke out, and now when they receive deliveries from both sources of supply they are, generally speaking, well supplied.

Generalizations, however, are not exact in the matter of the various steel products. While there is no marked demand in the matter of making fresh purchases in any line, there remains considerable pressure on the part of buyers for deliveries against old contracts in several lines, including nails, tin plate and the smaller sizes of merchant steel bars.

STEEL PRODUCTION INCREASING

Here and there, it appears, a small mill is decreasing its operations on account of lean order books, but such cases amount to very little in the general average. The large mills have been increasing production as physical limitations, particularly the matter of transportation, permit. The report on ingot production made by the American Iron and Steel Institute covers the output of thirty producing companies which contributed 84 per cent of the 1918 total output and 85 per cent of the 1919 total output. The production of these thirty companies increased by 7 per cent from July to August, and the influences permitting larger production have continued. The rate of steel ingot production for the whole country in August may be estimated at about 42,700,000 gross tons per annum. October, usually a very favorable month on account of seasonal conditions, may easily show a rate of 45,000,000 tons.

While the steel market is described as stagnant, it must not be inferred that there is no buying and that no new commitments at all are being made. Scarcely any material is sought in the open market, but the mills are entering more or less tonnage from regular customers quite steadily, the volume being somewhat reduced. Thus the Steel Corporation had bookings in August equal to about two-thirds of its capacity, and its bookings this month may run at about the same rate. The corporation's unfilled obligations decreased by 313,430 tons in August, this being the first decrease reported since that for May, 1919, but the August decrease was equal to only about 23 per cent of the month's capacity, while shipments may be estimated at 90 per cent of capacity, indicating bookings at 67 per cent. July had shown an increase of 139,651 tons in unfilled obligations, equal to 10 per cent of capacity, and if shipments in July be taken at 75 per cent the bookings appear to have been about 85 per cent. The decrease in bookings from July to August is thus about 18 points, while the increase in shipments was about 15 points. With an increase of 139,651 tons in unfilled obligations in July and a decrease of 313,430 tons in August, there was a net change of 450,000 tons, nearly half of which change is attributable to an increase in shipments.

PRICES MAINTAINED

The large independent steel mills are maintaining their prices quite well. There is no disposition to quote prices in the open market lower than prices at which there are unfilled contracts on books, as the net result would be unsatisfactory. For a ton of new business thus secured ten tons of contract business might be jeopardized. Some paper advances recently made, however, have not held. Thus some mills that had sold plates at 3.25c. put their nominal asking price up to 3.50c., but now admit that if real business were offered they would be willing to accept it at 3.25c. To go a single dollar a ton below 3.25c., however, would be an entirely different matter.

Those of the smaller mills that have had prices far above the prices of the larger independents have been disposed to reduce prices, but this represents simply a decrease in delivery premiums. It is difficult to sell even at reduced prices, hence these smaller mills are faced with lower production rates.

As there is no longer any danger of a price advance by the Steel Corporation encouraging the independent steel market to engage in a fresh flight the corporation has relaxed a trifle of its rigidity in holding its prices down to the Industrial Board schedule, promulgated March 21, 1919. Last month the corporation adopted a new card on wire nails, practically conforming to the card adopted by the independents last February and increasing the extras on small sizes above the base price. Since then the corporation has advanced its price on rods $5 a ton, to $57, but as the independents are quoting $70 to $75 this goes but a short distance toward bridging the gap between corporation and independent prices. It is not certain that the corporation may not reduce some of its prices, its object apparently being to readjust its prices in relation to the cost of production of different commodities. The Industrial Board schedule, to which the corporation has adhered, was not an independent price structure, but was little more than the war control schedule reduced horizontally, while production costs now are not aligned with each other as they were during the war.

Pig iron is stagnant in nearly all districts and practically everyone now feels that the recent price advances were

carried too far, so that the next change in pig iron prices will be in the downward direction. As the merchant furnaces are well filled with business for the nearby future nothing may occur for a while.

The Chemical and Allied Industrial Markets

New York, September 17, 1920.

No improvement in the chemical market has been made during the period. The same "waiting" attitude noticed among buying interests for the past few weeks continues in vogue, with the result that business has been rather dull and in a small way whenever transacted. The shading of firm prices by second hands in an endeavor to obtain the cash with which to lay in stocks for the coming year has fallen off and producers' prices practically govern the market. On the whole former prices have been well sustained, but on the other hand there have been no advances, which seems to indicate that the market will continue in its present inactive condition until there is a better understanding between buyer and seller.

Many Items Weaker

The exceptions to the otherwise steady market are those which have been weakening for the past week or two. Among these is *caustic soda*, which has been offered as low as $4.50 by second hands, but the average price for the usual material is still around $5.50 per cwt., with buyers showing no inclination to invest. Another item that has been affected by the sluggish condition of the market is *oxalic crystals*, which is quoted on contract at 45@50c. per lb., compared with the recent quotations of 53@54c., and it is not beyond probability that this figure can be lowered to 40c. in the open market for second-hand supplies. Demand for *citric acid* having quickened, there is a decidedly firmer note to this item, although the price has remained the same, it being still possible to obtain material in carloads at 78@81c. per lb. *Potassium bichromate* continues brisk at 35c., with some quotations slightly below this figure and the supply keeping fairly well up to demand.

Coal-Tar Products

The change in this market, if it can be called such, is one of attitude rather than actual conditions, as prices are about the same and buying has not been greater than for the past few weeks. This change of attitude is principally on the part of producers who have taken a decidedly optimistic view of the coming season's business and look forward to a heavy year. Indications seem to justify this opinion, as the resumption of activity in the textile trade will beneficially affect business and besides increased activity in the paint industry is expected to be the order for next year. There is no doubt that this market has been as dull for the past few months, after last winter's heavy buying, as it has been for some years and a break was expected, arrived and now a return to better conditions is being looked forward to in the near future.

The only items worth noting are *dimethylaniline*, which picked up after the recent drop and is quoted at 95c.@$1.05 compared with 80@90c. of the previous report and also *H acid*, which showed some weakness and is in better supply, at $1.90@$2.05 per lb., than it has been for some time.

Naval Stores

No great advance has been made in this line, but conditions are improving and the principal reason back of this statement is the active return of foreign interests, especially England, into this market. The local situation has not improved to any extent, as difficulty is still being met in making shipments from the South. *Turpentine* held firm at the former $1.49 level, with practically no business reported.

Oils

The bottom having been reached, it is now supposed that there will be a general tightening up, especially in *cottonseed* and *linseed* and a gradual return to the normal conditions. *Soya bean*, f.o.b. N. Y., and *peanut oil* crude seem to bear this statement out, as the former is being held firmly at 14@14½c. and the latter at 17@18c. per lb. *Chinawood*, in bbl., f.o.b. Pacific Coast, is also stronger at 15¾@16c. per lb. than it was last week and it is predicted by some and hoped for by all that these facts, combined with the fact that crushers have arrived at the point where they cannot go any lower, indicate increased activity.

The Chicago Market

Chicago, Ill., September 15, 1920.

All lines of the chemical trade in this market show steady quotations, in spite of which the market must be termed uncertain. In general, there is a feeling of nervousness, holders of stock not appearing anxious to dispose of commodities on a weak market and consumers being wholly unwilling to pay the quoted prices in the face of possibilities.

Heavy Chemicals

The heavy chemical line shows nothing of interest. Producers of alkalis have not yet made public their price ideas for next season and trading is at a minimum pending this announcement. The same prices that have been quoted for the past month are still in effect, but actual buying is so slight as to render them practically nominal. It is felt that many of the few transactions going on are closed with the seller shading the price fractionally. *Alcohol* and *formaldehyde* are unchanged in price but, regardless of difficulty in securing goods, demand is weak. *Mercury* has kept pace here with the sharp reduction noted on both coasts, and is obtainable for $78 per flask. Producers' prices on chlorine, based on 9½c. factory, are firmly held, with considerable business being done.

Coal-Tar Products

Coal-tar products show a continuation of the lethargy which has enveloped them for many weeks. The recent partial shutdown in the textile industry deprived the line of its last vestige of life and it is surprising only that demoralization was not the result. All things considered, prices have held up remarkably well and with the gradual resumption of the textile mills, which even now is beginning, things should brighten up. The past seven-day period has seen no price changes of moment and few deals.

Fertilizers

Fertilizers are likewise weak. Unusually heavy fall rains have retarded agricultural operations, thus delaying consumers' buying of fertilizer materials. As between the producer and dealer, a disposition for watchful waiting is shown. Considerable finished product is accumulating in makers' hands, but no interesting price changes are reported.

Naval Stores

Indications are that price recessions in naval stores have reached their limit, at least for a time. Reports from the South are to the effect that export bidding is taking a share in stabilizing prices and locally demand is keeping even pace with supply. *Turpentine* shows a shade more strength, the current price in barrels, less than carlots, being $1.52 per gal. Jobbers are quoting to the consuming trade, in small lots, $1.75, but it is doubtful if this price is being adhered to rigidly. *Rosins* also show strength, quotations being ½ to 1c. higher, and all grades going at the same price. It is understood this item is particularly affected by export demand. *Pine oil*, in slightly better supply, is still quickly absorbed at the prevailing high prices by hungry consumers.

Vegetable Oils

There is a point in the price trend of all commodities which, when reached, will induce buying almost regardless of surrounding conditions. This same point seems to have been reached in the trading in vegetable oils. With indications of enormous supplies practically unchanged, prices showed a decided resistance to further hammering and considerable trading was indulged in, largely by the speculative element, as consumers still seem disposed to hold aloof.

A falling off in the estimated coming crop of flaxseed has caused plenty of bull talk in *linseed oil*, but the market failed to react. Tanks, for prompt and immediate delivery, f.o.b. Chicago, are quoted at $1.15 per gal., with post-September deliveries at $1.06@$1.07. In barrels 7c. is added. Jobbers' printed quotation to consumers in less than 5 bbl. is $1.45, but bona fide orders probably find a slightly lower level. There seems to be nothing in the flax outlook that points to higher prices.

Corn oil, at the current quotation of 8¾@9c. per lb., created wide interest, the price being low enough to cause buyers to come out of retreat. The slightest indication of an advance above 9c. was sufficient to stop trading, however, and that level seem fixed as the maximum for some days. Actual quotations on *cottonseed oil* show no change, prime summer yellow being quoted at 12½c. lb. in tanks, Chicago, and refined at 16½c. The consumer is remaining out of the market at these figures, even though the southern planters are protesting that the price is dangerously low.

Oriental oils remain quiet. *Coconut oil* is quoted at the coast in seller's tanks at 13¼@13⅝c., current local price in barrels being 16@16½c. Transactions are few. *Soya bean oil* is held for 9@9¼c. for prompt coast shipment, buyers' lack of response indicating that the consumer thinks it is still too high. *Chinawood oil* finds light demand at the f.o.b. Chicago price of 16½@16¾c., and *red oil* reflects the partial paralysis of the textile trade by registering no business on the low basis of 13c. per lb., Chicago, in tank cars.

The St. Louis Market

St. Louis, Mo., September 14, 1920.

The chemical market in this district has been quiet for the last month, there having been a slight easing-off of business over that of a month ago. Producers assert, however, that there is enough business to permit them to dispose of their entire volume without any danger of bearing down the market and that inquiries are coming in in good volume. Orders are well divided between those for immediate delivery and those for 1921 delivery. Prices have made no change during the past month, quotations made then having included increased costs due to the freight rate raises.

Chemical Supply Equal to Demand

The supply of chemicals on hand locally is, with the exception of *muriatic acid*, amply sufficient to meet the demand, but no price trend downward is noticeable, and the following quotations, based on carlots unless otherwise noted, are holding firm. There is a fairly good demand for *sulphuric acid* with prices steady. The 60 deg. grade is quoted at $16 per ton and 66 deg. at $24 per ton. There is slightly better demand for *oleum*, which is still quoted at $27.50 per ton.

Shortage of Muriatic Acid

A considerable shortage of *muriatic acid* has developed, but prices remain unchanged at $25 per ton and 2 to 2½c. per lb. in carboys. The shortage is ascribed to the fact that there is a better demand now than there was a month ago and supplies from the East have been shut off.

Stocks of *sodium bisulphate* are good and prices remain the same, $5 to $6 a ton being quoted, depending on the size of the order.

Nitric acid is showing signs of activity, inquiries being good. It is quoted at $7 per cwt. for the 36 deg. and $10 per cwt. for the 42 deg. Standard mixed acid remains firm at 1½c. per lb. of sulphuric and 11½c. per lb. of nitric.

There is no change in the price of *zinc chloride*, which registered a 25c. increase some time ago. Producers think this price will remain stable for some time. It is being quoted at $4 per cwt.

There are large stocks of *phenol* on hand, but the St. Louis firm which is disposing of the surplus Government supply is having no trouble keeping the market on it steady. It is being quoted at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	....	$0.65 - $0.75
Acetone	lb.	$0.15 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 - 16.00	16.25 -
Boric, crystals	lb.	.15½ - .16	.16½ - .19
Boric, powder	lb.	.15½ - .16½	.17 - .20
Citric	lb.	.78 - .80	.82 - .84
Hydrochloric (nominal)	cwt.	2.25 - 3.00	3.10 - 4.00
Hydrofluoric, 52 per cent	lb.	.13½ - .14	.14½ .15½
Lactic, 44 per cent tech	lb.	.10 - .11½	.12 .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		....	....
Nitric, 40 deg.	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg.	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.45 - .50	.52 - .55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	......-......
Sulphuric, 60 deg., drums	ton	....	....
Sulphuric, 66 deg., tank cars	ton	16.00 17.00	18.00 20.00
Sulphuric, 66 deg., drums	ton	26.00 28.00	-
Sulphuric, 66 deg., carboys	ton		. - .
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 35.00	40.00 -......
Tannic, U. S. P.	lb.	1.45 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 .70	.80 - .90
Tartaric, crystals	lb.	....	.74 - .77
Tungstic, per lb. of WO	lb.	....	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 - 5.75	6.00 - 7.00
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof (nominal)	gal.	.. . . .	1.12 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	..- . .	1.05 - 1.10
Alum, ammonia lump	lb.	.05 - .05½	.05½ - .06
Alum, potash lump	lb.	.08½ - .08¾	.09 - .09½
Alum, chrome lump	lb.	. . - .17	.18 - .19
Aluminum sulphate, commercial	lb.	.04½ -	- ...
Aluminum sulphate, iron free	lb.	.06 -	. -. . . .
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 - .35½	.35 - .37
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - .13½	.13½ - .14½
Ammonium nitrate	lb.	.09 - .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ -. ....
Amylacetate	gal.	..... -. . .	5.00 -. .
Amylacetate tech	gal.	... .-	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.14 - .16	.16½ - .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.17 - .18	.19 - .23
Barium chloride	ton	130.00 - 150.00	-
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .12	.12½ - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		. . - ..	......-......
Blue vitriol (see copper sulphate)		......-....	......-......
Borax (see sodium borate)		......-....	......-......
Brimstone (see sulphur, roll)		......-....	......-......
Bromine	lb.	.70 .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3.55	.... -......
Calcium carbide	lb.	.04½ .04½	.04½ - .05½
Calcium chloride, fused, lump	ton	33.00 - 34.00	35.00 - 45.00
Calcium chloride, granulated	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	7.00 - 7.50	8.00 - 8.50
Calcium peroxide	lb.	. . . -. ..	1.50 - 1.70
Calcium phosphate, monobasic	lb.	... . -. ...	.75 - .80
Calcium sulphate, pure	lb.	.. -. ...	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.14 - .15	.16 - .17
Carbonyl chloride (phosgene)	lb.	... . . .	-. . . .
Caustic potash (see potassium hydroxide)		... . .	......-......
Caustic soda (see sodium hydroxide)		.. . - . .	....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	......- . .	2.00 2.05
Copperas (see iron sulphate)		......-....	..... -. . .
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	..... -. ..	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		. -	. . -. . ...
Epsom salt (see magnesium sulphate)		. : -. ...	... -......
Ethyl Acetate Com. 85%	gal.	1.10 - 1.30	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		.... -....	1.75 -......
Formaldehyde, 40 per cent (nominal)	lb.	.48 - .50	.... ..
Fusel oil, ref	gal.	..... -. . ..	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	.. ..-.....	..... - .. ..
Glauber's salt (see sodium sulphate)		......-.. .	....
Glycerine, C. P. drums extra	lb.	..... -.	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	......-....	.03 - .20
Iron sulphate (copperas)	cwt.	2.00 - 2.25	2.35 - 2.75
Lead acetate, normal	lb.	... ..-	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	......-.....	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	......-....	1.50 -......
Magnesium carbonate, technical	lb.	.12½ - .13½	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 - 3.90	4.00 - 4.50
Magnesium sulphate, commercial	100 lb.	......-... .	3.50 - 3.60
Methanol, 95%	gal.	..... -..	3.25 - 3.30
Methanol, pure	gal.	......-. ...	3.50 - 4.50
Nickel salt, double	lb.	......-.....	.14 - .16
Nickel salt, single	lb.	......-.....	.13 - .14
Phosgene (see carbonyl chloride)		......-.....	1.25 - 1.50
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	......-.....	.35 - .37
Potassium bichromate	lb.	.33½ - .36	.39 - .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0 52 - $0.56	$0.57 - $0.58
Potassium bromide, granular	lb.	... - ...	.70 - .73
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .21	.23 - .25
Potassium chlorate, crystals	lb.	.18 - .18½	.19 - .20
Potassium hydroxide (caustic potash)	lb.	.27 - 28	.29 - .33
Potassium iodide	lb.	... - ...	3.35 - 3.60
Potassium nitrate	lb.	.17 - .17½	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.85 - .95	1.00 - 1.05
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$240.00 - 255 00	... - ...
Rochelle salts (see sodium potas. tartrate)		... - ...	... - ...
Salammoniac (see ammonium chloride)		... - ...	... - ...
Sal soda (see sodium carbonate)		... - ...	... - ...
Salt cake	ton	... - ...	48 00 - 50 00
Silver cyanide (nominal)	oz.	... - ...	1.25 - ...
Silver nitrate (nominal)	oz.	... - ...	.60 - 62
Soda ash, light	100 lb.	... - ...	3.20 - 3 50
Soda ash, dense	100 lb	... - ...	3.55 - 3 65
Sodium acetate	lb.	.10 - 15	.20 - 25
Sodium bicarbonate	100 lb	2.50 - 2 75	3 00 - 3.50
Sodium bichromate	lb.	22 .24	.26 - 27
Sodium bisulphate (nitre cake)	ton	7 00 - 8 00	9.00 - 11 00
Sodium bisulphite Powered, U.S.P.	lb.	08¾ - ...	.10 - 11
Sodium borate (borax)	lb	09 - .10	.11 - 12
Sodium carbonate (sal soda)	100 lb	2 00 - 2.10	2.15 2.25
Sodium chlorate	lb	11 - .12	.12½ - .14
Sodium cyanide, 96-98 per cent	lb.	.25 - .30	.32 - .35
Sodium fluoride	lb	.18 - ...	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	5.60 - 5 70	5.75 - 6 00
Sodium hyposulphite	lb.	...	03 .04
Sodium molybdate	lb	2.50 - ...	3.25½ - ...
Sodium nitrate	100 lb.	3.00 - 3 25	3 75 - 4.00
Sodium nitrite	lb.	16 - 18	.19 - .20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03¾ .04½	.04½ .05
Sodium potassium tartrate (Rochelle salts)	lb	.	.39 .40
Sodium prussiate, yellow	lb.	.23 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ .01¾	.02 .02½
Sodium silicate, solution (60 deg.)	lb.	02½ - .03	.04 - 05
Sodium sulphate, crystals (Glauber's salt)	cwt	1 60 - 1.70	1.75 2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	09½ - 10	.10½ - .11
Sodium sulphite, crystals	lb.	04 - 0 4½	04½ .05
Strontium nitrate, powdered	lb.	15 - 18½	.19 - 20
Sulphur chloride red	lb	08 - 09	.10 - .10
Sulphur, crude	ton	16.00 - 20 00	... - ...
Sulphur dioxide, liquid, cylinders	lb	09 - ...	.10 - .12
Sulphur (sublimed), flour	100 lb	...	3.80 4 35
Sulphur, roll (brimstone)	100 lb	...	3 40 - 3.90
Tin bichloride (stannous)	lb.	.42½ 44	.45 - .46
Tin oxide	lb	... - ...	55 - 65
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb	13 .13½	.13½ - .17
Zinc cyanide	lb.	.45 .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, U. S. P.	lb	17 - .25	...
Zinc sulphate	lb.	.03½ - .03¾	.04 .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities

Alpha naphthol, crude	lb.	$1 40	$1 50
Alpha-naphthol, refined	lb	1 60	1.70
Alpha-naphthylamine	lb	50	.52
Aniline oil, drums extra	lb.	.30	.33
Aniline salts	lb	.35	.40
Anthracene, 80% in drums (100 lb.)	lb	.90	1 00
Benzaldehyde (f.f.c.)	lb	2 00	2 10
Benzidine, base	lb	1 35	1 40
Benzidine sulphate	lb	1.15	1 25
Benzoic acid, U S P	lb.		90
Benzoate of soda, U S P	lb.	80	.90
Benzene, pure, water-white, in drums (100 gal)	gal	.38	.40½
Benzene, 90%, in drums (100 gal)	gal	.36½	.38
Benzyl chloride, 95-97%, refined	lb	.35	40
Benzyl chloride, tech.	lb	.25	.35
Beta-naphthol benzoate (nominal)	lb	3 50	4 00
Beta-naphthol, sublimed (nominal)	lb	..	
Beta-naphthol, tech (nominal)	lb	.80	.85
Beta-naphthylamine, sublimed	lb	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb	.18	.19
Ortho-cresol, in drums (100 lb)	lb	.23	.25
Cresylic acid, 97-99%, straw color, in drums	gal	1 15	1.20
Cresylic acid, 95-97%, dark, in drums	gal	1.05	1 10
Cresylic acid, 50%, first quality, drums	gal	.65	.75
Dichlorbenzene	lb	.08	.10
Diethylaniline	lb.	1 50	1.60
Dimethylaniline	lb	.95	1.05
Dinitrobenzene	lb	.30	.37
Dinitroclorbenzene	lb	.32	35
Dinitronaphthalene	lb.	.45	.55
Dinitrophenol	lb	.40	.45
Dinitrotoluene	lb.	..	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	.40
Diphenylamine (nominal)	lb	.80	.85
H-acid (nominal)	lb.	1.90	2.05
Meta-phenylenediamine	lb.	1.25	1.30
Monochlorbenzene	lb	.18	.20
Monoethylaniline	lb.	2.00	2.40
Naphthalene crushed, in bbls. (250 lb.)	lb.		.
Naphthalene, flake	lb.		.14½
Naphthalene, balls	lb.	.15	.17
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzene	lb.	.14	.19
Nitro-naphthalene	lb.	.40	.50
Nitro-toluene	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzene	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	.85
Ortho-nitro-toluene	lb.	.25	.40
Ortho-toluidine	lb.	.30	.35
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlorbenzene	lb.	.08	.12
Paranitroaniline	lb.	1.10	1.15
Para-nitrotoluene	lb.	.35	
Para-phenylenediamine	lb.	.50	
Para-toluidine	lb.	00	2 25
Phthalic anhydride	lb.	.60	70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.20
Pyridine	gal	00	3.50
Resorcinol, technical	lb	25	4.50
Resorcinol, pure	lb	2)	6.75
Salicylic acid, tech., in bbls (110 lb)	lb	.50	52
Salicylic acid, U. S. P.	lb	.50	60
Salol	lb.	.90	00
Solvent naphtha, water-white, in drums, 100 gal	gal	33	35½
Solvent naphtha, crude, heavy, in drums, 100 gal	gal	23	26
Sulphanilic acid, crude	lb.	.32	35
Tolidine	lb	70	2 50
Toluidine, mixed	lb	45	.55
Toluene, in tank cars	gal.	.35	..
Toluene, in drums	gal	.38	40½
Xylidines, drums, 100 gal.	lb	.50	65
Xylene, pure, in drums	gal	47½	.50½
Xylene, pure, in tank cars	gal	.45	...
Xylene, commercial, in drums, 100 gal	gal	.32½	.35½
Xylene, commercial, in tank cars	gal.	30	

Waxes

Prices based on original packages in large quanti

Beeswax, refined, dark	lb	$0 36	$0 39
Beeswax, refined, light	lb	.37	.38
Beeswax, white pure	lb.	.63	.68
Carnauba, No. 1 (nominal)	lb	90	.95
Carnauba, No. 2, regular (nominal)	lb	85 -	.86
Carnauba, No. 3, North Country	lb	.35 -	.36
Japan	lb	.17	.18
Montan, crude	lb	25	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09 -	.09½
Paraffine waxes, crude, scale 124-126 m p.	lb.	.09¾	.10
Paraffine waxes, refined, 118-120 m p.	lb	.11	.11½
Paraffine waxes, refined, 125 m p	lb	12¾	
Paraffine waxes, refined, 128-130 m p	lb	.13	15
Paraffine waxes, refined, 133-135 m p.	lb	.16	.17
Paraffine waxes, refined, 135-137 m p	lb	.17½	.18½
Stearic acid, single pressed	lb	.20	21
Stearic acid, double pressed	lb	.22 --	.23
Stearic acid, triple pressed	lb	.24	25

NOTE—Paraffine waxes very scarce

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal	$2.15
Pine oil, pure, dest. dist.	gal	1 80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f o b Jacksonville, Fla	gal	.35
Pine tar oil, double ref., sp.gr. 0.965-0 990.	gal	.85
Pine tar, ref, thin, sp. gr., 1 080-1.960	gal	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal	1 75
Hardwood oil, f o b. Mich, sp. gr, 0.960-0 990	gal	35
Pinewood creosote, ref.	gal	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots

Rosin B-D, bbl	280 lb	$14 60	
Rosin E-I	280 lb	14 50	
Rosin K-N	280 lb	14 50	
Rosin W. G-W. W.	280 lb	14 50	
Wood rosin, bbl.	280 lb.	15 00	
Spirits of turpentine	gal	1 49	
Wood turpentine, steam dist.	gal		
Wood turpentine, dest dist.	gal		
Pine tar pitch, bbl	200 lb		8 50
Tar, kiln burned, bbl. (500 lb)	bbl	14 50	15.00
Retort tar, bbl	500 lb	15 00	15 50
Rosin oil, first run	gal	72	
Rosin oil, second run	gal		
Rosin oil, third run	gal		

Solvents

73-76 deg., steel bbls. (85 lb.)	gal	$0.40
70-72 deg., steel bbls. (85 lb.)	gal	.38
68-70 deg, steel bbls (85 lb)	gal	.37
V. M and P naphtha, steel bbls. (85 lb).	gal	.29

Crude Rubber

Para—Upriver fine	lb	$0.29	-- $0.31
Upriver coarse	lb	19	.20
Upriver caucho ball	lb	20	.22
Plantation—First latex crepe	lb	30	.
Ribbed smoked sheets	lb	.28	- ..
Brown crepe, thin, clean	lb	.26	— ..
Amber crepe No. 1	lb.	.28	-- ..

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots

Castor oil, No. 3, in bbls			$0 18
Castor oil, AA, in bbls			
China wood oil, in bbls (f o b. Pac coast)	lb	.15½ -	.16
Coconut oil, Ceylon grade, in bbls	lb.	.15 --	.16
Coconut oil, Cochin grade, in bbls (nominal)	lb	.16	.17½
Corn oil, crude, in bbls	lb	.11½ -	.13
Cottonseed oil, crude (f.o b. mill)	lb	.10	.11
Cottonseed oil, summer yellow	lb	.14	.15
Cottonseed oil, winter yellow	lb.	.17½ --	.18½
Linseed oil, raw, car lots (domestic)	gal	1.25 —	....
Linseed oil, raw, tank cars (domestic)	gal	1.22 —	...
Linseed oil, boiled, car lots (domestic)	gal.	1.33 —	...

Olive oil, commercial	gal.	3.00	3.50
Palm, Lagos	lb.	.10½	.....
Palm, bright red	lb.	....	.....
Palm, Niger	lb.	.10	.10½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10½	.12½
Peanut oil, refined, in bbls	lb.	.17	.18
Rapeseed oil, refined in bbls	gal.	1.40	1.50
Rapeseed oil, blown, in bbls	gal.	1.60	1.70
Soya bean oil (Manchurian), in bbls N. Y.	lb.	.14	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½	.11

FISH

Winter pressed Menhaden	gal.	$0.90	$1.05
Yellow bleached Menhaden	gal.	0.95	1 05
White bleached Menhaden	gal.	1.00	1 25
Blown Menhaden	gal.	1.00	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22 00	$25 00
Barytes, ground, off color, f o.b. Kings Creek	net ton	18 00	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8 00	10 00
Barytes, ground, white, f.o b Cartersville, Ga.	net ton	23 00	25 00
Barytes, ground, off color, f o b. Cartersville	net ton	16 00	19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12 00	
Barytes, floated, f.o.b. St Louis	net ton	26 50	28 00
Barytes, crude, min. 98% ba , Missouri	net ton	11 00	11 25
Blanc fixe, dry	lb.	.05½	.06
Blanc fixe, pulp	net ton	60.00	80.00½
Casein	lb.	.15	.18
Chalk, domestic, extra light	lb.	.05	.06
Chalk, domestic, light	lb.	.04½	.05½
Chalk, domestic, heavy	lb.	.04	.05
Chalk, English, extra light	lb.	.05	.07
Chalk, English, light	lb.	.05	.06
Chalk, English, dense	lb.	.04½	.05
China clay, (Kaolin) crude, f.o.b mines, Georgia	net ton	9 00	12.00
China clay (Kaolin) washed, f.o b Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	12.00
China clay (Kaolin) ground, f.o b. Virginia points	net ton	15.00	40.00
China clay (Kaolin), imported, lump	net ton	25.00	35 00
China clay (Kaolin), imported, powdered	net ton	30.00	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	10 00
Feldspar, ground, f o b. Maine	net ton	21 00	23 00
Feldspar, ground, f.o b North Carolina	net ton	17.00	21.00
Feldspar, ground, f o.b. N. Y State	net ton	17 00	21.00
Feldspar, ground, f o b Baltimore	net ton	30 00	
Fuller's earth, granular, f.o.b. Fla	net ton	25 00	
Fuller's earth, powdered, f.o.b. Fla	net ton	18 00	
Fuller's earth, imported, powdered	net ton	35.00	40.00
Graphite (dust polish grade 30%) Ashland, Ala	lb.	....	.01
Graphite (dust facing grade 50%) Ashland, Ala	lb.	....	.02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	......	.05
Graphite, crucible, 90% carbon Ashland, Ala	lb.	......	.10
Graphite, crucible, 85% carbon	lb	....	.08
Graphite, crucible, 88% carbon	lb.	....	.09½
Graphite, crucible, 90% carbon	lb	....	.10½
Pumice stone, imported, lump	lb	.04	.50
Pumice stone, domestic, lump	lb	.06	....
Pumice stone, ground	lb.	.04	.07
Quartz (acid tower) fist to head, f.o b Baltimore	net ton	....	10 00
Quartz (acid tower) 1½@2 in., f.o.b Baltimore	net ton		14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5 00	7.50
Shellac, orange fine	lb.	1 35	1.40
Shellac, orange superfine	lb.	1 40	1.45
Shellac, A. C. garnet	lb	1 10	1 15
Shellac, T. N	lb.	1.15	1 20
Soapstone	ton	15 00	25 00
Talc, paper-making grades, f.o.b. Vermont	ton	10 00	20.00
Talc, roofing grades, f.o b. Vermont	ton	9.00	15 00
Talc, rubber grades, f.o.b. Vermont	ton	10.00	15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	15.00
Talc, imported	ton	60.00	70.00
Talc, California Talcum Powder grade	ton	20.00	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	100- 110
Chrome brick, 9-in. strs and sizes, f.o b. Baltimore	net ton	100- 105
Fire clay brick, 1st quality, 9-in shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55- 60
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45-
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50 55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	110 120
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90- 100
Silica brick, 9-in. and 9-in sizes, Chicago district	1,000	65- 70
Silica brick, f.o b. Birmingham	1,000	56- 61
Silica brick, f.o.b. Mt. Union, Pa	1,000	65- ...

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	18	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	21
Ferro-manganese, 76-80% Mn, domestic	gross ton	195.00	200 00
Ferro-manganese, 76-80% Mn, English	gross ton	170 00	175 00
Spiegeleisen, 18-22% Mn	gross ton	80 00	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 25	2.75
Ferro-silicon, 10-15%	gross ton	60 00	65.00
Ferro-silicon, 50%	gross ton	80.00	90.00
Ferro-silicon, 75%	gross ton	150.00	160.00
Ferro-tungsten, 70-80%, per lb of contained W	lb.	1.10	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	..
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20¼% silica, not more than H4% moisture.	gross ton	$10.00	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.65	.70
*Coke, foundry, f.o.b. ovens	net ton	18.00	20.00
*Coke, furnace, f.o.b. ovens	net ton	17.00	18.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	85.02
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	.65	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.70	.75
Monazite, per unit of ThO_2	unit	42.00	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12	.14
Pyrites, domestic, fines	unit	.12	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	5.00	
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	3.00
Vanadium pentoxide, 99%	lb.	12.00	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25	
Zircon, washed, iron free	lb.	.10	

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	18.50
Aluminum, 98 to 99 per cent	34.90
Antimony, wholesale lots, Chinese and Japanese	7.00
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5-ton lots	45.50
Lead, New York, spot	8.40
Lead, E. St. Louis, spot	8.20
Zinc, spot, New York	8.00
Zinc, spot, E. St. Louis	7.70@8.05

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	4.00@6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	115.00
Iridium	oz.	350.00
Palladium	oz.	100.00@110.00
Mercury	75 lb.	83 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	15.00	17.00	14.00	15.00
Copper, heavy and wire	14.00	16.00	13.50	14.50
Copper, light and bottoms	12.50	14 00	12.00	13.00
Lead, heavy	7.00	4.75	7.00	7.00
Lead, tea	5.00	3.75	4.00	6.00
Brass, heavy	9.50	10.50	10.00	14.50
Brass, light	7.00	7.50	7.00	8.00
No. 1 yellow brass turnings	8.50	10.00	7.50	8.00
Zinc	5.00	5 00	4.50	5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.58	$3 97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.73	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.73	4.12	3.37	....	3.27	3.87	3.37
Soft steel bands	6.43	5.32	4.07	6.25	....	....	...
Plates, ¼ to 1 in. thick	4.78	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Colorado

DENVER — The Eaton Metal Products Co., 1843 Mazoe St., is having plans prepared for the construction of a 1 story steel products manufacturing plant on York St. near the Union Pacific shops. Estimated cost, $175,000.

DENVER—The Federal Glass Co., 1717 Champa St., is having plans prepared for the construction of a glass factory. Estimated cost, $250,000. J. W. Busard, c/o Sylvester & Co., 1717 Champa St., engr. Noted Sept. 1.

DENVER — The Great Valleys Sugar Corp., 800 Central Savings Bank Bldg., is having preliminary plans prepared for the construction of 3 complete sugar factories. Estimated cost, $3,000,000. A. F. Lyster, engr.

LA SALLE—The Industrial Sugar Co., Barclay Block, Denver, has awarded the contract for the construction of a sugar factory, consisting of several buildings, to Baum & Baum, Salt Lake City, Utah. Estimated cost, $1,800,000.

Connecticut

ANSONIA — The Amer. Brass Co., 58 Liberty St., plans to build several large additions to its plant on Bridge St.

Illinois

DE KALB—Rev. J. A. Solon plans to build a 3-story, 40x179-ft. hospital. A chemical laboratory will be installed in same. Estimated cost, $150,000. Arthur Foster, 1555 North Clark St., archt.

Indiana

TERRE HAUTE — The Hoosier Rolling Mills Co. will build a 1-story, 100x600-ft. factory. Estimated cost, $100,000. Work will be done by day labor.

Iowa

MALLARD — The City Clerk will soon receive bids for the construction of a sewage disposal plant, sand filter and sludge beds. Estimated cost, $50,000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., engrs.

NEW MARKET—The City Clerk will soon award the contract for the installation of a septic tank and sludge bed. Estimated cost, $64,000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., engrs.

Maine

HOWLAND—The Howland Pulp & Paper Co., 301 Congress St., has awarded the contract for the construction of a 38x72-ft. addition to paper machine building and a 75x103-ft. addition to sulphate pulp mill to Green & Wilson, Waterville. Estimated cost, $120,000.

Maryland

BALTIMORE—The Baltimore Malleable Iron & Steel Castings Co., Charles and Wells Sts., plans to install additional blast furnaces and other equipment. Estimated cost, $100,000.

CANTON (Baltimore P. O.)—The Standard Oil Co., Pratt and South Sts., plans to build an oil refinery here. Estimated cost, $7,000,000. E. A. Holbein, supt.

SPARROWS POINT — J. E. Sperry, archt., 409 Calvert Bldg., Baltimore, will soon award the contract for the construction of a 3-story hospital for the Bethlehem Steel Corp. A laboratory including equipment will be installed in same. Estimated cost, $150,000.

Massachusetts

PALMER—The Palmer Fdry. & Machine Co., 27 Foundry St., has awarded the contract for the construction of a 1-story foundry to the Flynt Bldg. & Constr. Co., 356 Main St. Estimated cost, $20,000.

RUSSELL — The Chapin & Gould Paper Co., 317 Main St., Springfield, has awarded the contract for the construction of a 4-story paper factory to F. T. Ley & Co., Inc., 499 Main St., Springfield. Estimated cost, $100,000.

WORCESTER—Holy Cross College, College St., plans to build 5 buildings including a science hall, etc. Estimated cost, $1,000,000.

Michigan

DELRAY (Detroit P. O.) — The Inland Delray Salt Co. will soon award the contract for the construction of a 2-story, 140x170-ft. factory. Estimated cost, $60,000. Stahl & Kinsey, 435 Woodward Ave., Detroit, archts.

MONROE—Reed M. Dunbar, archt., will soon award the contract for the construction of a 1-story, 90x210-ft. foundry on East 1st St. for the Monroe Auto Equipment Co, East 1st St. Estimated cost, $100,000. Noted Sept. 15.

New Hampshire

GROVETON—The Groveton Paper Co., Inc., has awarded the contract for the construction of a 2-story, 55x200-ft. paper factory to Swan & Son, St. Johnsbury, Vt. Estimated cost, $100,000.

New Jersey

BRIDGETON—The Illinois Glass Co. has awarded the contract for the construction of a glass factory including a 3-story, 330x700-ft. main plant and two 50x150-ft. units, etc., to the Keeley Bros. Constr. Co., 507 Federal St., Camden. Estimated cost, $3,000,000. Noted Sept. 15.

HIGHTSTOWN — The Borough has awarded the contract for filtration plant equipment including 2 horizontal steel pressure filters to the New York Continental Jewel Filtration Co., Flatiron Bldg., New York City. Estimated cost, $8,000.

NEWARK — The George LaComte Co. plans to build a 75x140-ft. factory for the manufacture of concrete blocks on Victoria St. Estimated cost, $25,000. Fred Noble, engr.

New York

RIKERS ISLAND — The Dept. of Correction received bids for the installation of sterilizing and disinfection machines at the farm here from Kny-Scheerer Co., 56 West 23rd St., New York City, $1,770; Cromwell Dean Co., $1,779.

Ohio

ALLIANCE—The Alliance Brick Co. is building a plant and is in the market for brick-making machinery.

CANTON—The United Eng. & Fdry. Co., 13th St., N.E., has awarded the contract for the construction of a 1-story, 136x240-ft. factory on Grace Ave., N.E., and 13th St., N.E., to R. G. Whitter, 1539 Howard Court, N.W. Estimated cost, $75,000.

LONDON — The Williams Mfg. Co. has awarded the contract for the construction of a 1-story, 50x180-ft. factory to W. H. Robbins, Springfield. Estimated cost, $45,000.

TOLEDO — The Acklin Stamping Co., Dorr St., has purchased a site on Nebraska Ave. near the Lake Shore Crossing and plans to build a large factory on same. Annealing furnaces, nickel plating and galvanizing plants, electric welding and tool departments will be installed in same. D. T. Anderson, supt.

Pennsylvania

AVONDALE — The Consolidated Bd. of New Gordon and Loudin Grove Townships in West Grove and Avondale Boroughs, Chester Co., plans to build a 2-story high school here. A chemical laboratory will be installed in same. Estimated cost, $100,000. Ritter & Shay, North Amer. Bldg., Philadelphia, archts.

Texas

WICHITA FALLS — The State Bd. of Control, Austin, will receive bids until Oct. 4 for the construction of a sewage disposal plant, etc., at the Northwest Texas Insane Asylum here.

Vermont

NORTHFIELD—H. Pelaggi & Co. will build a 1-story, 60x425-ft. plant addition. Estimated cost, $50,000. Work will be done by day labor.

Wisconsin

MERTON — The Merton Dairy Products Co. has awarded the contract for the construction of a 1-story, 30x45-ft. addition to its creamery to Reisinger & Co., 425 East Water St., Milwaukee. A chemical laboratory will be installed in same. Estimated cost, $18,000. Noted July 28.

Quebec

MONTREAL—The L'air Liquide Society, Maisonneuve, plans to build extensions to its welding and cutting plants.

MONTREAL—The Natl. Drug & Chemical Co., 34 St. Paul St., has awarded the contract for the construction of a factory to Church, Ross & Co., 10 Cathcart St. Estimated cost, $75,000. Noted June 23.

Ontario

AGATE — S. Bromley, Pembroke, representing owners, plans to build a pulp and paper mill here. Estimated cost, $500,000.

PETROLEA—E. A. Stokes plans to build a plant for the manufacture of nitroglycerine and is in the market for machinery and equipment for same. Estimated cost, $100,000.

Manufacturers' Catalogs

THE READING IRON PIPE CO., Reading, Pa., has issued Bull. No. 1, entitled "Reading Wrought Iron Pipe." It is a very instructive booklet, and gives in thirty-two pages very interesting descriptions of the origin and development of the wrought iron industry, the puddling process, the manufacture of skelp, why wrought iron is better for making welded pipe than steel, Reading iron pipes in oil country service, building service, refrigerating service, coal mine service, and charcoal iron boiler tubes for locomotive, marine and stationary boilers, together with appropriate illustrations.

THE JEFFREY MANUFACTURING CO., Columbus, O., has issued two new catalogs. No. 312 is entitled "Jeffrey Storage Battery Locomotives for Mines." Particular attention is called in this catalog to the Jeffrey pivoted battery box, which makes motors accessible for inspection and oiling without having to remove the battery box, also allows removing and replacing of the pinions on the armature shaft without having to run the locomotive under a crane or over a pit. It fully illustrates and describes other important features of Jeffrey storage battery locomotives for mining service, including motor equipment, new style journal box for inside wheel type locomotive, etc., and also contains illustrative photographs of electric gathering locomotives of the Standard cable reel and crab reel types. Catalog No. 263 is entitled "Jeffrey Mine Locomotives." This catalog fully illustrates and describes the electrical and mechanical features of this company's complete line of mine locomotives, including the "Armorplate" type of main haulage locomotive, and electric gathering locomotives of the cable reel, crab reel, combination cable and crab reel, and electric storage battery types. Both of these catalogs are interesting and contain many illustrations.

VACUUM OIL CO., New York, has published a 32-page booklet on Bearings and Their Lubrication. The construction, types and materials used in bearings are briefly outlined. Oiling systems, distribution and lubrication are discussed. Oils and greases are described relative to their application.

THE PERMUTIT CO., New York, announces the publication of Bull. No. 101, which covers the various products manufactured by the company. This attractive 32-page catalog contains a brief discussion of water rectification or conditioning problems, and the solution by the complete line of apparatus manufactured by the Permutit Co., such as softeners, filters, iron and manganese removal equipment, etc., although it is not an attempt to cover the vast field, but serves principally to indicate the problems which have been met and solved by its technical staff. Many interesting illustrations are given, together with descriptive matter.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

A.I.M.E. PETROLEUM AND GAS MEETING is being held in St. Louis, Mo., Sept. 21 and 22, in conjunction with the American Society for Testing Materials and the Petroleum Fuel Section of the A.S.M.E. It is expected that this meeting will crystallize into a petroleum and gas section of the A.I.M.E.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS is holding its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

THE CHEMICAL WARFARE POST of the American Legion will hold its next meeting Sept. 22, at 8 p.m., in the conference room of the Grand Central Palace, New York City.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

NATIONAL ASSOCIATION OF PURCHASING AGENTS will hold its annual convention at the Congress Hotel, Chicago, Ill., Oct. 11, 12 and 13.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) is being held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE RUBBER SECTION of the National Safety Council will consider safety problems of especial interest to the rubber industry at a section conference to be held Sept. 29 to Oct. 1, in connection with the national session of the Council to be held in Chicago.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

UEHLING INSTRUMENT CO., New York City, manufacturer of fuel economy equipment, announces that it is now being represented in the New England States by the Smith Engineering & Supply Co., 89 State St., Boston, Mass., manufacturers' agent and engineer, specializing in power plant equipment. S. W. Smith, president of the latter company, was until very recently associated with the Uehling Instrument Co. with headquarters in the New York office.

C. M. TEATS, formerly secretary of the Oklahoma Brick Manufacturers Association, has moved to Memphis, Tenn., where he will be local manager for the Reliance Brick Co., manufacturer of building and enameled brick, hollow tile, etc.

THE INDUSTRIAL DEVELOPMENT COMMITTEE of the Oklahoma Chamber of Commerce is planning a survey of the industries of that territory. The work is divided into various sections, such as banking, labor conditions, transportation, agriculture, oil, tar, living conditions, business utilities, etc. Increased production of mining and manufacturing has made the inauguration of a comprehensive study necessary.

THE PORTER POTTERY CO., INC., of Clinton Ky., has established a branch office in the McCall Bldg., at Memphis, Tenn.

THE SAMSON MOTOR TRUCK CO., of Janesville, Wis., a division of the General Motors Corp., has established a branch at 228 Monroe Ave., Memphis, Tenn.

A. LUSSKIN & CO., New York City, announces that I. Miller of its staff sailed on the Adriatic, Aug. 14, for an extended trip through Europe, in connection with the purchase and sale of chemicals, colors, oils and waxes.

THE VOOLRATH CO., of Sheboygan, Wis., manufacturer of enameled ware, has secured a building for the installation of a plant at 821 West Lake St., Chicago, Ill.

THE JEWELL POLAR CO., manufacturer of water stills, has purchased the 2-story factory at 565 West Van Buren St., Chicago.

QUIGLEY FURNACE SPECIALTIES CO., New York City, announces that the furnaces for the new sheet mill of Follansbee Bros. Co., Toronto, Ohio, will be fired with powdered coal. For transporting the pulverized fuel from the milling plant to the furnace bins, the Quigley air transport system has been adopted. A standard blowing unit of five tons capacity consisting of pulverized fuel bin, blow tank and scales, which is capable of transporting ten tons of pulverized coal per hour, will be installed. The total distance for transporting fuel is approximately 1,700 ft. This blowing equipment is being furnished by the Quigley Furnace Specialties Co.

EASTON CAR & CONSTRUCTION CO. announces the opening of a new office in the Peoples Gas Bldg., Chicago, to take care of the increasing business in the West and Middle West districts.

THE METAL & THERMIT CORP., New York City, has made arrangements to secure life insurance for all its employees who have served the company for at least six months. The amount of protection is graded according to the length of service, ranging from $700 for six months' service up to $3,000 for twenty years' service. The company bears the entire expense of this insurance, which is in addition to any compensation to which its employees might be entitled under the present state compensation laws. The insurance will be paid in monthly payments during the first year after death.

THE WHITMAN & BARNES MFG. CO., operator of a large forging plant in Chicago, has merged its plant with J. H. Williams & Co., manufacturer of drop forgings and tools, with plants at Brooklyn and Buffalo, N. Y.

WILSON WELDER & METALS CO., whose general offices were formerly at 2 Rector St., is now located at 253 26th St., Bush Terminal, Brooklyn, N. Y., and the Wilson Welding Repair Co. has moved its offices from 2 Rector St. to 263 First St., Jersey City, N. J.

THE FORD ROOFING PRODUCTS CO., now in St. Louis, plans to move its executive offices to Chicago and within the year to build a $1,000,000 plant there. The new offices will be located in the Conway Bldg. J. W. Ford is president.

BEER, SONDHEIMER & CO., INC., New York City, has legally changed its name to the International Minerals & Metals Corp. The active business management of the corporation and its relationship to its affiliated and subsidiary companies has in no way been affected and will continue as heretofore.

PROF. CHARLES H. LAWALL, dean of the Philadelphia College of Pharmacy and well-known analytical and consulting chemist, has removed his laboratory and office from 30 South Tenth Street to 636 Franklin Sq., Philadelphia.

THE CUTLER-HAMMER MFG. CO. announces the following recent installations of Thomas meters: At the Readsboro (Vt.) plant of the International Nitrogen Co., a 50,000 cu.ft. per hr. meter, measuring carbon monoxide gas given off in the process of carbide manufacture; a 300,000 cu.ft. per hr. station meter for measuring water gas in Plymouth, England, at the Plymouth and Stonehouse Gas Light & Coke Co.; another English installation is that of a 400,000 cu.ft. per hr. meter, measuring water gas; another foreign order has been received from the Brokenhill Proprietary Co., New Castle, Australia, for five 500,000 cu.ft. per hr. meters for measuring coke-oven gas. At Sparrows Point, Md., three new meters are being installed: one for the Consolidated Gas, Electric Light & Power Co., for measuring coke-oven gas pumped into the distribution system and another of 200,000 cu.ft. per hr. meter, measuring surplus coke-oven gas purchased from the Consolidated Gas & Electric Light Co., the gas at this point being under 10 to 15 lb. gage pressure; while a third at this same location is of 300,000 cu.ft. per hr. capacity for measuring surplus coke-oven gas. The Consolidated Gas Co. of New York has installed in the Westchester Light Co. plant a 500,000 cu.ft. per hr. station meter, measuring water gas. Two 1,250,000 cu.ft. per hr. meters and two 800,000 cu.ft. per hr. meters purchased by the Koppers Co. are for installation at the Chicago By-Product Coke Co., the first two to measure water gas sold to the Peoples Gas Light Co., and the smaller meters to measure surplus coke-oven gas sold to the Peoples Gas Light Co.

C. A. BREED, metallurgist, and E. M. HEUMANN, chemical engineer, have recently joined the staff of the new industrial research laboratory established in Cleveland, Ohio, by Daniel M. Luehrs.

THE CELITE PRODUCTS CO. announces that P. A. Boeck, manager of distribution at the New York office, is now located at the company's Los Angeles office, where he will supervise the production work. Thomas G. Lee, Jr., will act as general sales manager, with headquarters in New York.

THE LAKEWOOD ENGINEERING CO., Cleveland, O., announces that Robert M. Gates has been appointed managing engineer in charge of the Philadelphia district of the company, with offices at 1034 Widener Bldg., Philadelphia.

THE SEMET-SOLVAY CO. has appointed J. L. Landt superintendent of the Buffalo plant, manufacturing coke and byproducts.

THE CELITE PRODUCTS CO. announces that it is now represented in the Buffalo district by the Empire Co., 331 Ellicott Square, Buffalo, N. Y.

GUSTAVE DROBEGG, consulting chemist, specializing in intermediates for dyes, pharmaceuticals, essential oils and synthetic aromatics, announces his removal from 38 Park Row to 5 Beekman St., New York City.

THE BETHLEHEM FOUNDRY & MACHINE CORP. has purchased the business of Stevens Bros., 149 Broadway, New York. All of the personnel and staff of Stevens Bros. are retained and the Bethlehem Foundry & Machine Corp. will conduct a business as engineer and contractor to the chemical industry at 149 Broadway, New York City.

THE CRESCENT PRODUCTS CO. of Hartford, Conn., was recently incorporated to deal in chemical formulas, etc. The organizers of the company are J. L. Porcheron, H. G. Wilson and W. E. Chapin, attorney of 874 Main St., Hartford, Conn. The capital of the new company is $10,000.

THE MONO CORPORATION OF AMERICA announces the removal of its main office from Buffalo to 25 West Broadway, New York City, where its complete line of automatic continuously recording gas analyzing instruments for CO_2, CO, O_2, SO_2, H_2, N_2, CH_4, etc., will be displayed. F. D. Harger, vice-president and general manager. D. W. Reid and others will offer chemical service in matters relating to the automatic, continuous recording of gas analyses in the scientific control of combustion and chemical processes.

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ELLWOOD HENDRICK
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ALAN G. WIKOFF
Assistant Editors

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

Volume 23 New York, September 29, 1920 *Number* 13

Facts First; Classification Second

THE coal operators shipping over the Virginian Railway for export through the Sewalls Point Coal Exchange are taking a very advanced stand in their agreement with the United States Bureau of Mines with regard to the sampling and analysis of coals. They propose to have a complete set of mine samples and analyses, tipple samples and analyses, and commercial coal tests throughout the year to serve as a basis for determining the classification of their coal shipments.

As in all such co-operative agreements, all analyses obtained by the bureau may be published, and all users of smokeless and high volatile fuel from this district can therefore profit by the conclusions. This work will be of great value to other users of coal from this territory as well as to the tidewater and foreign interests directly concerned in the shipments handled by this coal exchange.

This is practically the first time that a large group of operators have been willing to face the facts so frankly; they and their patrons are to be congratulated accordingly. It is not too much to expect that other districts will fall in line, so that all users of fuel may ultimately have reliable mine- and commercial-coal analyses as a basis upon which to judge their purchases. The time is coming when a coal purchaser may again buy upon quality. Just now, of course, he has to take what he can get and be thankful for that. When quality again becomes the determining factor such work as this just undertaken will have increased value for all.

New Problems In the Chemical Industry

HIGH prices and increased transportation costs necessitate industrial adjustment. In what way will this adjustment affect the chemical industry?

Like others, the chemical industries have shown a marked tendency toward centralization and large-scale operation. This has not been illogical and has done much to bring about the high efficiency and the present position of importance of the chemical industry in this country. There were other and less apparent causes for centralization, among which the low cost and ease of transportation and a relatively concentrated market were important. Also there was a lack of appreciation on the part of the investing public of the economic importance and industrial stability of the chemical industry. Men whose initiative, ability and training fitted them to establish and operate small chemical plants felt that the large chemical companies offered more attractive employment and a greater opportunity.

Now, however, the conditions have changed in a marked degree. Industrial expansion throughout the country and more particularly the increase in general manufacturing in Western states, which has called for larger quantities and varieties of chemicals have emphasized the burdensome effect of centralization in those sections distant from the source of the needed chemicals. Transportation difficulties and more recently the increase in freight rates have forcibly emphasized this effect of centralization. As a consequence interest has been stimulated in small-scale production to supply a local market.

Undoubtedly the small plant will become an increasingly important factor in the chemical industry, and bring about a new set of problems for chemists and chemical engineers to solve.

Why Not a Revolving Fund?

CHEMICAL Warfare Service is to embark upon many activities which have possible peace-time value. These activities should be fostered, for the Service can be most effective in war times if it has been allowed to be business-like and effective in times of peace. One specific proposal is that a portion of the war-gas reserves be sold each year and a new supply be made in the plants of C.W.S. to replace the amounts disposed of. This would permit only fresh stocks to be kept and continual attention could be given to revision of manufacturing methods and maintenance of plant and equipment in genuine working order.

Any such program still has one important limitation, however. The income from such sale of materials would not be credited to the accounts of the Service for further developments and operations. It is a general practice that such income incident to any Government activity "be covered into the Treasury as miscellaneous receipts." In other words, the Service, although in effect financially self-sustaining, has each year no income credited to it, for these miscellaneous receipts do not appear as part of its assets. Occasionally a somewhat different practice is followed under what is termed "a revolving fund." An appropriation for this purpose provides that any income from the work authorized shall be credited to the appropriation and thus be allowed to facilitate an extension of the work or its continuance beyond the time that the initial appropriation would provide for.

Far be it from us to encourage Chemical Warfare Service or any other branch of the Government in the thought of "going into business" in competition with established industry. However, to remain an effective military agency this department must be maintained upon a business-like basis. A most effective means to

this end would be the transaction every year of a small amount of business directly associated with industry. The personnel of the Service would thus be kept in touch with industrial conditions most effectively and would know just how the current work could most quickly be expanded to a larger scale in case of military emergency.

A relatively small appropriation will permit fairly large-scale operation of the Service if the appropriation is on the basis of a revolving fund. On the other hand, if definite appropriations for all work must be made every year and income simply goes into the Treasury of the United States, we know there must be a continual fight in Congress to obtain the necessary money. Each year the effectiveness of the Service will be jeopardized by the possibility of political attack or unreasonable so-called "economy." It seems that an appropriation on the basis of a revolving fund would have great merit in these circumstances.

Fees vs. Salaries For University Professors

NOTING the inadequate technical instruction in iron and steel now existing in America, not only in trade schools but more especially in the so-called institutions of higher learning, the president of one of our honorably known colleges set out to find a professor of ferrous metallurgy. He wanted to find a man of personality such that men in the surrounding industry would naturally come to him for advice; the new professor was to be an executive who could lay the foundations for a great department; he must know iron and steel metallurgy and metallography, and be able to speak and write on these subjects clearly, easily and convincingly.

Some well-meaning friend referred Dr. PREX to us for a list of possible candidates. After hearing the specifications and learning that the salary of $4,500 a year was offered, the answer was instant: "It simply can't be done! Metallurgists of that caliber are extremely rare. If you could find one it would be difficult to interest him at twice the figure. If you succeed it will be pure good fortune."

"True," said the visitor, "but I hope to interest some man already a teacher, or with a desire to become a teacher, who is perhaps even now occupying a subordinate educational position, and who might not be held by a consulting practice, and therefore be willing to make the change for the opportunity it offers."

Here, indeed, is a phase of the situation only now being realized by educational administrators. Granted that an engineering professor should do some consulting work in order to keep him familiar with the shifting advance of technology, it is often forgotten that the teacher's first duty and great opportunity is to instruct and inspire his students. If his salary for this welcome task is so pitifully inadequate that financial worries and half-baked consultation fill his mind and time, then the teacher is teacher in name only, he loses his upright independence and the honorable title "Professor" is truckled to quack and charlatan.

Inbreeding and stagnation in university faculties are an ever-present danger from many causes without tying a teacher to a certain city or region simply because he is reasonably sure of certain outside fees. Why should he go from hardly won pound cake at Harvale to several years of bread and butter at Illiota?

Dr. PREX has evidently seen the great need of competent instruction in iron and steel. When will his board of directors apply to college management the same principles which rule their business: that the man and not the salary is the thing of importance? They know that if they get the right man he will earn the salary he will ask, but it seems they have not yet received sufficient urge from teachers, alumni or industry to act upon that knowledge.

An Excellent Publication On Hydro-electric Power

A PAMPHLET has been circulated by the Guaranty Trust Company which looks like good tidings. It urges investment in hydro-electric enterprises. It consists in a study of the power facilities of the United States, recognizes the prospective exhaustion of our oil supply with the increasing demand made upon it and the imports, running up in 1919 to 70,000,000 barrels. The burden upon railways for carrying coal is considered, as is the increase of 175 per cent in the cost of coal at the mines since 1914. The immense saving of labor and in traffic to be obtained by the development of water-power stations instead of hauling coal and the reasonableness of co-ordinating these with central-power stations fed by steam and gas are set forth with such clarity that it seems—of course this is a venturesome statement but it *almost* seems—as if it might make the dear public understand something of the thefts that we of today are committing against unborn generations.

There is told also how in the electrified mountain section of the Chicago, Milwaukee & St. Paul Railway (which formerly bore the initials C., M. & P. S. and was sometimes referred to as the Chicago, Milwaukee and Paint Saul), the company found that one electric locomotive does the work of four steam locomotives. The Butte, Anaconda & Pacific Railway accomplishes with seventeen electric locomotives work that formerly required twenty-eight steam engines of the mastodon type. The Norfolk & Western Railway achieves similar results. The interconnection of seventy-five hydroelectric with forty-seven steam plants in California covers a distance of over 800 miles with 7,200 miles of high-tension transmission lines, having a capacity of 785,000 kilowatts and serving nearly 600,000 consumers. California uses more electric power on farms (chiefly for pumping water for irrigation) than all the rest of the farms in the United States. The California rice industry that began in 1912 and that last year produced a crop worth $27,000,000 is almost wholly dependent on electric pumping.

In Kansas this summer the wheat of at least a dozen counties was threshed by electricity. One company supplies power to sixty towns and 500 farms. In Montana and Idaho the mines and smelters are electrified, and in the Northwest paper mills and sawmills are using electricity for power. And the immense significance of long-distance transmission whereby manufacturing concerns may select the most convenient locations, instead of building out at the falls, is emphasized.

We congratulate the Guaranty Trust Company on rendering a real service in public education. The public is naturally conservative in regard to what it does not understand, and this is as it should be. But it is also very slow in trying to understand, and this is as

it should not be. There are indications, however, that the passage of the water-power bill at the last session of Congress is stimulating hydro-electric development in this country. Up to September 19 the Federal Power Commission had received fifty-six applications for preliminary permits and licenses. These applications are being filed from all parts of the country and the power is to be used for a variety of purposes, including mining, irrigation and public utility service.

Don't Forget The Time Element

A GREAT many persons by losing sight of the time element, are in danger of misinterpreting or of failing entirely to percieve the economic changes that are in progress. They forget that time has passed and time is passing. That is a common fault. It is the chief thing, for instance, that makes an "old fogy" what he is. The passage of time makes less impression upon the older man and he expects events to move less rapidly in keeping with his duller impression. The man who does not become an old fogy is the one who makes allowance for the change in personal equation.

We are in a period of particularly great changes and especially rapid flux by reason of the great war having occurred. The passage of time is especially important as suggestive of the passage from one set of conditions to another set and still another. What many men neglect to allow for is the fact that almost two years have passed since the Armistice.

The idea entertained during the war in some quarters that there would be a period of readjustment or a "transitionary period" from war-time conditions to stable peace conditions in the matter of business and the affairs of men generally has been shown to have been altogether erroneous. We are to have continued changes. At the present time there is in progress a downward readjustment in the values of many things. In the case of commodities, the great bulk of commodities is included. In the case of labor, the rates in money per hour or per day do not decline, but the performance increases, and while the labor unions consider labor a commodity to be weighed out simply by time, the fact is that in the long run the workman sells performance, which one may regard as service rather than as a commodity.

There are not a few who shrink from the mere contemplation of such a thing as declines in the prices of commodities. They seem to think it will spoil everything for prices to decline. They forget that almost two years have elapsed since the Armistice. They fail to allow for the progress of time. We have had a period of price advances—and quite a long period considering how rapidly things would naturally move after such great disturbances as the World War could not but produce. It is only natural that at some time prices should decline. During the war the common prediction was that there would be a "period of prosperity" after the war, and some predicted only three years of that. Well, two years have elapsed and they have not been years of real prosperity, which means both progress or advancement and contentment. These things obviously we have not had, and if they were possible in the circumstances that existed they would have obtained. Others, the most sanguine, predicted a period of seven or eight years of "prosperity." Assuming for argument that they were right, a fourth of the period has passed and has been practically squandered. If the fates really do decree that when mankind indulges in a great war with enormous destruction of life and property and great waste of time it shall be rewarded by being given a period of riotous living, how many years of such reward is mankind entitled to receive?

The thing to do is to recognize that the two years have not given us real prosperity and that they represent an amply long period for the experiment. We should be glad to see things change, for any change would be promising of better luck in the next experiment. If we do not have changes, if we do not try various means of arriving at real prosperity, we might as well take it that the world has gone to the dogs to stay there.

First in War, First in Peace, and First (?) in the Hearts of the Congressmen

THE Chemical Warfare Service is undertaking a most desirable public responsibility when it seeks to apply during peace time some of the important results of its military preparedness. The chemist can do well to follow the various activities of this Service, for doubtless much of its effort will prove to have immediate commercial application as well as the military value primarily sought. In this connection it is interesting to note the efforts toward rat extermination with poison gas, the possibility of poison-gas bombs being used in the capture of criminals who have barricaded themselves in inaccessible places and the destruction of grasshoppers and other pests by appropriate offensive gas preparations. These, of course, have a popular as well as a technical interest.

To the chemical industry it will be more interesting to consider the proposal that the stocks of war-gas materials be used industrially to a certain extent each year. By this plan it is hoped that the facilities and equipment of the Service may each year be actively in use on a small scale and thus be more easily maintained up to date and in operating condition. The sale of 25 per cent of the reserves of chlorpicrin and phosgene each year is one of the specific suggestions to this end which would permit co-operation of the Chemical Warfare Service with the dye interests. Numerous other means of co-operation will suggest themselves also.

It is certain that these efforts will afford a most encouraging element upon which to base our support of the needed increases in financial backing for the C.W.S. Congress will doubtless be asked to appropriate considerable sums next winter to augment the facilities for additional research work needed. If the chemists diligently study the opportunities for peace-time service of this branch of our military organization they can most enthusiastically and effectively support these requests. Our profession is signally recognized by the maintenance of this branch of the Army and it is a responsibility of the profession to support the Service accordingly. The proposed advisory committee of chemists which the American Chemical Society is to appoint to work with the C.W.S. will be one medium through which our support may be afforded, but an individual responsibility of chemists is equally important, especially wherever there is opportunity for industrial application of or co-operation in C.W.S. activities.

Readers' Views and Comments

College and University Finances

To the Editor of Chemical & Metallurgical Engineering

SIR:—All our educational institutions have recently felt the pinch of limited resources, and many have made strenuous efforts to raise large endowments, intended for the most part to increase the salaries of the teaching staff.

This whole idea is essentially undemocratic and un-American, so long as the colleges and universities do not make a charge for tuition equal to its actual cost. As long as this condition exists, increased endowments to make up the deficit are in the nature of charity and tend to pauperize the beneficiaries—i. e., the students or their parents paying their tuition.

At the present time no one of these institutions has stamina sufficient to charge for tuition its actual cost. Rich and poor alike are charged the same, an average of about one-half the actual cost. Neither the rich nor the poor are informed as to the actual cost being double the price charged, and the rich are not even invited to pay the cost.

No one with the true American spirit wishes to educate his children at less than its cost, if he is able to pay the cost. But our universities proceed on the tacit assumption that the preceding statement is untrue, that the American parent always wishes to get the education at as low a figure as possible and to avail himself as far as possible of the endowment funds which charitably disposed persons have contributed to assist the colleges in their work. I am firmly convinced that this tacit assumption is the one that is totally false; that the American spirit recoils from accepting charity and prefers to pay the proper price and preserve its self-respect.

One result of the charge for tuition being placed at only a fraction of its actual cost is that the more students in attendance the greater is the strain on the institution's finances, the more endowment is needed to meet the deficit, and, in general, the more the institution has to plead poverty and to cut to the lowest possible figure all expenditures, such as salaries of the teaching staff, etc. Our institutions being of late notoriously overcrowded, it results that the greatest sufferers are the teaching force, the restricting of whose salaries is the chief avenue open for economy. We can say with almost absolute truth that rich men's children are being educated in our colleges at half price largely at the expense of the teaching staff, whose salaries must be restricted to the minimum if the institution is to make ends meet.

Is the proper remedy for this condition to appeal to wealthy patrons generously to donate large endowments whose income shall go to increasing salaries of the teachers? Is this not adding insult to injury? It surely should appeal to level-headed business men rather to solve the question by making the charge for tuition its cost, which would then be paid by all able to pay it. In this way, the parents do not receive charity from the institution's endowment in the form of tuition for their children at half its cost; neither are the teaching staff receiving living wages from endowment provided by generous and wealthy patrons.

What is needed is a return to normal, healthy business methods in the running of our higher educational institutions, and to give the independent American the chance to pay for what he is getting. Departure from such a principle causes most lamentable confusion, plainly evident to those who will study the subject dispassionately and sanely.

The writer is a university professor, receiving as salary only a fraction of what his services would command industrially; the same is true of my assistants. The university could pay me and my assistants increased and more proper salaries if full cost of tuition were paid for those students whose parents are able to pay it. Out of whose pockets, then, is this deficit coming? It is a fallacy to consider it as coming from endowment; it really is extracted, under present circumstances, from the salaries of the teaching staff. The well-to-do parents should be given the opportunity to right this wrong, and the proper remedy is to make the charge for tuition equal to its cost.

The only valid argument against this innovation is that it will prevent large numbers of worthy students from getting an education because of inability to pay the cost. It may be admitted at once that under the proposed new charges, more students will be unable to pay the charge than at present. But that is not an insuperable difficulty. At present, no worthy student who shows good scholarship is turned away for inability to pay tuition. He either gets a scholarship, intended to help just such men, or else he is granted "deferred tuition" for a half, a quarter, or all the tuition charge. This means that he pays what he can, and the college lends him the rest, he promising to repay it, without interest, as soon after graduation as he is able. This is the right and proper use of endowment funds; to help those who need help, and not foolishly to waste it on those who need no help and can pay the full cost of tuition.

Adoption of the proposal to make the tuition charge the full cost of tuition would liberate endowment funds now misapplied and turn them into the proper channel of assistance to worthy students not able to pay the cost. No worthy student need then be turned away, there are all grades of financial ability and disability among students; no one would be asked to pay more than the mere cost, no matter how rich he or his parents. For the fraction unable to meet this very reasonable requirement, the endowment funds should be wisely appropriated, so as to make up the difference between cost and the students' ability to pay. Most of this would come back to the institution a few years after the recipient graduated, and thus the endowment funds would not be diverted but largely returned.

Concrete application of this abstract principle will show that it is practicable and financially sound, as well as being ethically far superior to the present antiquated and absurd system. Adoption of the system advocated will put endowment to work in its proper channels,

will increase the self-respect of the students, who will feel that they are not objects of charity when the cost of their tuition is being paid, will increase the self-respect of the American parent who pays the full cost of his children's education, will enlighten the financial burdens of the institution by making income more nearly proportional to expenses, and will enable the institution to apply the sums saved to the increase of salaries of the teaching force, where they properly belong, and whence they are at present being unwisely and unnecessarily diverted.

Are endowments made to higher educational institutions intended to help educate well-to-do peop'e's sons at half cost, or to help educate those unable to pay the simple cost of their education? Should the compensation of the teaching staff be restricted to less than proper living salaries to make it possible to educate well-to-do people's children at half the cost?

Lehigh University, South Bethlehem, Pa. JOSEPH W. RICHARDS.

Massachusetts Institute of Technology School of Chemical Engineering Practice

To the Editor of Chemical & Metallurgical Engineering

SIR:—The School of Chemical Engineering Practice of the Massachusetts Institute of Technology, which was started in 1916-17 and then discontinued on account of the war, has been reopened. The work of this school is part of a 5-yr. course in chemical engineering offered by the Institute and consists of twenty-four weeks' field work at three chemical engineering practice stations. These stations are located at Bangor, Me., Everett, Mass., and Buffalo, N. Y. The plants co-operating with the Institute in this important educational work are the Eastern Manufacturing Co., manufacturing electrolytic bleach, sulphite pulp and writing papers; the Penobscot Chemical Fibre Co., Oldtown, Me., manufacturing soda pulp; the Revere Sugar Refinery, Charlestown, Mass.; the Merrimac Chemical Co., Everett, Mass., producing heavy chemicals; the Boston Rubber Shoe Co., Malden, Mass., the Lackawanna Steel Co., Buffalo, N. Y., and the Larkin Co., Buffalo, N. Y., manufacturer of soap, etc.

In the practice school the students study the various unit chemical operations such as filtration, evaporation, combustion, etc., on full-scale apparatus and under practical working conditions. Sometimes this is accomplished by actually working with the operating men, and at other times by running a full-scale test to determine either the efficiency of the equipment or process, or to find optimum conditions of operation. Such tests are always carried out under regular factory conditions without interfering with the quality or quantity of the output and are along lines which are of interest to the co-operating companies. Work at the Bangor station includes investigations into the production of chlorine and bleach, the absorption of SO_2 in the manufacture of bisulphite liquor, the efficiency of quadruple effects evaporating caustic soda solutions, etc. Work of similar character but along different lines is carried out at the other stations.

The students will complete their work in the practice school at the end of December, and will then return to the Institute for two terms of advanced study. This advanced work is wholly elective and enables the student to specialize in that line of chemistry or engineering in which he is most interested. In the choice of courses and in the viewpoint toward this advanced work, the student will be greatly benefited by the practical plant experience he receives in the field work of the practice school.

There is one important difference between the School of Chemical Engineering Practice and other co-operative engineering courses, where the student is regularly employed for part of his time in the factory, and the remainder is spent in class room and laboratory work at the college or university. This difference lies in the fact that instead of being on routine factory production work, as is customary in such courses, the student in the School of Chemical Engineering Practice is always under the direct charge of a resident faculty member at each station and the student's work is so planned that he shall obtain the greatest possible benefit from the time spent in the plant.

Two matters which have occupied considerable attention in scientific and engineering circles are the education of future engineers and the establishment of closer relationship between the work of the university and that of industry. In the School of Chemical Engineering Practice, progress along both of these lines has been made, and a great forward step taken in the sound, rational education of the Chemical Engineer.

Cambridge, Mass. R. T. HASLAM, Director.

Self-Contained Engineering Journals

To the Editor of Chemical & Metallurgical Engineering

SIR:—With so many highly-specialized engineering journa's in the field, a reader who wishes to keep in general touch with engineering has to do as Thomas Edison does and read them all. A recent magazine article (was it in *Engineering and Contracting*?) reported that Edison reads regularly fifty-two technical periodicals. Even then the average reader is bound to miss much that he would like to see, and he really cannot expect anything else. The best that he can do is to find the majority of the best articles that discuss his particular hobbies.

For instance, a reader interested in the cyanide process for gold ores can find suggestive articles in *Engineering and Mining Journal*, *Mining and Scientific Press*, CHEMICAL & METALLURGICAL ENGINEERING, and several of the publications of the chemical societies. Of course, a member of the staff of any one of these periodicals will assert that his particular paper publishes all that is worth seeing, but that is not true. Each paper has its merits.

The point I am getting at is, Why do not the editors of the various engineering journals acknowledge more often that such and such a paper has printed an unusually good article on this or that? The readers undoubtedly would be glad to hear about it, and would credit the editor for his fairness and generosity. Most engineers subscribe to only one technical journal, and would be glad to know from an editorial note that an unusually good article on some particular subject has appeared in another paper, which they could refer to at a library.

In other words, are not engineering journals too self-contained? Are not the editors too chary of praising or acknowledging or even criticizing (good criticism helps enormously) the achievements of other journals? American engineering journals are, if anything, too highly specialized, but why can they not make up for it by passing the news around of something worth while in the other papers? P. B. McDONALD, Assistant Professor of English.

New York University, College of Engineering.

Synthetic Production of Hydrocarbon Fuels

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest Edward G. Acheson's letter in your issue of Aug. 18, p. 268, and while disclaiming much knowledge of chemistry outside of my business, yet, in view of what has been accomplished, the synthetic production of hydrocarbon fuels does not seem impossible.

This leads to the thought that should synthetic hydrocarbon be produced it is more than likely that the fuel will be a simple compound, and not a conglomerate of a dozen hydrocarbons such as we now obtain from the crude, each with its own boiling point and other individual peculiarities that in combination produce most of our troubles with the internal combustion motor.

For example, should it be possible to produce pure pentane, the designing of carburetors would at once be a simple matter, and nine-tenths of our motor troubles would vanish.

I am also led to think that Mr. Acheson is perhaps the one man in this age who by training, accomplishments, physical resources and financial independence is best equipped to tackle the problem.

EDWARD T. BIRDSALL, M.E.

President and Chemist,
The Parker Rust Proof Co.,
Cleveland, Ohio

Nitrogen Fixation in the Soil by Inoculation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am firmly convinced that soils may be profitably inoculated by azotobacter and possibly other large-celled organisms, in order to provide for the non-symbiotic fixation of nitrogen under adequate control, and believe that in time a method will be developed which will economically take the place of commercial nitrogenous fertilizers. However, we have not continued our investigations along this line since the publication of Bulletin 45, but are in hopes of doing so in the near future.

This station does not recommend the purchase of commercial nitrogen for Iowa conditions, believing that by a judicious use of inoculated legume and the proper handling of farm manures the supply may be made adequate. I believe, however, that by a further inoculation with azotobacter at some period during the rotation the excess carbohydrates in the soil may be utilized by these organisms to produce even greater quantities of nitrogen than is produced at present by the symbiotic organisms.

PAUL EMERSON,
Assistant Chief in Soil Bacteriology.

Iowa State College of Agriculture and Mechanical Arts,
Ames, Iowa

Resistance Between Cup and Lip

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial on "Resistance Between Cup and Lip" hits the spot. Several years ago while in Szechuen, China, I saw the wonderful possibilities of a complete industrial development of a backward country and prepared a preliminary survey and suggested plan. American manufacturers would not even consider co-operating with us in the plan; others wanted knowledge of the markets to be sent to them but were not willing to supply any funds to get the needed information.

A company organized to get the information and digest it, proposing same to the right parties, has a big, useful and most interesting field of opportunity.

H. K. RICHARDSON.

Middlebury, Conn

Phosphate Rock Deposits in Morocco

BY JAMES C. MARTIN

THE large and growing demand for phosphate rock and superphosphate fertilizer in Europe justifies the keen interest with which American producers have received rumors of the discovery of additional large deposits of phosphate rock in western Morocco. A shortage of shipping in the Mediterranean has recently prevented the producers of rock phosphate in Tunis and Algeria from shipping from abroad all they could deliver to the docks, but the quantity thus delivered is at best insufficient to supply the present European need. Accordingly, though the discovery of vast deposits of rock phosphate may not afford a means of supplying the demand at once, the adequate working of the deposits and the marketing of their output will furnish additional competition with the American product.

For the information of Americans who are interested in the phosphate industry the following data regarding the deposits in Morocco have been compiled by the Foreign Mineral Section of the United States Geological Survey, Department of the Interior.

France has a mild form of monopoly over the output in Tunis and Algeria and allocates a part of each year's output to other European countries in rough proportion to their estimated needs, taking in exchange other materials required for the manufacture of superphosphate, such as coal, pyrite and sulphur. In addition to her deposits of phosphate in Algeria and Tunis, France controls vast undeveloped deposits in Morocco. These deposits are said to be extremely rich, containing hundreds of millions of tons, worth billions of dollars to France and capable of furnishing considerable aid in rehabilitating her war-depleted treasury. If current reports concerning the high grade and great extent of these deposits are true, France will be in a dominant position in supplying Europe with phosphatic fertilizer. Her allocation of African phosphate in 1919 and 1920 to the countries in Europe and the requirements of those countries are shown in the following table, but on account of the lack of vessels the quantities actually delivered to many countries in 1919 were only fractions of the quantities allocated.

PHOSPHATE REQUIRED IN EUROPE IN 1919 AND 1920 AND FRENCH ALLOCATION OF AFRICAN ROCK FOR THOSE YEARS*

	Required		Allocated		
Country	Tons	Per Cent†	Tons	Per Cent†	Per Cent of requirement
France	1,100,000	42	700,000	50	64
Italy	600,000	23	355,000	25	59
England	400,000	15	247,600	18	62
Spain	200,000	8	73,600	5	37
Belgium	100,000	4	3,600		4
Netherlands	100,000	4			....
Portugal	50,000	2	14,700	1	29
Scandinavia	40,000	2	.		....
Switzerland	10,000	...	5,500	....	....
	2,600,000		1,400,000		54

*Adapted in part from *American Fertilizer*, vol. 52 (1920) p. 140.
†Nearest whole number

The intensification of agriculture in the countries recently at war will create a large demand for phosphate, and the exploitation of the Moroccan deposits will undoubtedly disturb the American phosphate industry. At present, however, European consumers cannot obtain more than a fraction of the phosphate they need from America.

The Flow of Oil in Pipes—I

A General Method for Determining the Friction Loss of Any Liquid From Its Saybolt Viscosity; With Tables for Pipes From One to Six Inches in Diameter

BY ARTHUR C. PRESTON

THE following discussion of the flow of viscous liquids in pipes aims to develop a method for determining friction loss as a function of the viscosity and density of the liquid. The viscosity may be taken either in absolute units or as the time of flow through any commercial instrument which can be accurately calibrated with respect to the absolute unit. The appended tables are based on viscosity-seconds as measured by the Saybolt Universal Viscosimeter, because that is the standard of viscosity measurement most frequently employed in commercial practice, and it is thought that in this form the tables will be found most generally useful.

The present discussion relates primarily to the flow of mineral oils, but the method is general and may be applied to any other fluid.

The most accurate and important part of the experimental data on which these conclusions rest is the work of other investigators, although it is corroborated in all essential points by the results of a fairly extensive series of experiments on the flow of oil in wrought iron pipes which the writer carried out several years ago at the University of Colorado. The writer's part in the present instance has been chiefly to correlate and adapt the work of others, so as to put the whole in familiar and convenient form for use in general engineering design.

FACTORS AFFECTING RATE OF FLOW OF LIQUIDS THROUGH PIPES

The rate of flow of a liquid moving through a pipe under a gravity head is influenced primarily by three characteristics of the liquid itself—namely, the density, which supplies the pressure producing flow; the viscosity, which retards flow; and inertia, which under certain conditions manifests itself in the dissipation of energy by the collision of eddying particles. These three constitute what may be called the internal group of factors affecting flow; the other factors, such as the diameter, length and roughness of the pipe, and the amount of the gravity head, may be called the external group; and the latter, although of great importance in their bearing on the final resultant flow, are secondary in the order of consideration of the problem as a whole. Any or all of the external factors may in practice be varied at will, and the resultant flow will respond to these variations according to laws which may be experimentally determined and analytically stated; but underlying all the observed phenomena are the fundamental limitations to flow imposed by those inherent properties of the liquid which have been described as the internal group.

It is essential to grasp this distinction clearly at the outset of any attempt to consider the general problem of liquid flow, because it is entirely lost sight of in the account of hydraulic theory which is commonly made available for engineering study and reference. In the presentation of that theory the factors of the internal group are usually entirely neglected. They are left out of consideration because they are nearly constant for water at ordinary temperatures, and the laws deduced from hydraulic experiment are only those which exhibit the influence of the external group. Hydraulic flow is a very special case of liquid flow; hydraulic theory is not at all an exposition of general liquid theory, but applies only to such liquids as have the same density and viscosity (or more accurately the same ratio of density to viscosity) as water; and indeed the laws as usually stated apply only to a limited range of velocity even for such a liquid.

Hydraulic tables do not furnish a satisfactory basis for estimating the flow of any other liquid, even when the internal characteristics of the latter are known; but when the general solution for the problem of liquid flow is obtained it takes the place of hydraulic formulæ and gives the same results, simply by substituting in the general formula the physical dimensions of the pipe and the values for the particular density and viscosity of water.

DATA FROM RESEARCH INVESTIGATIONS APPLIED IN PRACTICAL FORM

Experimental work leading to this general solution has been carried on in recent years by numerous investigators, influenced greatly, no doubt, by the rapid development in the use of mineral oils in the industries and the consequent need of rational methods for designing oil piping. Out of a number of valuable researches which have been published, each contributing to some phase of the question, two in particular have seemed to cover the ground most satisfactorily; these are two series of researches on the flow of air, water and oil in pipes, conducted and published by the British National Physical Laboratory,[1] which have not had wide currency in this country. Just after the publication of these came a third work, the standardization of the Saybolt Universal Viscosimeter, by the Bureau of Standards,[2] which taken in conjunction with the theory developed in the two first mentioned has made it possible to adapt that theory to practical form for the use of engineering designers. From these sources, whose conclusions are confirmed by the work of many other experimenters, it has been possible to compile the tables which are presented herewith, showing the discharge for a given pipe and head, for liquids of any density and viscosity, simply by reference to the time

[1]Collected Researches, National Physical Laboratory, Teddington, England, Stanton and Pannell, vol. 11, 1914, and Pannell and Higgins, vol. 13, 1916.

[2]Winslow H. Herschel, Bureau of Standards, Technologic Paper No. 112, Washington, 1919.

of flow through a standard commercial viscosimeter. It is believed that the first published tables of this form were those offered by the writer in his report of the work done at the University of Colorado, which are now superseded by the more accurate tables given in this article.

The method of developing the process was briefly as follows:

It had been demonstrated[1] that in a given pipe at constant velocity, the head lost in friction is the same for all liquids which have the same ratio of density to absolute viscosity. This was substantiated by experiments on large and small pipes, at high and low velocities, with fluids of such varying viscosity as air, water and oil. The general relation between these factors had been derived, so that only a knowledge of the values of density and viscosity was required to make it available for the solution of any given problem.

Second, the standardized Saybolt Universal Viscosimeter had been calibrated[2] so that it could be used as a means of determining these values, and this work had shown that liquids having the same ratio of density to absolute viscosity have the same time of flow through the Saybolt instrument.

As a result of the foregoing, the conclusion is drawn that liquids of equal Saybolt viscosity have equal pipe friction losses, and means are given for computing friction loss from Saybolt viscosity as primary data. To this are appended tables, which have been computed for convenience of reference.

KINEMATIC AND ABSOLUTE VISCOSITY

Viscosity may be defined loosely as the internal friction of a moving liquid. In set terms, it is the force required to move a plane surface of unit area past another at unit distance, at unit rate of speed, the space between being filled with the viscous liquid. Various means may be devised for measuring this force; as, for instance, by dragging a solid body with flat surfaces through the liquid and noting the pull exerted; but the form of instrument most frequently used consists of a tube of narrow bore and relatively great length, through which the liquid moves under a small gravity head at low velocity, so as to prevent eddying. The moving body may be considered as made up of an infinite number of concentric cylindrical films of infinitesimal thickness, all moving forward along the axis of the tube. The outermost film wets the wall of the tube and sticks fast there; the next film slips or shears over the first at a rate which depends on the viscous resistance of the fluid; and so on to the center filament, where the motion is fastest. The resistance to slipping of one film surface over another, which corresponds in some degree to the phenomenon of friction between the surfaces of solid bodies, is the measure of the viscosity of the liquid. It is evaluated by integrating the sum of all the resistances from the circumference to the center of the tube, and equating this sum to the pressure due to the gravity head, less the velocity head, since all the pressure, except the small amount which appears as kinetic energy, was used up in overcoming the slippage resistance and consequently is equivalent thereto. The method will be found fully explained by Archbutt and Deeley;[3] and is the basis of the design of the Saybolt and similar flow-type instruments. The mathematical expression for the absolute viscosity is

$$\mu = \frac{\rho g r^2 h}{8 v l} \qquad (1)$$

Where ρ = density in grams per c.c., or pounds per cu.ft.

g = gravity = 981 cm., or 32.2 ft. per sec. per sec.
r = radius of tube in centimeters or feet
h = head in centimeters or feet
v = average velocity of flow in centimeters or feet per second
l = length of tube in centimeters or feet.

This gives μ, the coefficient of absolute viscosity, in dynes per sq.cm. or in poundals per sq.ft., according to the system of measures employed. The equation applies only to the condition of steady or non-eddying flow.

The conversion factor between the two ways of expressing absolute viscosity is 14.9, by which the c.g.s. value must be divided to give the English equivalent. For most purposes it is more convenient to deal with the ratio. $\frac{\mu}{\rho}$, which is called the kinematic viscosity and is the quantity measured by commercial flow-type viscosimeters. The conversion factor for kinematic viscosity is 929.03, by which the c.g.s. value must be divided. The c.g.s. system certainly is more convenient for laboratory use, and is adopted in most of the investigation and literature of viscosity; but in the present case it is necessary to use the English units in order that the theory as developed may be applied directly to our everyday practice of making measurements in that system.

EDDYING FLOW

From the form of equation (1) it may be seen that for the condition of non-eddying flow, the relations of the governing factors are very simple; and this kind of flow characterizes many cases of practical interest, particularly with small pipes or with liquids of high viscosity. Since the rate of variation of all these quantities is linear, it follows that, if the friction loss for a given combination of factors be known, the loss due to any variation in these factors may be deduced by simple proportion, throughout the range in which the equation holds good; or, the loss for any case may be determined by substituting the proper values for viscosity and density in the equation. Further, it is seen that when the pipe dimensions and velocity are constant, friction losses are equal for all liquids having the same kinematic viscosity. Now it will be shown later on that liquids of equal kinematic viscosity have the same time of flow through a Saybolt or other viscosimeter of similar type; from which it follows that liquids of equal Saybolt viscosity have equal friction losses, at least throughout the range of velocity in which flow is steady, and, as will be demonstrated, for all higher velocities also.

This relation then might have been of considerable use to pipe line designers in the past, but for two principal facts; first, that designers rarely have means for determining absolute viscosity, and even if they know the Saybolt or other commercial viscosity of the liquid with which they deal, they do not know how to convert it to units of absolute viscosity; second, that equation

[3]Archbutt and Deeley, "Lubrication and Lubricants," Griffin & Co., London.

(1) applies only to a limited range of low velocities, and breaks down entirely at the point where eddying begins, leaving the friction loss at all higher velocities to be determined by methods which until recently were not thoroughly studied or understood.

If a liquid be set flowing in a pipe at a low but steadily increasing velocity, the phenomena at first are those of the steady flow which has just been described, the increase of friction head being linear or as the first power of the velocity. When a certain rate of flow is reached a sudden change occurs, and equation (1) no longer holds. This new régime begins with a brief period of uncertain flow, during which friction loss increases at a much greater but variable rate, until when another definite velocity is reached a second sudden change occurs, and friction loss thereafter increases regularly, but more slowly than in the preceding stage. If the smoothness of the pipe is equivalent to that of drawn piping, the rate of increase is approximately as the 1.74 power of the velocity. This is the régime of eddy flow.

Critical and Post-Critical Velocity

The point at which the first change occurs is quite definitely fixed by the relations of viscosity, density and diameter of pipe. It is determined by the so-called Reynolds criterion,

$$\frac{v\rho d}{\mu} = R \tag{2}$$

where R is a number which undoubtedly varies somewhat with the roughness of the pipe, but which for smooth drawn pipe or tubing is quite accurately equal to 2,050. The point at which the second change appears is fixed in the same way by another value of the same expression, which for want of a better name may be called the post-criterion, where R for the same kind of pipe equals 2,900. The velocity at the first point is called the critical velocity, and that at the second point may be called the post-critical velocity.

The explanation of these changes, as was developed by the work of Osborne Reynolds,[4] is that at the critical velocity the steady or stream-line flow of concentric cylinders sliding over each other is broken up, and the particles of liquid begin to eddy and whirl, using up in the friction and impact of collision the extra head which makes its appearance at that point.

Mathematical Analysis of B. N. P. Lab. Data

A graphic illustration of the relation of velocity to friction head, embodying the phenomena described in the foregoing paragraphs, is given in Fig. 1, in which part (a) has been plotted directly from the data sheets in the published report from the National Physical Laboratory, for an oil of kinematic viscosity 0.00011474 —about 62 seconds Saybolt—flowing in a 3-in. drawn steel pipe. The friction head in feet per hundred feet of pipe is plotted against the velocity in feet per second, by the familiar method of logarithmic plotting—that is, not the quantities themselves but their logarithms are plotted against each other. The points are found to fall on straight lines, whose slopes are the exponents of the variables in the equations which express the relation of h and v; for if m be the slope of the line and C its intercept on the axis of abscissas, then $\log h = m\ (\log v - C)$. Taking C as the logarithm of some constant A,

$$\text{Log } h = m\ (\log v - \log A);\ \text{or,}$$

$$h = \left(\frac{v}{A}\right)^m = Kv^m \tag{3}$$

so that each of the three broken lines of which the graph is composed represents a condition of flow in which h varies as some power, m, of v. The lower part of the graph represents the region of steady flow, and the slope of the line is 1.0, confirming the statement that the variation in this region is linear, or as the first power. The upper part of the graph represents the region of eddy flow, where the slope of the line is 1.74, and the friction head varies as this power of the velocity. The intermediate line represents the region of uncertain flow, where the points as plotted do not suffice to determine the slope of the line, and where in fact successive experimental determinations cannot be made to agree. The line which has been drawn as the average locus of points in this region runs from the value of log v which makes $\frac{v\rho d}{\mu}$ = 2,050 (Reynolds criterion) to that which makes it equal to 2,900; these values of R are mean values from all the experiments

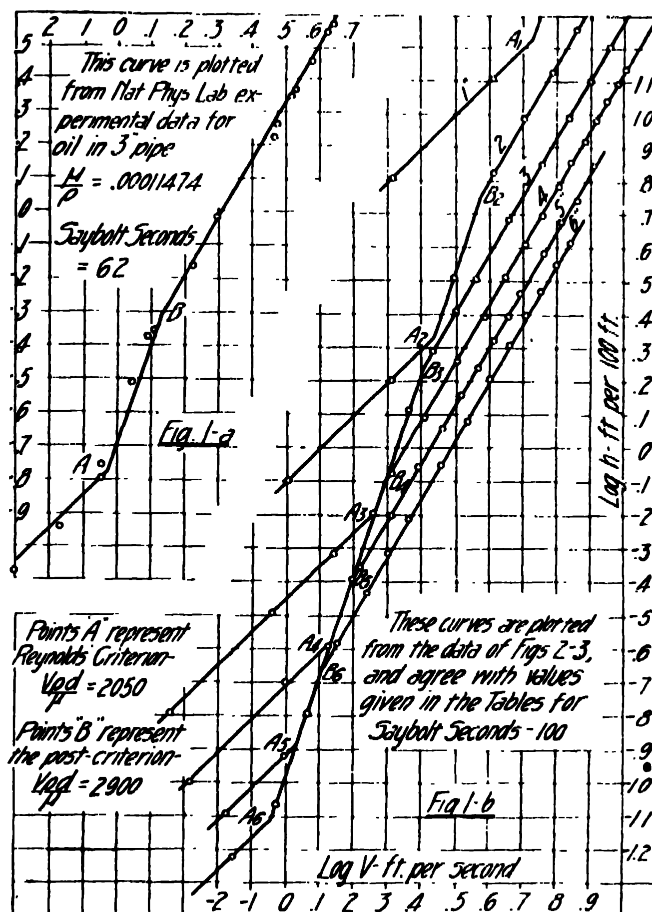


FIG. 1. RELATION OF VELOCITY TO FRICTION HEAD

on which the report is based, and they make the slope of the line equal to 3.0, so that h in this region varies approximately as the cube of v. It must be remembered that the variation here really is indeterminate, the flow being apparently unstable. The matter is of little practical importance because the uncertainty extends only over the short range from the critical velocity to a velocity about 1.41 times as great; the important matter

[4] *Phil. Trans. Royal Soc.*, vol. 174, p. 935 (1883); vol. 186A, p. 123 (1895).

is to know that the friction head will vary as the first power of the velocity below the point where $R = 2{,}050$, and as the 1.74 power above the point where $R = 2{,}900$.

In Reynolds' opinion, the fact that these changes occur suddenly instead of developing gradually indicates that the whole régime of steady flow is unstable. From this point of view we may suppose that when the break does come, the friction head increases in the erratic and rapid manner noted in order to gain the régime of eddy flow as quickly as possible; attaining this point, as we have seen, by the time the velocity has increased sufficiently to make $R = 2{,}900$.

Calculation of Friction Head

We are now in possession of a crude method for calculating the friction loss of any liquid in pipes of smoothness equal to that of drawn-piping, provided we can find means to determine the kinematic viscosity of the liquid—that is, the ratio $\frac{\mu}{\rho}$, for substitution in the foregoing formulæ. We can compute, from equation (2), the value of v_1 which makes $R = 2{,}050$. Then from equation (1) we can find the value of the corresponding h_1, and we know that for all lower velocities the value of h decreases directly as the velocity, or

$$h_1/h_0 = v_1/v_0 \qquad (4)$$

Next we may compute the value v_2 which makes $R = 2{,}900$, and we know that

$$h_2/h_1 = v_2/v_1 \qquad (5)$$

The same ratio of variation holds for velocities between v_1 and v_2. Finally, for any higher velocity v_x we know that

$$h_x/h_2 = v_x^{1.74}/v_2^{1.74} \qquad (6)$$

This would indeed be a bungling method, and liable to error both from the magnification of slight inaccuracies in the work and from the fact that the last exponent does not continue equal to 1.74 for the very highest velocities, nor for great changes in roughness, although it is sensibly so for all cases of practical interest. But it is worth while to note the possibilities of this method because it really offers a more complete analysis of the problem than the simpler and more convenient process to be described later, on which the tables are based.

Relations of Saybolt to Kinematic Viscosity

From what has been said about the determination of viscosity, it may be seen that any long pipe, even a pipe in industrial service, could be used as a viscosimeter if observations could be made on it with sufficient accuracy, the velocity being kept low enough to avoid eddying. For physical laboratory use this condition is obtained with tubes of capillary fineness, and correspondingly refined methods of observation; while in the commercial laboratory instruments are used which are somewhat simpler in construction, although based on the same principle, such as the Engler, Redwood and Saybolt Universal, the latter being the one most in use in the United States.

The Saybolt instrument consists essentially of a smooth vertical efflux tube, 1.225 cm. long and 0.1765 cm. in diameter, through which it is intended that steady or non-eddying flow shall take place. This tube is surmounted by a vertical cylindrical container, 2.975 cm. in diameter and about 9.7 cm. long, connected to the upper end of the efflux tube by a converging section about 1.575 cm. long. The upper container holds a little more than 70 c.c. and the whole is surrounded by a water bath to maintain a constant temperature of the liquid in the container. The determination consists of filling the container with the liquid under investigation, and letting 60 c.c. run out through the tube into a graduated vial, noting the time of flow required in seconds.

Referring to equation (1), we see that a constant average head, h, and constant values of r and l are assured by the construction of the instrument, and the time of flow of course is proportional to v; consequently if the flow were truly steady, the kinematic viscosity, $\frac{\mu}{\rho}$, would be truly proportional to the time of flow or so-called Saybolt seconds. But the instrument is faulty, in that for liquids of low viscosity the flow is not steady, but eddying, so that the Saybolt seconds are no indication of true viscosity. There are also other sources of error, chief of which is the resistance to flow offered by the surface tension of the drop as it forms on the end of the efflux tube. The kinetic energy or velocity head of the flowing liquid also ought to be allowed for and subtracted from the total average head. The net effect of these and other inaccuracies of the method is to make the time of outflow for liquids of low viscosity enormously greater than it would be if the flow were steady, and entirely out of proportion to the true viscosity.

Prof. Flowers[5] tells us that in designing the original Saybolt instrument it was intended that the length and diameter of the tube should be such as to assure the condition of steady flow for water, which was to be used as a standard. This may have been true of the form of the instrument first used, but it is not true of the present, called the Universal, instrument. For this the time of flow of water is about 31 seconds, while the errors above described are serious for all liquids up to those which have a Saybolt time of about 250 seconds. The comparison with water, therefore, should never be looked upon as having any relation to the true viscosity of another liquid, and is in no way an indication of the friction loss to be expected in handling that liquid in pipes. When the time of flow is above 250, however, the errors are not so serious and the Saybolt seconds vary almost exactly as the kinematic viscosity.

Calibration of Saybolt Viscosimeter

The only way, then, to get true viscosity readings from a Saybolt viscosimeter is to calibrate the instrument by the use of liquids of known viscosity previously determined by physical laboratory apparatus; and this calibration will apply only to the particular instrument for which it is made, because not all of these instruments are of accurately similar dimensions. To overcome this difficulty, the Bureau of Standards has published, in the work referred to, an account of an agreement with Mr. Saybolt whereby certain definite dimensions are hereafter to be used and considered as characterizing the standardized Saybolt Universal Viscosimeter; and the same paper gives the calibration of this instrument, by means of which the

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[5] American Society for Testing Materials, *Proceedings*, vol. 14, 1914, p. 565.

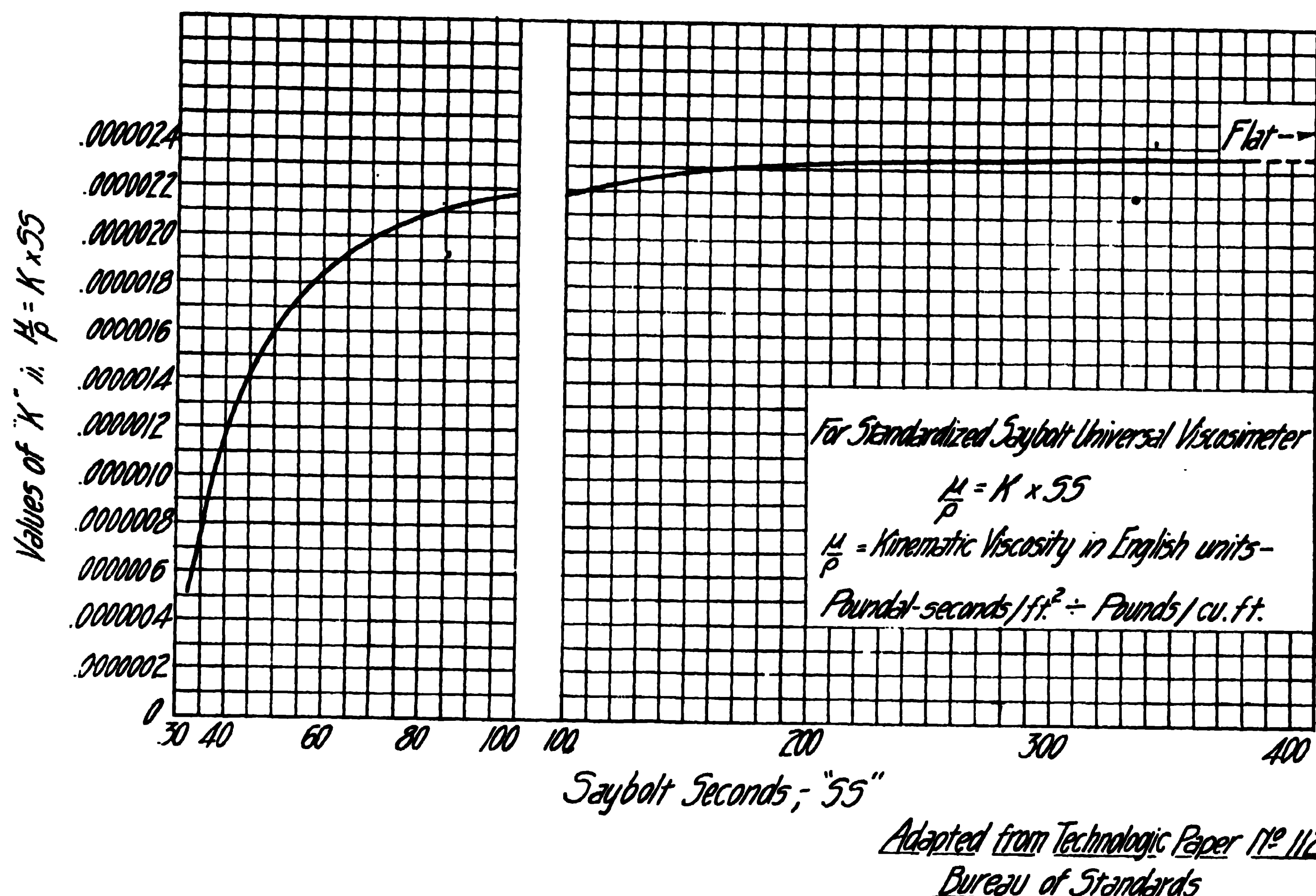


FIG. 2. RELATION BETWEEN SAYBOLT SECONDS AND KINEMATIC VISCOSITIES

kinematic viscosity of a liquid may be known from its Saybolt seconds; thus providing us with a practical means of completing the method of equations (1), (4), (5) and (6) for computing pipe friction loss as a function of the kinematic viscosity.

In the publication of the Bureau of Standards, the calibration is given as an equation and also in the form of a table, the values being in c.g.s. units. In Fig. 2 of the present paper the table is put into graphic form, the values being converted to English units. The curve is used by entering with the Saybolt seconds, from which a conversion factor is found, by which the Saybolt seconds must be multiplied to give the kinematic viscosity.

It will be seen that this work is of the greatest value in investigations of the kind with which we are concerned. The determination by the Saybolt instrument is very easily made; the refiner or seller of mineral oils can always give the Saybolt viscosity at any temperature which the user may assume as governing his particular case. In developing the method for computing pipe friction loss and compiling the appended tables, this calibration has been assumed to apply to all Universal instruments. In making this assumption the fact is not lost sight of that it really applies only to a standardized instrument; but as the standard dimensions and calibration taken were the average for several instruments investigated, it is believed that the error will not be greater than is permissible in computations of liquid flow, and that the convenience and usefulness of having a definite and general means for calculating friction loss will justify the slight degree of approximation involved.

It has been stated above that the method of equations (1), (4), (5) and (6) was developed more for the sake of analyzing the nature of friction loss than as a rule to be followed in practical designing. A more convenient way of exhibiting the same results, although it does not show the fundamental relations of the variables so clearly, is given in the work of the National Physical Laboratory. These experiments were begun for the purpose of determining the frictional resistance of the atmosphere to the passage of an airplane body, the method used being the reverse process of passing air through smooth-walled pipes. The results obtained were so suggestive that the investigations were extended to include a study of water and of oil; then a second series of experiments on the friction resistance of fuel oils carried out for the British Admiralty gave similar results, and finally all available recorded researches on the subject of fluid friction were re-computed and recast in the same form, and were found to be consistent with the rest. The whole investigation covered the flow of air in pipes from 0.361 to 20.0 cm. diameter; of water from 0.361 to 28.5 cm.; and of oil from 3 to 5 in., over a very great range of velocities, all in smooth-drawn brass or steel pipes. The conclusion to which all this work led was that for equal values of $\frac{v\rho d}{\mu}$, values of the friction factor f are always equal in the well-known Fanning formula

$$h = f\,\frac{l\,v^2}{d\,2g} \qquad (7)$$

The curve of Fig. 3 is plotted with values of $\frac{v\rho d}{\mu}$ as abscissas and values of f as ordinates. No attempt

is made to state the relation in mathematical form; it is simply to be scaled from the curve as drawn.

The significance of this is that since for a given velocity and pipe diameter all liquids of equal kinematic viscosity have equal values of $\frac{v\rho d}{\mu}$ and consequently equal values of f, it follows that they have equal values of friction head h. But it has been shown that liquids of the same kinematic viscosity have equal Saybolt seconds; so that it must be concluded that liquids of equal Saybolt viscosity always have the same loss of friction head when flowing at the same velocity in the same pipe. This is a conclusion of very great interest and importance.

It has always seemed probable, from general considerations, that such a relation must exist, but apparently it never before was experimentally and satisfactorily demonstrated. From this fact it follows that if a series of experiments were conducted on the flow of liquids of conveniently varying Saybolt viscosities, the results would serve once and for all as a basis on which to calculate the friction losses of other liquids within the same Saybolt range. But with the aid of the Bureau of Standards calibration it becomes unnecessary actually to carry out such a set of experiments; for we may determine the kinematic viscosity, $\frac{\mu}{\rho}$, directly from the instrument and Fig. 2, and then find the value of f for the desired v and d from Fig. 3; completing the calculation of h by means of the Fanning equation (7). It was by this method that the tables given with this article were computed.

Partly as a matter of interest, and partly as a means of checking up and locating discrepancies, these tables were plotted by the logarithmic method of (a) Fig. 1, and one of the resulting diagrams is shown in (b) of the same figure for a Saybolt viscosity of 100, with pipe diameters of from 1 to 6 in. The plotted points fall very accurately on lines of slope 1.74 above the post-critical velocity, and on slopes of 3 and 1 in the two other régimes of lower velocities. The source of the breaks at critical and post-critical points is clearly seen in Fig. 3, for in that curve, which is the direct record of experiment, it is found that steady flow changes to uncertain flow at the Reynolds criterion, $\frac{v\rho d}{\mu} = 2{,}050$, while uncertain flow changes again to the regular condition of eddy flow at the post-criterion, $\frac{v\rho d}{\mu} = 2{,}900$.

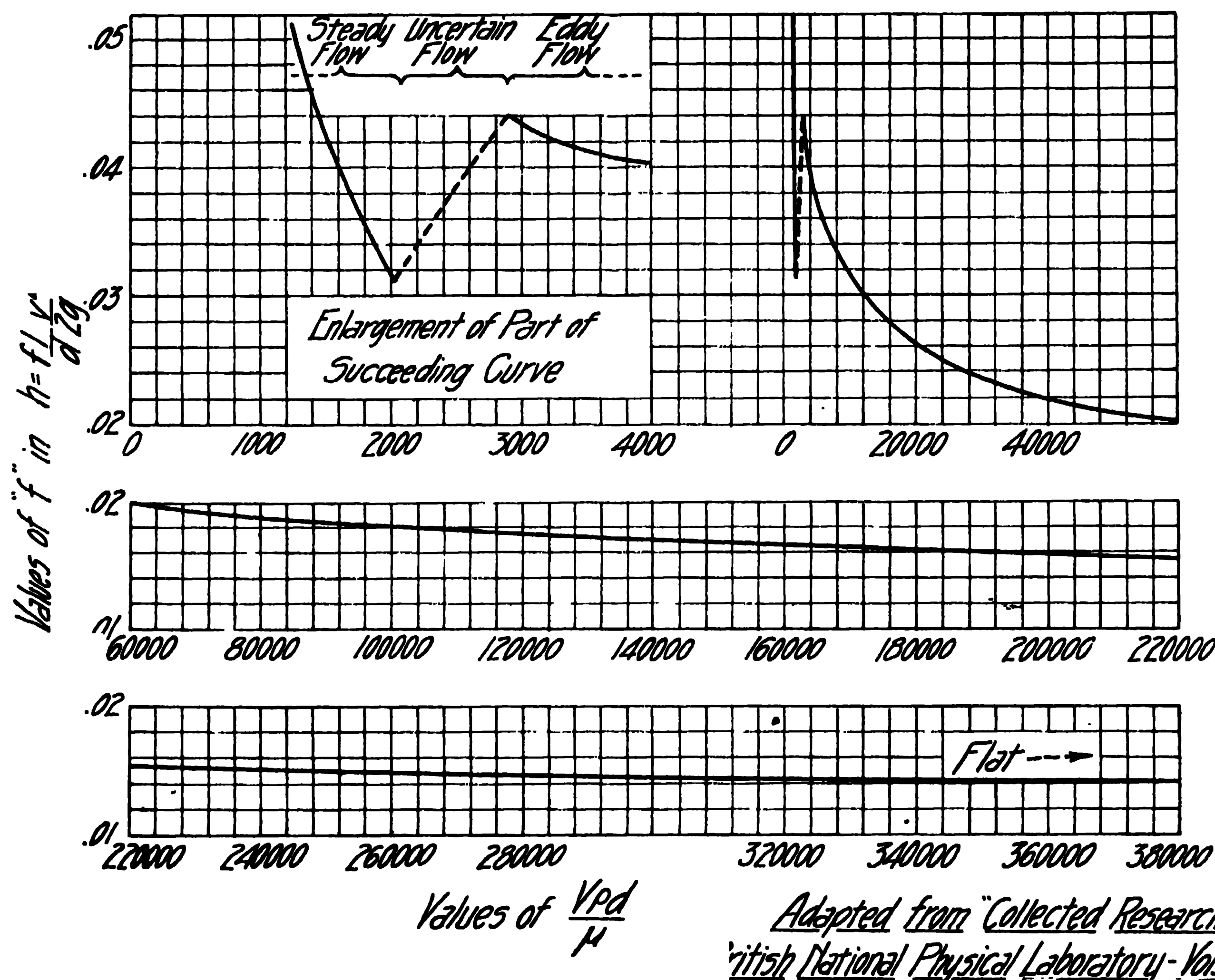


FIG. RELATION BETWEEN FRICTION FACTOR AND $vd/\nu\rho$

The appearance of the first two branches of the curve in Fig. 3 is so irregular as to require some explanation. In the experiments at the National Physical Laboratory, from which the curve was plotted, the method used was to observe all the quantities in equa-

tion (7), and solve for f. This was rational as long as the character of flow was of the regular eddy type, to which alone the equation applies. But the experimenters used the same process when the flow was steady and also when it was in the uncertain régime; so that they were then arbitrarily forcing their experimental values into an equation which does not properly present the facts. In this way they got the values of f shown in the first two branches of Fig. 3, which serve a legitimate purpose in illustrating the fundamental truth that friction loss depends on velocity, diameter and kinematic viscosity, but give an erroneous idea of the true relations of these factors. The same truth is expressed, with reference to the régime of steady flow, by equation (1), which shows equally well that friction loss depends on the factors mentioned, and shows the real nature of the relation; and as a matter of fact, if values of h be computed from equation (1) and then substituted in equation (7) to deduce values of f, these latter will lie exactly on the first branch of the curve in Fig. 3.

Equation (7) itself, although it is perhaps the most generally accepted statement of the law of hydraulic (eddy) flow, is quite likely to mislead the student unless he notes carefully the significance of the coefficient f. This coefficient is not constant, but varies with every variation of v or d. For use with formula (7) it is necessary to provide an extensive table of values of f, showing its changing value over the desired range of velocity and diameter. The general form of the equation gives the impression that friction loss varies as the square of the velocity, but that is not really the case; the variable coefficient f acts to reduce the computed value of h to what it would have been if the exponent of v had been written correctly, its true value being 1.74 for the drawn pipes under consideration, and about 1.80 for wrought and cast iron pipes of ordinary roughness. In the present case, for a constant kinematic viscosity, equation (7) could be written

$$h = F\frac{lv^{1.74}}{d} \qquad (8)$$

in which F varies only with the diameter; or, the formula may be made general by expressing F as a function of d. This is the form which most recent experimenters have used for expressing their results. A formula established at the University of Texas for the flow of water at 68 deg. F. in clean iron pipes up to 3 in. diameter, with velocities up to 3 ft. per sec., was

$$h = 0.00685\frac{v^{1.77}}{d^{1.275}} \qquad (9)$$

where h = friction head in feet per foot and d = diameter in inches.

This formula has been used in connection with the present work for comparison of the results obtained by its use with those obtained from Fig. 3 and equation (7) for the case of water in drawn pipe, as an indication of the amount by which friction loss in wrought-iron pipe exceeds that in drawn pipe.

Equation (9) holds only for the limited range wherein the exponent of v remains constant; this exponent increases noticeably with great increase of velocity, but it remains sensibly constant throughout the working range of practical interest, so that the index relation, while not a complete statement of hydraulic law, serves as a satisfactory working rule.

(Part II will be published in a subsequent issue.)

Report on the Leather Section, Sixtieth Meeting, A.C.S.

In the absence of Dr. Marbaker the meeting was presided over by Dr. A. W. Thomas, of Columbia University.

Nature of the Hide-Tannin Compound and Its Bearing Upon Tannin Analysis

This paper, by Dr. John Arthur Wilson, disproves the contentions of the opponents of the new method of tannin analysis as outlined by Dr. Wilson before the American Leather Chemists Association in Atlantic City. In this previous paper comparative tests showed the official method of the American Leather Chemists Association to be greatly in error, exceeding 200 per cent for typical samples of gambier extract. The much higher percentages of tannin obtained by the A.L.C.A. method for every material examined were attributed to the formation of a readily hydrolyzable compound between the hide powder and a variable fraction of the non-tannins. The chief aim of the opposition in the A.L.C.A. was apparently to show that the low results obtained by the new methods were due to losses of tannin in the manipulation of the methods, but no readily conclusive evidence was offered in support of these contentions. The object of the present work was to investigate these points because they are of great importance not only to this new method but to the theory and practice of tanning itself.

Typical commercial tanning extracts have been chosen for examination ranging in properties from the extremes of gambier and sumac to those of hemlock and quebracho. Two mixtures have also been included, each consisting of a pair of extracts of very different nature.

Extract manufacturers often remove only about 80 per cent of the tannin from the raw materials because in order to get the last 20 per cent they have to extract a large proportion of undesirable non-tannins that would considerably lower the purity of their product. The raw materials used were extracted completely and therefore contain a higher ratio of non-tannin to tannin than the commercial extract, and this, as shown, would increase the error obtained by the American Leather Chemists Association extract.

The results of these experiments show conclusively that prolonged washing is quite without influence upon the values obtained for the per cent of tannin in various materials by the new methods; and, further, that tannin once combined with hide cannot be washed out by any amount of washing that would be practical. Thus the major contention of opponents of the new method is disproved.

It was further found that the non-tannins are capable of undergoing chemical change with the formation of substances capable of tanning. Just what chemical actions are involved in the conversion of non-tannins to tannins must remain a matter of speculation until more data are available. Oxidation, condensation and polymerization may all be involved. It is conceivable that gallic acid might be converted into digallic acid under suitable conditions, and it seems extremely likely that a polymerized form of digallic acid would have tanning properties. A detannized solution which gives no test for tannins can

be made to give a strong test merely by passing oxygen gas through it. Long exposure to air has a similar action. It is evident that the new method furnishes a valuable means of studying the conversion of non-tannins into tannins and might conceivably be applied to a study of the formation of tannins in nature and to the aging of barks.

Experiments were further carried on to show the effect of the time factor in tanning and the aging of leather.

We feel justified in recommending that the new method, or some modification of it, be adopted as a standard to replace the present official method. One modification of the new method for routine control work is to tan the hide powder as usual, transfer it to an alundum thimble, wash it by means of a mechanical arrangement and then dry and weigh it, the increase in weight of the dry hide powder being taken as tannin. No doubt other modifications will suggest themselves as the work proceeds, but the saving of time in the A.L.C.A. method is not sufficient compensation for the errors involved.

Summarizing, tannin once combined with hide cannot be removed to an appreciable extent by any amount of washing that would be practical. It has been discovered that chemical changes are produced in the tan liquor by boiling and evaporating whereby certain non-tannins are converted into substances capable of tanning. Such changes can be followed quantitatively by means of the author's new method of tannin analysis, but not by the official method of the American Leather Chemists Association. The new method gives results which agree closely with tanning practice, whereas the A.L.C.A. method was found to be greatly in error. It is recommended that the new method be adopted as a standard.

The Mechanism of Bating

Dr. John Arthur Wilson also read a paper on "The Mechanism of Bating." The curious process of bating, so little known because of its secret origin, is at least some centuries old. After the skins are taken from the lime liquors, unhaired and washed, they are plump and rubbery, a condition not particularly suitable for putting them directly into tan liquors. The object of bating is to prepare the unhaired skins for tanning, and originally consisted in keeping them in a warm infusion of the dung of dogs or fowls until all plumpness had disappeared and the skins had become so soft as to retain the impression of thumb and finger when pinched and sufficiently porous to permit the passage of air under slight pressure. As a result of investigation the use of dung as a bating material has been replaced in many tanneries by the mixture of ammonium chloride and pancreatin.

The question arises as to whether bating is not simply a means of bringing the skins into a condition of minimum swelling, especially since such a condition would give the skins those physical properties which are widely accepted as indicative of properly bated skins. If this is so it would reduce bating to perhaps the simplest of the tannery processes.

Experiments show that a pure solution of ammonium chloride, of the same concentration and alkalinity as the bate liquor, produces practically the same degree of swelling. Another test was made by comparing the action of ammonium chloride alone with that of a commercial bate, supposedly containing ammonium chloride and pancreatin. This test indicated either that pancreatin was of no practical benefit or else that the commercial bate was deficient in enzymes.

What Rosenthal proved was merely that bating removed almost to completion certain nitrogenous matter from the limed skin, but whether this was elastin or hide substance which had previously been attacked by lime appears open to question. Other investigators concluded that elastin is present only in the grain membrane and that it must be digested before tanning to produce a satisfactory grain, but that the bating of the skin under the grain is not only unnecessary but often undesirable.

We have made experiments to determine definitely the question of the removal of elastin in the bating process by means of photomicrographs of cross-sections of the skin taken before and after bating. Fibers were stained with magenta to make the elastin fibers discernible. Microscopic examination of a piece of skin from the trypsin liquor used showed that practically all of the elastin had been removed, while on a piece treated with ammonium chloride only the elastin was left apparently unaltered. The view of Seymour-Jones that the main body of skin contains no elastin was substantiated.

The value of removing elastin from skins must depend to some extent upon the particular properties desired in the leather. The mechanism of bating evidently consists of two distinct parts: (1) Reducing limed skin to a condition of minimum swelling and (2) digesting the elastin fibers present in the outer layer of the skin.

Nitrogeneous Fertilizer From Tannery Waste Sulphide Liquors

D. H. Kadish presented a paper on "A New Method for the Recovery of Nitrogenous Fertilizer Material From Tannery Waste Sulphide Liquors."

There are two methods of liming—namely, the still and paddle process and the sodium sulphide process. Both methods give about the same result in the finished leather, although the second method is not so foolproof as liming. In the first method hair is recovered, but in the second method it is dissolved. This hair is at present sold on the market for a price that makes it worth while saving, while there is a question of the disposal of liquor in the second method. At the present time this is turned into the sewer, but we believe it may be recovered economically.

The method designed for this recovery consists of a tank into which the waste sulphide liquor is poured and from which it is drawn into an orifice box and subsequently at a pipe connection meets with acids drawn from a similar tank, usually sulphuric or liquor made from niter cake. After the two have joined in the pipe the flow is carried on to a settling tank which contains a slight excess of acid. This settling tank is covered over and has an exhaust port at the top for recovering the H_2S and carrying it to a tower where it may be made into sodium sulphide and reused. The recovery of sodium sulphide is from 50 to 75 per cent of that employed in the tanning.

At the bottom of the settling tank the liquor is finally drawn off, leaving a solid material in the tank which consists of colloids packed down of their own weight. This colloid matter, being changed to triscoids, is shoveled out like dirt. It has a maximum

water content of 10 per cent and may be sold on the market for fertilizer. The plant may be erected to have a capacity of from 3,000 to 30,000 gal. of waste liquor per hour.

The operation of the plant shows that 39 lb. of fertilizer may be recovered per 100 lb. of liquor. This fertilizer has an average content of 12 per cent ammonia and sells at the rate of about $72 per ton. The operation cost is slight. Analysis of the fertilizer showed 11.04 per cent nitrogen or 13.18 per cent ammonia. This plant has been erected at the Pfister & Vogel tannery at Milwaukee and the process is covered by U. S. Patents 1,269,189 and 1,298,960.

Chemical Control of the Tannery

While the paper, "Chemical Control of the Tannery," by F. C. ORTHMANN, came from one of the finest leather laboratories in the United States, it was a mere outline of methods that might well be employed in many laboratories. It is generally a method of keeping records and abstracts for heads of departments with loose-leaf binders, including the analysis of all compounds that are purchased or sold from the tanneries.

Swelling and Falling Off of White Hide in Vegetable Tan Liquors

"The Swelling and Falling Off of White Hide in Vegetable Tan Liquors," by G. D. MCLAUGHLIN and R. E. PORTER, was a paper in which the authors reported an exhaustive set of tests, plotting ten sets of curves showing the action of a hide with lactic, acetic, pyrogallic and gallic acids, together with the calcium compounds of same.

The result showed that vegetable tanning liquor may not be regarded as an entity and that lactic acid is a natural reagent. This latter is good to use in the tannery and the specific amount should be worked out for local conditions. Acetic acid is dangerous in too great quantities.

Excess gallic acid gives a thin, poorly tanned leather.

Lactic acid is particularly good for a mellower in a new tannery starting into operation. The methods of tests have shown that they are good for judging astringency. The samples used were taken from a uniform rectangle cut just above the tail of the hide.

In the discussion of this paper SIGMUND SAXE, of New York, stated that it was one of the best papers he had ever heard on the subject.

The Influence of Non-Tannin Acids on the Tannin Content of Tan Liquors

ALAN A. CLAFLIN made an exhaustive set of tests on chestnut and quebracho extracts and gave the results of his experiments in a paper entitled "The Influence of Non-Tannin Acids on the Tannin Content of Tan Liquors." He expects to continue to cover a series of other extracts. Experiments were presented on the whole series in a half-way state of the work. The author entered a plea for other chemists to also take up this work.

The experiments were based on the action of non-tannin acids—i. e., that sulphuric acid will precipitate tannin and fermentation will cause a loss of tannin. Dilute sulphuric acid causes a heavy precipitate which is not analyzed in the literature at present available. Fermentation changes tannin to gallic acid.

The theory is that tannin anhydrides are formed and analyses were made before and after the addition of the non-tannin acids to the extract solution. The A.L.C.A. method of analysis was used in the first set of experiments. The results of the work with the extracts were tabulated to show the solids and insoluble matter with no acid, with normal lactic acid, with acetic, sulphuric and hydrochloric acid.

The discussion brought out the fact that the results were not surprising, because so-called spruce or lignosulphonic acid from the paper mills gives a clear solution on testing.

The Effect of Concentration of Chrome Liquor Upon the Adsorption of Its Constituents by Hide Substance

ARTHUR W. THOMAS and MARGARET W. KELLY presented a paper on "The Effect of Concentration of Chrome Liquor Upon the Adsorption of Its Constituents by Hide Substance," which is a continuation of the work that Dr. Thomas is carrying on in colloids at the Research Laboratory of Pure Chemistry, Columbia University. This work is being carried out under the funds of the Gallun Co., and all results of work are to be made available to the public. This is just another example of the attitude of a generous manufacturer in making public all research carried out under funds furnished by the company. Such a spirit will go far in the development of our leather industries.

The experiments reported in this paper were conducted to test whether the adsorption from various liquors containing 0.038 to 6.640 g. of chromic oxide per 100 c.c. of liquor, insuring a maximum at concentration of 1.5 to 2.0 g. of chromic oxide per 100 c.c. would not have shown a point of minimum beyond which increasing concentration would have caused greater fixation of chrome if the liquors had been carried to higher concentration. The results of the experiments are shown in Tables I and II.

TABLE I

Number	Gms. Cr_2O_3 per 100 c.c. of Liquor Before Adsorption	Composition of Chromed Hide Powder — Protein per Cent	Cr_2O_3 per Cent	SO_3 per Cent	Ash, per Cent
1	0.0363	98.19	1 30	1 09	1 59
2	0.2881	83 70	7 86	6 07	8 84
3	0 7738	76.63	10 58	8 18	11 82
4	1 5526	75 90	10 85	8 67	12.12
5	3 0853	78 43	10 25	8 89	11 23
6	4 8073	80.17	9 36	8.25	10.09
7	7.3070	83 87	7 85	7 21	8 62
8	9.7267	84 83	5 92	6 12	6 50
9	12 175	89 77	3 86	5 19	4 89
10	14 754	90 67	2 35	4 48	3 82

TABLE II. COMPOSITION OF LIQUORS AFTER ADSORPTION

Number	Grams Cr_2O_3 in 100 c.c.
1	0 0096
2	0 0510
3	0 4464
4	1 2586
5	2 8577
6	4 7387
7	7 4350
8	10 0215
9	12 5820
10	15 4000

The values obtained show removal of hydrogen ion from the liquors up to the solution of concentration of 7.4 g. of chromic oxide per 100 c.c., beyond which the curves join and run together, indicating that if hydrogen ion was removed it was so slight that the buffer action of the chromic sulphate could take care of it.

The authors concluded that on experience to date the reaction between chromic sulphate solutions and hide substance is chemical and not physical. If the adsorption were a simple physical process—namely, merely a partition of the chromic oxide and sulphuric acid between the solid hide substance phase and the solution phase—the curve should follow Henry's law, $C_1 = kC_2^n$, which is parabolic in shape. As the experiments show, the curve begins to slope downward after the concentration of the liquor exceeds approximately 25 grams of chromic oxide per liter in the solution of the composition $Cr(OH)SO_4$.

Dyes as Used in the Leather Trade

"Dyes as Used in the Leather Trade," by P. R. Roberts, was a plea that the tannery chemists test all dyestuffs before purchasing with regard to reduction of strength of the leather, retardation of penetration or action to generally deteriorate. The specific gravity of the various dyes entering into mixtures should run even because of possible segregation in the mill. Every tannery should have a dye labaratory and not use a mixture that will settle out compounds of different specific gravities. The dye chemists of the tanneries should co-operate with the color house for securing proper colors in the dyeing of leather.

Determination of Hydrochloric Acid and Neutral Chlorides in Leather

"The Determination of Hydrochloric Acid and Neutral Chlorides in Leather" was discussed by Arthur W. Thomas and Alexander Frieden. The extent to which sulphuric acid in leather will rot the finished product is an important one to vegetable tanners, but sulphuric acid is only one of the mineral acids that may be present, and if the work is to be complete hydrochloric acid must be included. The method of analysis depends on the principle that divalent ions are adsorbed more readily than the trivalent ions. Ammonium and sodium phosphate was used in making the test, while ethyl alcohol was used as a solvent for the chlorides.

The chlorides were precipitated with silver nitrate with a slight extract of nitric acid to wash down the organic content. The nitric acid was present in sufficient quantity to prevent the forming of silver phosphate and did not impair the accuracy of the method. It was obvious from the experiments carried out that the water extraction could not be used for separation of neutral chloride from acid chloride in leather.

Hence, in our opinion, acids are combined chemically with collagen provided they come in contact with the collagen before all the free valences of the collagen are satisfied by tanning agents and the removal of an acid from leather by hot water is due to hydrolysis. It is evident, then, that the hydrochloric acid collagen compound is hydrolyzed much more readily than the sulphuric acid collagen compounds.

The results obtained by the methods employed were compared with the amounts of chloride obtained by the method of determination by ashing the leather soaked with sodium carbonate solution and covered with dry sodium carbonate. The ashing was conducted at as low a heat as possible and the amount of chloride present in the sodium carbonate was determined and correction applied in each case.

The total chloride found by ashing at low heat in the presence of alkali is in every case higher than the total chloride found by the phosphate digestion. This is due to the chlorine present as a part of the protein molecule, or present in the leather in forms other than chloride.

An objection might be raised for the use of ethyl alcohol, which is difficult to obtain in quantity on account of restrictions imposed due to the new law. We see no reason, however, why denatured alcohol that has been twice distilled, first over phosphoric acid and then over alkali, would not serve just as well as pure ethyl alcohol.

"Comment on Wilson's and Kern's Recent Contribution to the Knowledge of Vegetable Tanning Agents" was given by A. W. Thomas. In a recent work by Wilson and Kern, which showed large errors obtaining by use of the official method of the American Leather Chemists Association, these errors were shown as follows, in order of the greatest amount of non-tannins:

	Per Cent		Per Cent
Gambier	220	Larch bark	89
Osage orange	198	Oak bark	88
Sumac	166	Hemlock bark	63
Chestnut wood	117	Quebracho	43

Since tannins react with gelatine to form insoluble compounds while non-tans do not so react with gelatine, it was considered that a comparative measure of the content of non-tans in extracts could be indicated by their diffusion through gelatine jelly, the extent of the diffusion being measured by the formation of a black color. The results of experiments along these lines were as follows:

DIFFUSIONS OF NON-TANS THROUGH GELATINE JELLY

Material	48 Hr. Mm.	96 Hr. Mm.	144 Hr. Mm.	216 Hr Mm.
Sumac	17.3	22.3	27.0	32.5
Gambier	13.8	18.0	22.0	26.0
Chestnut wood	12.0	17.8	20.0	23.8
Oak bark	9.0	13.0	15.2	18.3
Larch bark	9.0	12.0	14.5	16.0
Hemlock bark	6.0	8.3	9.5	12.0
Osage orange	4.3	4.8	5.0	6.0
Quebracho	3.8	4.8	5.8	7.3

The order of diffusion of the non-tans was, therefore; sumac > gambier > chestnut wood > oak bark > larch bark > hemlock bark > quebracho > osage orange.

With the exception of osage orange, the order found here is similar to the order given by Wilson and Kern. This is, therefore, confirmatory of the work which has been previously mentioned.

Business Meeting

At the close of the technical papers, the Section held its annual business meeting, and elected Dr. John Arthur Wilson as Chairman and G. D. McLaughlin as Secretary of the Section. It was further voted that the Leather Section will not meet at the spring meeting of the Society in Rochester, but will hold one large meeting in New York next September.

Colored Plasters

The investigation of colored plasters by the Bureau of Standards has been completed. It has been found possible to make colored wall plasters of any desired color or texture by use of dyed wood fiber in gypsum plaster. Panels of this material have been submitted to the Gypsum Industries Association in Chicago, and a publication on the subject is now being prepared.

Manufacture of Rich Copper: Aluminum Alloys or Hardeners

Describing the Methods in Use in Aluminum Foundries of the United States for Manufacturing Rich Alloys of Copper and Aluminum, and Details of Experiments Carried Out for the Purpose of Comparing Different Methods

BY ROBERT J. ANDERSON

THE use of rich copper: aluminum alloys for introducing copper into aluminum in the manufacture of No. 12 alloy or similar other light aluminum: copper alloys is an old practice, and it dates back to the early days of aluminum founding. As has been pointed out[1] by the present writer, copper may be alloyed with aluminum in making up alloys for sand casting by two distinct methods; (1) by adding solid copper to liquid aluminum, and (2) by charging a rich copper: aluminum alloy with the aluminum. The majority of the aluminum foundries in the United States prefer to make up heats of No. 12 alloy by using a rich alloy containing about 50.0 per cent copper and 50.0 per cent aluminum. This rich alloy is referred to in foundry parlance as "hardener," "rich alloy" or "50: 50," and for brevity it will be referred to in this paper as 50:50 alloy. Another alloy preferred by a few is the eutectic containing 33.0 per cent copper and 67.0 per cent aluminum. A rich alloy containing 60.0 per cent copper and 40.0 per cent aluminum has also been suggested for the same purpose, but it has probably not been used commercially.

In the metallurgy of aluminum alloys, rich alloys are employed because they melt at temperatures lower than aluminum and, further, because they are brittle. The latter property permits them to be broken readily into small pieces, and thus to be weighed accurately. Originally, the rich alloys were used because they were a convenience, but under the conditions of fast practice in the large aluminum foundries of the United States, their use has become a necessity. Methods for preparing the rich copper: aluminum alloys vary somewhat in different foundries, but experience indicates that certain details in manufacture must be followed closely in order to avoid heavy dross losses. Whether the 33:67 or the 50:50 alloy is made is not a matter of a great deal of importance from the metallurgical standpoint, since the fundamental principles involved are the same for either alloy.

METHODS USED COMMERCIALLY

There are three distinct methods in use for the manufacture of rich copper: aluminum alloys (50:50), of which the second is the most generally used; the two other methods are employed mainly in small foundries for making small lots of hardener for their own consumption. These methods are essentially carried out as follows: (1) By adding solid aluminum to liquid copper; (2) by adding liquid copper to liquid aluminum; and (3) by adding solid copper to liquid aluminum. The alloys may also be prepared by pouring liquid aluminum into liquid copper, but the opportunity for segregation is greatly increased in this way, and this is, in fact, a decidedly inadvisable method.

SOLID ALUMINUM TO LIQUID COPPER

Rich alloys, such as 50:50 alloy, are made in a few foundries by the addition of solid aluminum to liquid copper; this is, however, not a desirable procedure. One way of carrying out this method in the foundry is to melt the copper in a crucible and then add small amounts of cold aluminum from time to time with stirring until the requisite amount of aluminum has been put in. Too much aluminum cannot be added at one time, unless the copper is greatly superheated, or the entire melt will freeze. Ordinarily, it is necessary to maintain the temperature of the copper in the crucible by holding the pot in the furnace with the burners on. This is wasteful of fuel, and the method is slow and conducive to heavy dross losses. It is still used, however, in some small foundries in spite of its very obvious disadvantages.

LIQUID COPPER TO LIQUID ALUMINUM

The most favored method for making rich alloys consists in melting the copper and aluminum separately and then pouring the liquid copper into the liquid aluminum. The resultant alloy is vigorously stirred to insure thorough alloying and prevent segregation; the alloy is then ingoted in the form of pigs of various convenient sizes from 10 to 60 lb. or more. Where large lots are made at one time, it is good practice after melting the metals to pour the liquid aluminum into a large mixing vessel or container and then pour the copper into the aluminum. For convenience, the mixing vessel should be located near the furnace used for melting the copper.

As it is important to keep the temperature of the resultant alloy as low as possible so as to avoid heavy dross losses, the liquid aluminum should be chilled by adding cold aluminum ingot or notch bar. Thus only part of the aluminum to be used should be melted—say about two-thirds—and the remainder should be retained for use in lowering the temperature of the alloy during the time the copper is being put in and afterward.

It requires considerable skill to maintain the resultant alloy at a low temperature because of the considerable rise in temperature which takes place when liquid copper is added to liquid aluminum.[2] The temperature rise is conducive to heavy dross losses, and it is best counteracted by the addition of sufficient cold aluminum in amount depending upon the temperatures of the liquid aluminum and liquid copper. Experience, together

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[1] "Diffusion of Solid Copper in Liquid Aluminum," CHEM. & MET. ENG., vol. 23, No. 12, p. 575 (Sept. 22, 1920).

[2] Due to thermit reaction. See "Some Theoretical Principles of Alloying," by R. J. Anderson, CHEM. & MET. ENG., vol. 23, p. 317 (Aug. 25, 1920).

with pyrometric measurements of the temperatures, will best indicate the correct procedure.

Solid Copper to Liquid Aluminum

This method for preparing rich alloys is similar to the method used for preparing No. 12 alloy by direct additions of solid copper to liquid aluminum. It is not used to any extent because foundries which prefer to add solid copper to liquid aluminum in the manufacture of No. 12 alloy do not use rich alloys. However, a few instances of the commercial use of this method have been reported. The method is carried out simply by melting the aluminum and then adding small amounts of light copper (sheet, punchings or other scrap) from time to time until the required amount of copper has been put in. After each addition of copper, the melt is stirred until the copper goes into solution. Dross losses are normally high in this method; furthermore, it is slow and not suitable for making large lots of 50:50 alloy.

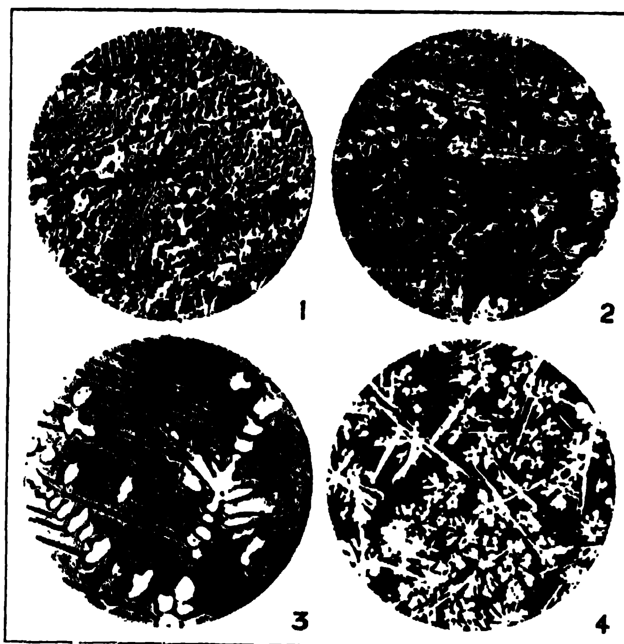
Liquid Aluminum to Liquid Copper

No instances of pouring liquid aluminum into liquid copper as a commercial practice for the manufacture of 50:50 alloy have been reported, although this has been tried. A modification of this method is used, however, in some small foundries for making up small lots. In this modification, the copper is melted in a crucible, preferably in a stationary gas- or oil-fired furnace. A small notch bar of aluminum is held by tongs in the mouth of the furnace so that it gradually melts; as it melts, drops of liquid aluminum fall into the liquid copper. The resultant alloy is stirred from time to time until all the aluminum has been put in. This is a slow and expensive method, and conducive to high oxidation losses.

Comparison of the Methods

In the commercial manufacture of rich alloys of copper and aluminum, the consensus of opinion among the larger foundries is that liquid copper should be poured into liquid aluminum, with an endeavor at the same time to keep the temperature low by chilling the melt with additions of cold aluminum ingot; this should be accompanied by vigorous stirring. Where solid aluminum is added to liquid copper, there is danger of explosions from absorbed water in the aluminum, and in this method the aluminum should be preheated so as to drive out any water. This can be done by placing the notch bars on top of the furnace while the copper is melting. This method is conducive to heavy dross losses because of the high temperatures and the thermit reaction if much copper oxide is present (as there usually will be unless the copper is melted under charcoal). This method is also slow and wasteful of fuel; only small amounts of cold aluminum can be added at a time, otherwise the whole melt will freeze. In general, this method is undesirable and but little used.

When liquid copper is poured into liquid aluminum, the temperature of the resultant alloy may become high because of the normal heat of formation of the alloy, and further, because of the thermit reaction which usually takes place. This is the only serious disadvantage in thus making the rich alloys, but it may be largely minimized by keeping the temperatures low by adding cold aluminum. This method is, in fact, the standard method for the manufacture of 50:50 alloy on a large scale, and while it is suitable for making both large and small lots, the method of adding solid copper to liquid aluminum may be preferable for small lots, say about 100 lb. Comparative figures as to dross losses for the various methods will be given later.



FIGS. 1 TO 4.

Fig. 1—Eutectic alloy of copper and aluminum (33Cu : 67Al); etched NaOH; × 130. Fig. 2—Eutectic alloy of copper and aluminum; etched $Fe_2(SO_4)_3$; × 230. Fig. 3—Rich copper : aluminum alloy (50Cu : 50Al); etched NaOH; × 130. Fig. 4 Rich copper : aluminum alloy (60Cu : 40Al); etched NaOH; × 35

Properties of the Rich Alloys

Alloys containing 33 : 67, 50 : 50, and 60 : 40 copper : aluminum are all white in color, similar to aluminum, but the fractures are coarsely crystalline and bright. These alloys are all brittle, but the excessive brittleness diminishes with increasing aluminum content; thus, the 33 : 67 alloy is not so brittle as the 50 : 50 alloy, but the 60 : 40 alloy breaks readily if dropped on the floor. The 50 : 50 alloy is sufficiently brittle for all practical purposes, and if the rich alloys are too brittle, they powder excessively on breaking, thus causing dusting losses. Typical microstructures of these several alloys are shown in Figs. 1 to 4. The characteristic acicular structure formed when 50 : 50 alloy freezes uninterruptedly is shown in Fig. 5; the large interlocking crystals are conducive to brittleness, and this characteristic, together with the actual brittleness of the compound $CuAl_2$, makes the alloy easy to break.

The eutectic alloy (33Cu : 67Al) melts at 540 deg. C., the 50 : 50 alloy at 575 deg. C. and the 60 : 40 alloy at 658 deg. C., practically the same temperature as aluminum.

Experiments With Rich Alloys

In foundry practice, the rich alloys used for introducing copper into aluminum in the manufacture of No. 12 alloy and other such alloys include the 33 : 67 and 50 : 50 copper : aluminum alloys. The preparation of these rich alloys, as well as the 60 : 40 alloy, was studied in connection with the present investigation. A rich alloy containing 60.0 per cent copper and 40.0 per cent aluminum is very brittle, and it melts at about the same temperature as aluminum. In using this alloy, less of

TABLE I. SUMMARY OF THE RICH ALLOY EXPERIMENTS

Experiment	Wt. Copper, Lb.	Wt. Aluminum, Lb.	Time Required to Melt Copper, Min.*	Time Required to Melt Aluminum, Min.*	Temperature Copper, Deg. C.	Temperature Aluminum, Deg. C.	Highest Observed Temperature of Alloy, Deg. C.†	Final Temperature of Alloy, Deg. C.	Alloy Poured at, Deg. C.	Wt. Pigs Poured, Lb.	Wt. Dross Recovered, Lb	Shrinkage, Lb.	Total Loss, per Cent	Metal Oxidized, per Cent ‡	Total Gas Consumption, Cu Ft §	Cost Gas Used, Dollars ¶	Alloy Made
A-1	8.25	16.75	26.0	....	1,155	25	....	705	700	24 00	0 85	0.15	4 0	1 80	3,860	1.16	33 67
A-2	8 25	16.75	28.0	27.0	1,125	880	1,065	1,065	1,040	24.15	0 65	0 20	3.4	1 38	5,915	1 77	33 67
A-3	8.25	16.75	....	26 0	25	820	925	890	874	23.55	1 15	0 30	5 8	2 44	2,730	0 82	33·67
B-1	12.50	12.50	38 0	....	1,120	25	1,225	685	677	23 75	1 00	0.25	5.0	2 12	4,730	1.42	50.50
B-2	12 50	12.50	40 0	26.0	1,203	705	1,085	1,080	1,061	23 50	1 00	0 50	6 0	2 12	7,130	2.14	50 50
B-3	12 50	12.50	.	24 0	25	690	906	900	887	22.25	2.25	0 50	11.0	4 77	3,145	0 94	50:50
C-1	15.00	10 00	42 0	.	1,170	25	1,278	860	842	22 60	2 00	0 40	9 6	4 24	4,620	1.39	60.40
C-2	15.00	10.00	43 0	21 0	1,205	750	1,256	1,225	1,190	23 50	1 00	0 50	6 0	2 12	6,935	2 08	60.40
C-3	15.00	10.00	..	22 0	25	783	855	809	787	22 15	2 55	0 30	11 4	5 41	3,360	1.01	60 40

* Solid metal temperatures are taken as room temperature—*i. e.*, 25 deg. C.
† The figures indicate the observed highest temperatures; higher temperatures may have been attained, but they were not observed
‡ Based on the assumption that dross is equivalent to Al_2O_3, containing about 53.0 per cent aluminum
§ The copper-melting furnace consumed 110.0 cu.ft per min., and the aluminum-melting furnace 105.0 cu ft per min, in some cases additional gas was used in addition to that required for melting.
¶ Based on gas at $0.30 per 1,000 cu ft.

it is required to make up a heat of No. 12 alloy than when using either of the two other rich alloys. For these reasons, the preparation of the 60 : 40 alloy was also investigated.

The metals were melted in gas-fired crucible furnaces, using natural gas as the fuel and plumbago-clay crucibles. The resultant liquid alloys were stirred with an iron rod from which any oxide was carefully scraped after using. The alloys were poured into small pigs weighing from 4 to 6 lb. each. Higher temperatures were taken with a platinum thermocouple protected by a quartz tube; and the lower temperatures were taken with a Wilson-Maeulen "pyod," using an indicating portable meter. The materials employed consisted of heavy copper clippings, light copper punchings and aluminum ingot of the analysis given in the subjoined table:

Material	Cu	Fe	Si	Al*
	Elements, per cent			
Aluminum ingot	0 25	0.39	0.31	99.05
Light copper punchings	99 89			
Heavy copper clippings	99 92			

* Aluminum, by difference.

The heavy copper used in experiments A-1, A-2, B-1, B-2, C-1 and C-2 was in the form of heavy clippings about ½ to 1 in. thick. The light copper used in experiments A-3, B-3 and C-3 was in the form of light punchings and clippings about 16 to 18 gage. The cold materials were charged into hot crucibles at a mean temperature of 600 deg. C., but this is an approximate mean temperature, as the variations were from 400 to 700 deg. C.

It required, on the average, 27 min. to heat a cold crucible to 600 deg. C., or a metered gas consumption of 2,800 to 2,900 cu.ft. The experiments are described in considerable detail below and are summarized in Table I.

33 : 67 Copper : Aluminum Alloy

This alloy was prepared by the three different methods mentioned above.

Experiment A-1. In this experiment, solid aluminum was added to liquid copper so as to make the desired alloy.

Charged copper into a hot crucible at 600 deg C., lb	8 25
Time required to melt copper, min	26 0
Gas consumption, cu ft	2,860
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,155
Charged aluminum in small amounts every few minutes during 30 minutes, lb	16 75
Final temperature of the alloy, deg C	705
Total gas consumption, cu ft	3,860
Poured into pigs at, deg. C	700
Weight of pigs poured, lb	24 0
Weight of dross recovered, lb	0 85
Shrinkage, lb	0 15
Loss of metal due to oxidation and shrinkage, per cent	4 0



FIG. 5. UPPER SURFACE OF A CHILL-CAST PIG OF 50 : 50 ALLOY; × ½.

TABLE II CHEMICAL ANALYSES OF THE RICH ALLOYS PREPARED

Alloy Made in Experiments	Elements, per Cent Cu	Fe	Si	Al*	Composition Aimed at
A-1	33 85	0 54	0 41	65 20	33:67
A-2	32 53	0 51	0 34	66 62	
A-3	32.78	0 44	0.32	66 46	
B-1	49 27	0 43	0 34	49 96	50:50
B-2	48 73	0 49	0 35	50.43	
B-3	49 73	0 55	0 35	49.37	
C-1	60 25	0 46	0 31	38.92	60 : 40
C-2	59 57	0 58	0 35	39 52	
C-3	58 04	0 55	0 39	41 02	

* Aluminum by difference

Experiment A-2. In this case, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg C, lb	8 25
Time required to melt the copper, min	28 0
Gas consumption, cu ft	3,080
Temperature of the copper at the time it was poured into the liquid aluminum, deg C	1,125
Charged aluminum (in a separate crucible) at 600 deg. C, lb	16.75
Time required to melt the aluminum, min	27 0
Gas consumption, cu ft	2,835
Temperature of the aluminum at the time the copper was poured in, deg C	880
Highest temperature of the resultant alloy, deg C	1,065
Total gas consumption, cu ft	5,915
Poured into pigs at, deg C	1,040
Weight of pigs poured, lb	24 15
Weight of dross recovered, lb	0 65
Shrinkage, lb	0 20
Loss of metal due to oxidation and shrinkage, per cent	3 4

Experiment A-3. Solid copper was added to liquid aluminum in this experiment in order to produce the desired alloy.

Charged aluminum into a hot crucible at 600 deg. C., lb	16 75
Time required to melt the aluminum, min	26.0
Gas consumption, cu ft	2,730
Temperature of the aluminum at the time the first addition of copper was made, deg C	820
Charged copper in small amounts every few minutes during 20 minutes, lb	8.25
Highest temperature of the alloy, deg. C	925
Total gas consumption, cu ft	2,730
Poured into pigs at, deg. C	874
Weight of pigs poured, lb	23.55
Weight of dross recovered, lb	1.15
Shrinkage, lb	0 30
Loss due to oxidation and shrinkage, per cent	5 8

50 : 50 COPPER : ALUMINUM ALLOY

This alloy was made under the same conditions and by the different methods described above for the 33 : 67 alloy—i.e., by adding solid aluminum to liquid copper, by adding liquid copper to liquid aluminum and by adding solid copper to liquid aluminum.

Experiment B-1. In this experiment solid aluminum was added to liquid copper so as to make the desired alloy.

Charged copper into a hot crucible at 600 deg. C., lb	12 50
Time required to melt the copper, min	38 0
Gas consumption, cu ft	4,180
Temperature of the copper at the time the first aluminum addition was made, deg. C	1,120
Charged aluminum every few minutes during 20 minutes, lb.	12 5
Temperature of the alloy after an addition of 2.0 pounds solid aluminum, deg. C	1,225
Temperature rise, deg. C	105
Final temperature of the alloy, deg C	685
Total gas consumption, cu ft	4,730
Poured into pigs at, deg C	677
Weight of pigs poured, lb	23 75
Weight of dross recovered, lb	1 00
Shrinkage, lb	0.25
Loss due to oxidation and shrinkage, per cent	5.0

Experiment B-2. Here, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg. C., lb	12 5
Time required to melt the copper, min	40.0
Gas consumption, cu ft	4,400
Temperature of the copper at the time it was poured into the aluminum, deg. C	1,203
Charged aluminum into a hot crucible at 600 deg C., lb	12.5
Time required to melt the aluminum, min	26 0
Gas consumption, cu.ft	2,730
Temperature of the aluminum at the time the copper was poured, deg. C.	705
Highest temperature of the resultant alloy, deg. C	1,085
Total gas consumption, cu.ft	7,130
Poured into pigs at, deg. C	1,061
Weight of pigs poured, lb	23.50
Weight of dross recovered, lb	1.00
Shrinkage, lb	0.5
Loss due to oxidation and shrinkage, per cent	6.0

Experiment B-3. Solid copper was added to liquid aluminum in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb	12.5
Time required to melt the aluminum, min	24.0
Gas consumption, cu.ft	2,520
Temperature of the aluminum at the time the first copper addition was made, deg. C	690
Charged copper every few minutes during 20 minutes, lb	12.5
Highest temperature of the alloy, deg C	906
Total gas consumption, cu ft	3,145
Poured into pigs at, deg. C	887
Weight of pigs poured, lb	22.25
Weight of dross recovered, lb	2.25
Shrinkage, lb.	0.5
Loss due to oxidation and shrinkage, per cent	11.0

Experiment B-4. In this experiment copper was melted under a charcoal cover to prevent oxidation, and solid aluminum was then added. The temperature rise was observed.

Charged copper, lb	10 0
Temperature of the copper at the time the aluminum was added, deg. C.	1,105
Charged solid aluminum, lb	2.5
Temperature of the resultant alloy after the aluminum had gone into solution, deg C	1,220
Temperature rise, deg. C	115

Experiment B-5. In this experiment a heat of 50 : 50 alloy was made in an electric furnace (Baily type), by adding solid aluminum to liquid copper.

Charged copper punchings into an electric furnace at 1,020 deg. C., lb.	50 0
Time required to melt the copper, min	60 0
Power consumption, kw.-hr	52 0
Temperature of the copper at the time the first aluminum addition was made, deg. C	1,050
Charged solid aluminum every few minutes during 60 minutes, lb.	50.0
Final temperature of the alloy, deg. C	965
Total power consumption, kw.-hr	114
Poured into pigs at, deg. C	800
Weight of pigs poured, lb.	91.5
Weight of dross recovered, lb	14.0
Shrinkage	Gain
Loss due to oxidation and shrinkage, per cent	8.5

60 : 40 COPPER : ALUMINUM ALLOY

This alloy was made by the methods mentioned above for the 33 : 67 alloy.

Experiment C-1. In this experiment solid aluminum was added to liquid copper so as to make the desired alloy.

Charged copper into a hot crucible at 600 deg. C., lb	15 0
Time required to melt the copper, min	42 0
Gas consumption, cu.ft	4,620
Temperature of the copper at the time the first aluminum addition was made, deg. C	1,170
Charged aluminum every few minutes during 20 minutes, lb.	10.0
Temperature of the resultant alloy after adding 2.0 pounds of aluminum, deg. C.	1,278
Temperature change, deg. C	108
Final temperature of the alloy, deg. C.	860
Total gas consumption, cu.ft	4,620
Poured into pigs at, deg. C	842
Weight of pigs pounred, lb	22.60
Weight of dross recovered, lb	2.00
Shrinkage, lb	0.40
Loss due to oxidation and shrinkage, per cent	9.6

Experiment C-2. Here, liquid copper was poured into liquid aluminum.

Charged copper into a hot crucible at 600 deg. C., lb	15.0
Time required to melt the copper, min	43 0
Gas consumption, cu. ft.	4,730
Temperature of the copper at the time it was poured into the aluminum, deg. C	1,205
Charged aluminum into a hot crucible at 600 deg. C., lb	10.0
Time required to melt the aluminum, min	21.0
Gas consumption, cu.ft.	2,205
Temperature of the aluminum at the time the copper was poured in, deg. C	750
Highest temperature of the resultant alloy, deg. C.	1,256
Total gas consumption, cu.ft	6,935
Poured into pigs at, deg. C	1,190
Weight of pigs poured, lb	23.50
Weight of dross recovered, lb.	1.00
Shrinkage, lb	0.50
Loss due to oxidation and shrinkage, per cent	6 0

Experiment C-3. Solid copper was added to liquid aluminum in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.0
Time required to melt the aluminum, min	22.0
Gas consumption, cu.ft	2,310
Temperature of the aluminum at the time the first copper addition was made, deg. C	783
Charged copper every few minutes during 35 minutes, lb.	15.0
Highest temperature of the resultant alloy, deg. C.	855
Final temperature of the alloy, deg. C.	809
Poured into pigs at, deg. C	787
Weight of pigs poured, lb	22.15
Weight dross recovered, lb.	2.55
Shrinkage, lb.	0.30
Loss due to oxidation and shrinkage, per cent	11.4

Experiment C-4. An experiment was made in the preparation of the 60:40 alloy for the purpose of observing the temperature changes on adding successive amounts of cold solid copper to liquid aluminum.

Charged aluminum, lb	10 0
Temperature of the aluminum at the time of the first copper addition, deg. C.	785

TEMPERATURE CHANGES

Additions	Temperature Deg. C.
Original melt	785
Added 2 lb. Cu	820
Added 2 lb. Cu more	830
Added 2 lb. Cu more	850
Added 2 lb. Cu more	846
Added 2 lb. Cu more	840
Added 5 lb. Cu more	808

Table I gives a summary of the results of the experiments made in preparing the various rich alloys by the three different methods. Table II gives the chemical analyses of the rich alloys prepared.

Discussion of the Experiments

These experiments have afforded some interesting data with regard to the temperature rise noted by other observers when solid aluminum is added to liquid copper. While most of the melts were made under such conditions that copper oxide was doubtless present in the liquid copper, some showed that a temperature rise is obtained even when aluminum is added to copper melted under charcoal. Others indicated that the temperature rise observed on adding solid copper to liquid aluminum continues with successive additions. These data prove that part of the temperature rise is due to oxidation of the aluminum and part of it to the heat of formation of the alloys. Practically, therefore, it is advisable to employ oxygen-free copper for making rich alloys, and the copper should either be deoxidized before pouring into the aluminum or be melted under reducing conditions so as to prevent the presence of any considerable amount of cuprous oxide in the copper bath.

Moreover, from a practical standpoint, it is desirable to hold dross losses low in the manufacture of rich alloys as well as keep the melting costs down. By the methods employed in the present experiments, the melting costs were highest for the three alloys when the method of pouring the liquid copper into liquid aluminum was employed. This is to be expected, because two different furnaces were running in this method, one on copper and the other on aluminum. In the other methods, where one solid metal is added to another liquid metal, some saving is had by taking advantage of the residual heat in the crucibles and furnace. The total losses (made up of dross plus shrinkage) and the dross losses were lowest in the case of the method of pouring copper into liquid aluminum, These losses were very heavy in the method where solid copper was added to liquid aluminum.

In considering the dross and shrinkage losses in Table I, it should be borne in mind that the experiments were carried out on a small scale, 25-lb. charges being used. The relative order of the losses in preparing the rich alloys by the different methods is correct, but the actual figures are not representative of large-scale practice. On preparing the alloys on a large scale, the losses would be considerably lower. Moreover, it should be pointed out that ordinarily the dross is not entirely loss in commercial practice, because a considerable recovery of metal would be made by running down the dross and skimmings.

The conclusion arrived at from these experiments is that the most desirable and best way of making any of the rich alloys is to melt the aluminum and copper separately and pour the copper into the aluminum. On a large scale, where, say, 2,000 lb. of the 50:50 alloy is made at a time, a satisfactory procedure is to melt about one-third of the total aluminum in an iron pot or other suitable vessel; after it is melted, cold pigs from part of the remaining aluminum should be thrown in to cool the metal. Here, solid aluminum would be floating around in the liquid metal. The copper should have been previously melted separately, and with the aluminum in the above condition, about one-fourth of the copper should be poured in. The addition of the copper will raise the temperature of the aluminum, but the resultant alloy may be cooled down by throwing in more pigs of cold aluminum. Then about one-fourth or more additional copper should be added and then more cold aluminum, and so on until the two melts have been properly alloyed. The alloy should be thoroughly stirred during the additions to facilitate alloying, and should be stirred well on pouring or ladling out into pigs. These directions are admittedly only very general, and the quantities of the several additions will vary considerably with the temperatures. The manufacture of rich alloys should be carried out under the supervision of a competent melter, and the use of pyrometers for frequent temperature measurements will be of value. In any event, the effort should be made to keep the temperatures as low as is consistent with rapid alloying and not allowing the alloy to freeze in the mixing vessel.

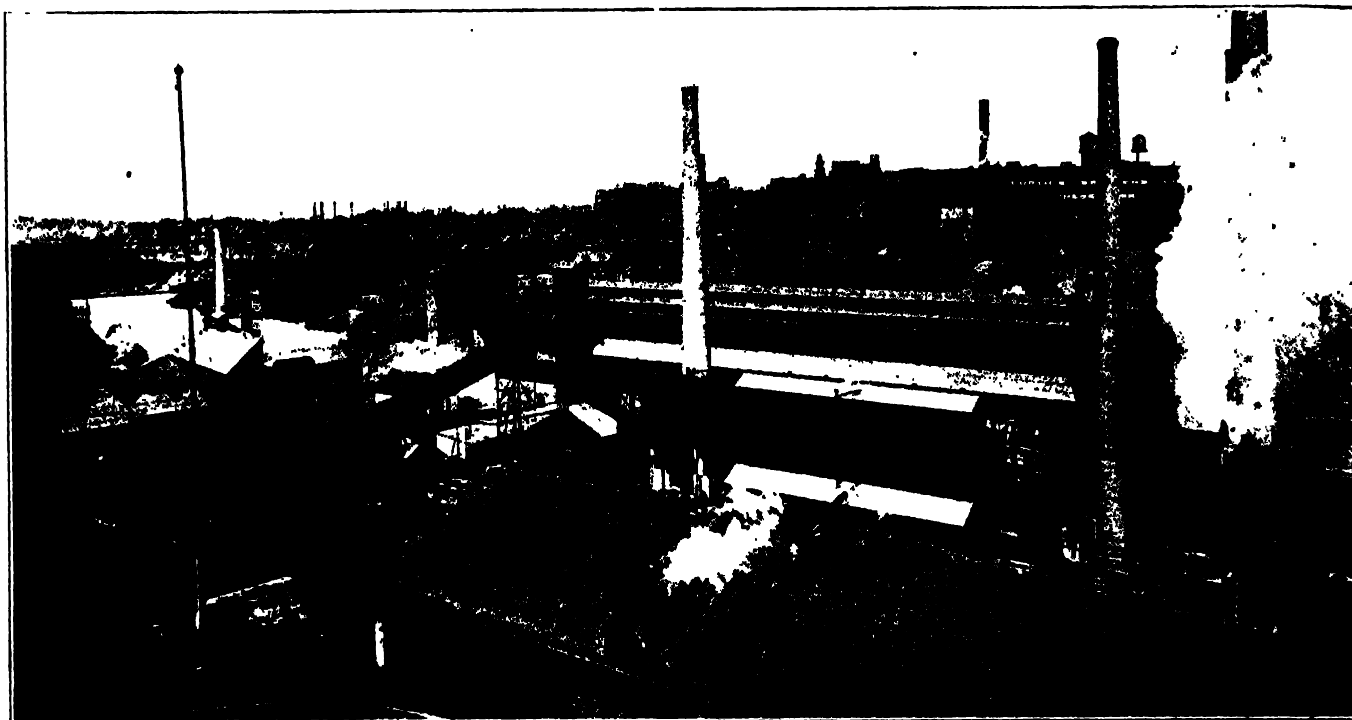
Status of the American Potash Industry

The American potash industry is in a more promising condition than at any time since the armistice. Domestic potash production in 1920 is expected to exceed that of the banner year, 1918. The producers not only have their entire possible output under contract but are being urged to take contracts for next year.

The domestic situation has been bettered by the refusal of the German syndicate to quote prices at American ports. This throws the burden of securing bottoms, negotiating freight rates and the absorption of demurrage on the American purchaser. On the other hand, the producers have had to face labor difficulties and trouble in obtaining materials. In Nebraska, the abnormal rainfall has so diluted the brine as to make much greater amount of evaporation necessary just at the time when fuel prices are at their peak.

Large new plants are being built at Searles Lake, Marysvale, Utah, and at New Brunswick, N. J.

Searles Lake producers have reduced the borax content of their potash to 0.5 per cent. In that connection it is pointed out that the borax content of the Searles Lake potash never was so great as to be hurtful when used under normal conditions. The only places where damage resulted, it is stated, were where prolonged drought prevented the washing out of the borax. The lowering of the borax content is a very simple matter and could have been done before had it been known that it possessed an element of danger, producers state. The company which produced the potash which caused some small damage to crops is not selling its potash for fertilizer purposes this year, its entire output having been purchased by chemical users.



ROCHESTER COAL GAS PLANT

The Gas Industry; a Diagnosis and Prescription

The Manufacture of Gas, Although Fundamentally a Chemical Problem, Has Been, and to Some Extent Still Is, Directed on Mechanical Technologic Lines; Healthy Progress in This Industry Requires a Better Knowledge of the Chemical Fundamentals Involved

BY R. S. McBRIDE*

THE title of this article implies that the gas industry is ill, and, frankly, it appears so to be. However, this conclusion need not be regarded in a pessimistic spirit, for a recognition of illness is perhaps the best promise of an early cure.

It is no simple disease from which the industry is suffering. A full diagnosis shows both mental and physiological problems. A nervous state of mind which threatens a most distressing case of melancholia is obvious to the casual practitioner who may be called into consultation. However, the root of the trouble is more serious. Careful analysis of all symptoms indicates that the patient is suffering from the gout, which has developed to its most acute and distressing stages despite the fact that the industry is simultaneously suffering from what appears to be an almost incompatible ailment -malnutrition.

A richness of opportunity has led the industry to pass through a period of opulence, during which, without proper self-restraint, it acquired all of the gouty characteristics of the dyspeptic plutocrat. At the same time neglect of important elements that must nourish the industry for any permanent healthy existence gave it the second ailment– malnutrition.

Let us lay aside this analogy and go straight to the root of the matter in plain English. The industry lacks today a proper vision; it stands of all great chemical industries the most negligent of science and technology except within the very narrow field of mechanical engineering; and it is almost without effective organization in the possibilities for development in lines of future need. It would be desirable to discuss the lack of science alone if this were possible, but the three points of need just cited are so interwoven that it seems impracticable to go into one without discussing all.

THE FUNCTION OF GAS

Except with respect to the ease of storage, gas certainly can be conceded to be the ideal fuel. It is clean and convenient of use and can be most efficiently applied of any heating medium. To a limited extent the industries recognize this, but the public in general, including the vast majority of technologists, has not been educated to an appreciation of this point.

The gas business not only has for its responsibility the supply of such ideal fuel but it has also the duty of furnishing a group of fundamental raw materials for other industrial chemical activities. It takes coal, the lowest form of energy supply, available through almost all parts of this country at the lowest price of any important raw material, and converts it into (1) coke, which is a fundamental metallurgical raw material, an almost ideal substitute for anthracite and an important means for other gas-making and industrial-

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heating operations; (2) gas, which is the ideal fuel just mentioned; (3) tar, a liquid fuel of wonderful possibilities in the Diesel engine, a raw material for more organic industrial products than any other of which we know and a source of manifold possibilities in road making, roofing, building-paper manufacture and in other activities; (4) ammonia, which is produced as liquor, anhydrous ammonia or sulphate, as the cheapest inorganic nitrogen resource available on American markets, affording a large portion of the supply needed in explosives, fertilizer and other industries; and (5) light oils, a group of liquids whose possibilities are yet little appreciated for automotive fuel, explosives production, solvents and organic chemical production.

It is a rather appalling task which confronts the industry when the ramifications of its products are thus appreciated. The importance of proper vision and intensive scientific application should at once be apparent.

The gas business, born a century or more ago during that epoch when the rule-of-thumb system of operation prevailed, has collectively been ancestor worshipping in the most impressive Oriental style. However, since industries have ceased to pass from father to son like real and personal property, we have come into the new era of industrial life, and those industrial activities which have been born in the latter period are independent in thought, vigorous in personality and wholly unwilling to give even that respect to father and mother which enjoys Biblical admonition. Witness the automobile, the telephone, the airplane and similar recent developments. Certainly no tradition has hindered here. Gas, however, has been the anthithesis of these.

The reason for this limitation of the gas business has apparently been the character of the men consistently chosen to direct the thought of the industry. The coking of coal, the gasification of oil and the production and handling of byproducts is fundamentally a chemical problem. Unfortunately, however, it has been almost exclusively directed by the mechanical engineer without the co-operation of chemical experts. The industry has, therefore, become almost a pseudomorph of mechanical engineering. The crystal habit of mechanical technology has prevailed almost to the exclusion of chemical thought. The machinery of the industry has been excellent, but the processes and the products have not developed correspondingly. The situation now demands an opportunity for free development of the natural habit of this chemical business. We would then see those crystal forms which are the natural product of chemical and physical science quickly taking shape, and a more perfect result would inevitably follow.

Public Utility or Manufacturing Business

Not all of the criticism offered of the present state of affairs in the gas business would be fair or reasonable if it were not clearly recognized in its presentation that some of these conditions are the inevitable result of operation of the business as a public utility. Gas manufacture has been restricted by regulations more stringent than control in any other chemical activity. Investment has been safeguarded by artificial means, but no opportunity has been given for the encouragement of epoch-making advancement in the business. Limited returns upon investment have made inevitable a certain measure of conservatism which never would have followed had it been an unrestricted manufacturing industry. Despite these obstacles, however, certain important developments can and should be achieved. Operating as a public utility rather than as an essentially manufacturing concern, the gas works manager has usually had to think of reduced cost per thousand feet of gas rather than of his major technical problems. R. B. Brown, of Milwaukee, in commenting on this particular point, brings out strikingly one of the most important reasons why the science of gas manufacture has been thus neglected.

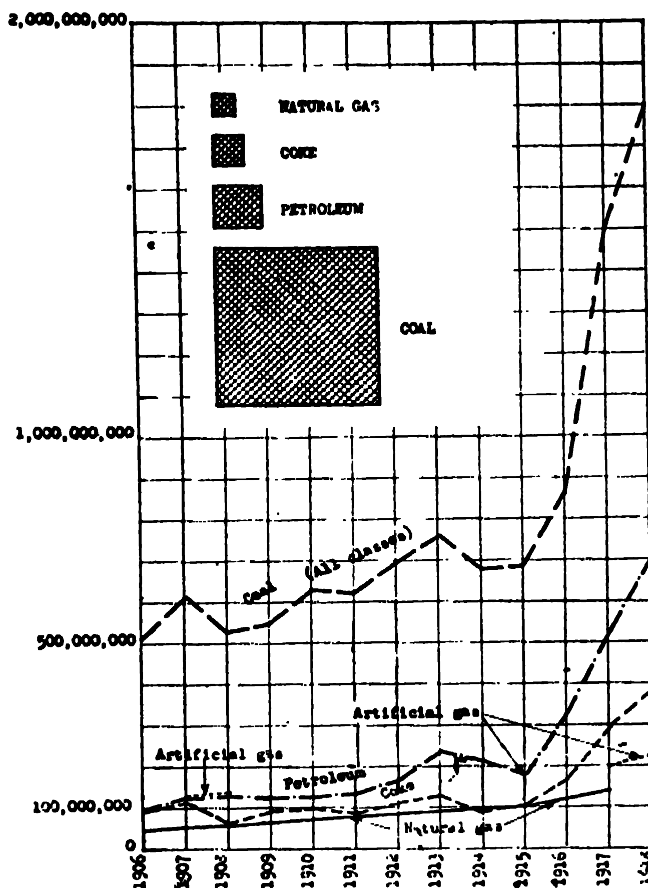
> The possible savings in the cost of gas manufacture may usually be enumerated in fractions of cents per thousand. The possible savings in the fixed charges on investment through more intensive sales policies and the increase in the units of gas sold per capita and per dollar of investment have been so tremendously greater that the most progressive and most successful operators have been those that have devoted a great deal of their attention toward increasing the volume of sales. It is a far cry from the first days when 3,000 ft. per capita was considered a good year's business and when 150 to 170 maximum day: was a reasonable load factor, to present-day conditions where 10,000 ft. per capita is only a stepping stone to greater things, and 280 to 300 maximum days is considered a fair load factor.
>
> The corresponding reductions in the cost of capital charges—interest and depreciation and taxes—per unit of gas sold have been tremendous and we are not through with that phase of the situation yet, though of course the present low purchasing power of the dollar and the present high costs of interest and of taxes have blinded many people to the fact that the greatest possible reduction in cost of operation still remain on that side of the job. Personally I am not at all blind to the possibilities in improvement of gas production processes, but financially these are not so attractive today as are many possibilities in other phases of the operation.

A whole article might be written on the subject of whether the gas-producing part of the city gas business should not be removed from the public utility field and be given free rein as a manufacturing business. However, that for the present would be altogether too great a diversion from our major theme.

Variety in Processes Important

Each type of bituminous coal has its own important characteristics with respect to coking. This fact is well known and is admitted by the gas man when he is pressed for comment on this particular point. However, the significance of the point has been concealed by the gas and coking interests in saying that certain coals are good coking coals, others are poor coking coals and some are non-coking coals. As a result, in the war period, when the promoters of a certain coking process came to Washington and set forth the claim that their process could "coke any coal" they stirred official Washington tremendously. In fact they created so great a stir, despite the fact their process had no fundamental novelty to offer, that the President himself was led to take personal cognizance and order an investigation of the processes described.

The recognition of limitations of coking of each type of fuel is not enough. We should take the other point of view and study and emphasize the advantages or possibilities of each particular supply. A high-nitrogen coal is to be avoided on the score that the nitrogen content of the gas is likely to be high and, therefore, the gas is lean and may not meet certain standards of quality which have been fixed. However, if we stop to consider the possibilities of such fuel for the greater production of ammonia when rightly coked we see that this characteristic may become a blessing and not a curse of the fuel. Similarly, if we are seeking solely a



MINERAL FUELS PRODUCTION IN U. S.

This diagram, prepared by E. G. Sievers of the U. S. Geological Survey, shows the values of mineral fuels produced in this country from 1906 to 1918, inclusive. The insert rectangles show the relative total value of these fuels for the 13-yr. period.

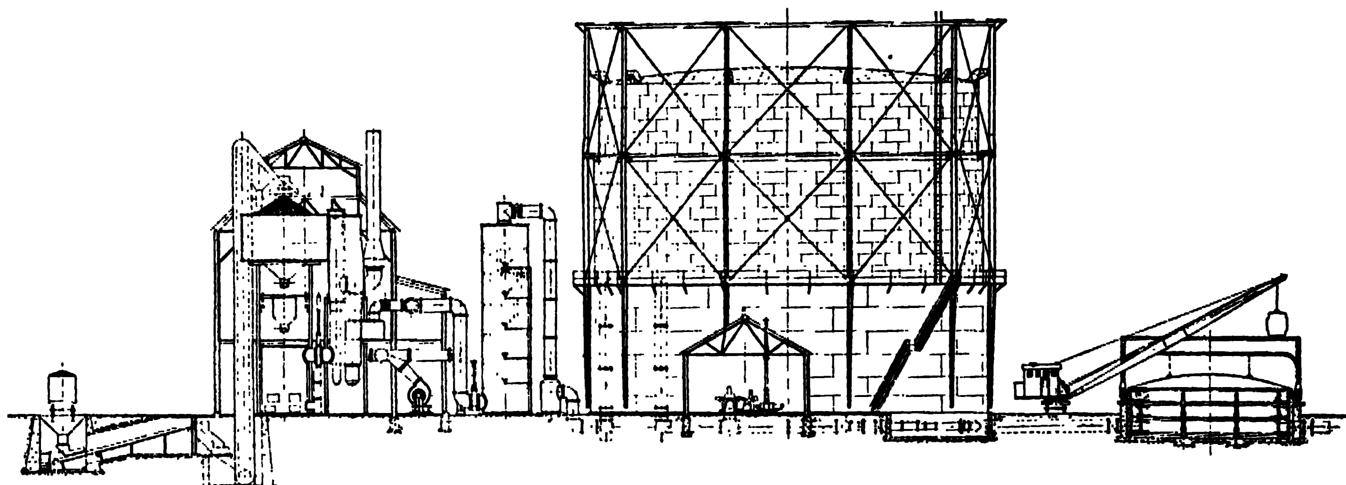
hard, dense coke and wish a high coke yield we would not choose a typical high-volatile Pittsburgh coal to use alone. On the other hand, when we consider the possibilities of this high-volatile fuel in the greater production of gas, the much higher yield of light oils and tar, the increased possibilities in other directions thus may far outweigh the limitations and characteristics of the coke. In other words, we emphasize the possibilities and not the handicaps of our raw material.

Today practically all the gas made in this country from solid fuel is produced in the "D" retort, the Lowe-type water-gas machine, or the chamber coke oven of Koppers or Solvay type. Why we are so limited in processes is an economic question of importance. There is no doubt that these particular processes have fundamental advantages of great importance. If it were not so they could not possibly have endured so long and have been applied so extensively. However, the future must give us better opportunity than this. Low-temperature carbonization in metal retorts, the use of vacuum retorts, continuous operation, vertical retorts, steaming of coke in retorts, fractional condensation of liquid products of distillation and numerous other such possibilities are receiving some of the attention which they deserve. Out of all these we will doubtless develop a much greater variety of processes permitting the application of many fuels not now well suited to gas manufacture, because the thermal history to which these processes limit us is not suited to the characteristic of the coal.

Knowledge of Fundamentals Required

The thermal history of the gas is important. The gas man says that the richest gas comes out of the coal first and that the lean gas remains in the coke until the end of the period of coking. This is another case of misleading use of terms which has probably been responsible for much of the misdirected effort in the coking of coals. In destructive distillation, as in any simple distillation process at lower boiling points, lighter fractions come off first and the heavier fractions remain behind until the later stages of the process. However, in destructive distillation of solid materials the quantity of the lighter materials which comes off in the early stages is so great that these materials flow rapidly out of the heated zone and many of the primary products of gasification leave the retort without being subjected to thermal disintegration. As the coking progresses the temperature increases, the quantity of material driven off per unit of time decreases and, therefore, the time and temperature of exposure of the initial products of the distillation are greater. We thus have at the later stages of heating the products of secondary decomposition of the primary products of distillation.

No one knows exactly what is the thermal history of the gases in most of the coking processes. We have still less idea as to what are the temperature ranges of formation and decomposition of each of the gas and vapor



BLUE WATER-GAS PLANT

This is a diagrammatic presentation of a blue water-gas plant designed to supplement a natural gas supply. The Bartlett-Hayward Co. was the designer and builder of this equipment. Capacity, 12,000,000 cu.ft. per day.

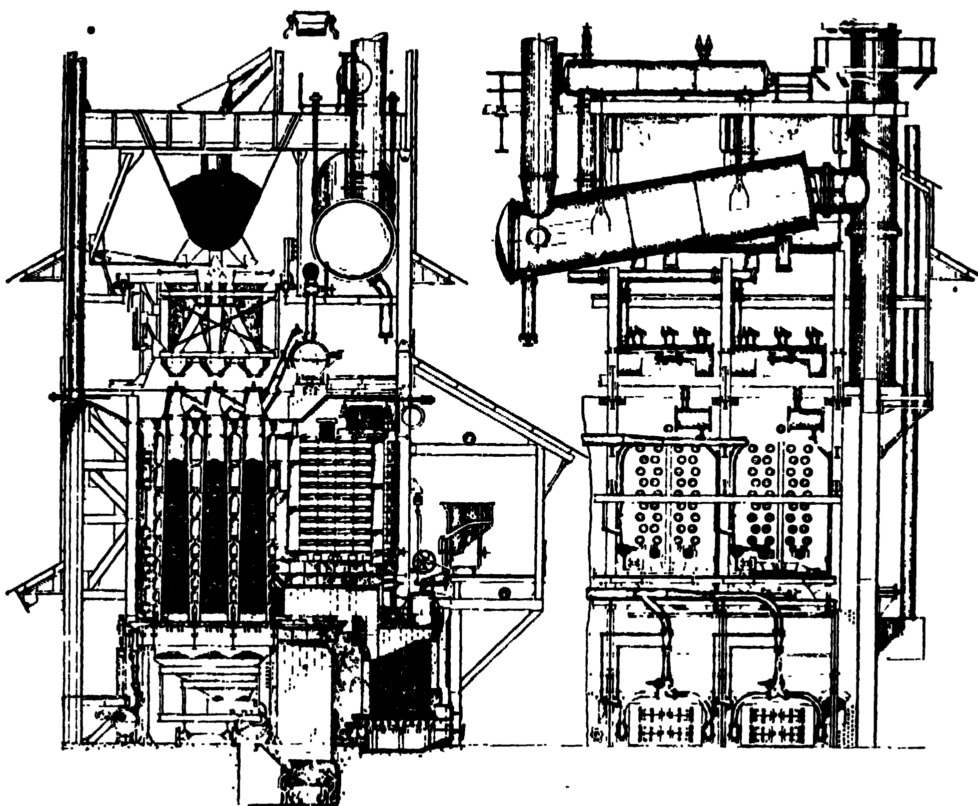
constituents. We know virtually nothing of the shielding effect of one gas upon another and are similarly ignorant as to the influence of time and solid surface action upon these thermal chemical reactions.

Take the case of ammonia alone. We have perhaps the greatest fund of physicochemical information regarding this constituent of crude gas that we have for any of the important products produced by coal distillation. However, except for limited conditions, we know very little as to the influence of factors upon the yield of ammonia. We know vaguely that the presence of a certain amount of water vapor is important in order to protect the ammonia or to facilitate its formation. (No one knows just which it is.) However, we are not quite sure to what extent the higher moisture content of the coal charged is justified, because this would require rather accurate information to balance against the increased ammonia yield the simultaneous increase of fuel requirement for heating the retort or the oven.

The products of low-temperature distillation give great promise. But who knows what low-temperature tar oils are worth? No one apparently. As an important element in our future liquid fuel supply we cannot afford to ignore these liquid products of coal distillation. If we can achieve anything like the estimated yields of these products, say 40 or 50 gal. of liquid per ton of coal treated, the carbonization of large quantities of coal may be justified in order to secure these liquid fuel resources alone. However, until we know much more of the fundamental characteristics of the liquid constituents of crude gas as coming from coal we can neither have direct manufacturing processes for their production nor appreciate the utilization possibilities.

In the future it appears likely that the chemist will come to the mechanical engineer and say somewhat as follows: "Here is the coal we intend to use. We wish to subject it to a certain thermal treatment. We will specify for you the condition of the coal and quantities of the various products which must be handled. We will give you the limitations of temperature, both maximum and minimum, at each stage of the handling of the raw coal, the crude gas and the various products eliminated from the gas. Mr. Mechanical Engineer, you will design and build us a machine to carry through the process within these limitations." Then, and not until then, can the mechanical engineer intelligently and effectively design gas-making equipment.

Of course when that time comes doubtless the engineers and the financial interests will insist upon some measure of uniformity in the processes which the chemist will ask for. This will be only proper, for it will be no more reasonable to build a plant for a single coal than to build a house to suit all the peculiar ideas of one individual. If we build our gas plant for a single coal we place too severe a limitation of raw material which it must have. Nevertheless, recognizing this necessity for certain process uniformity, we will find a much greater variety in thermal history possible for the treatment of our fuels.

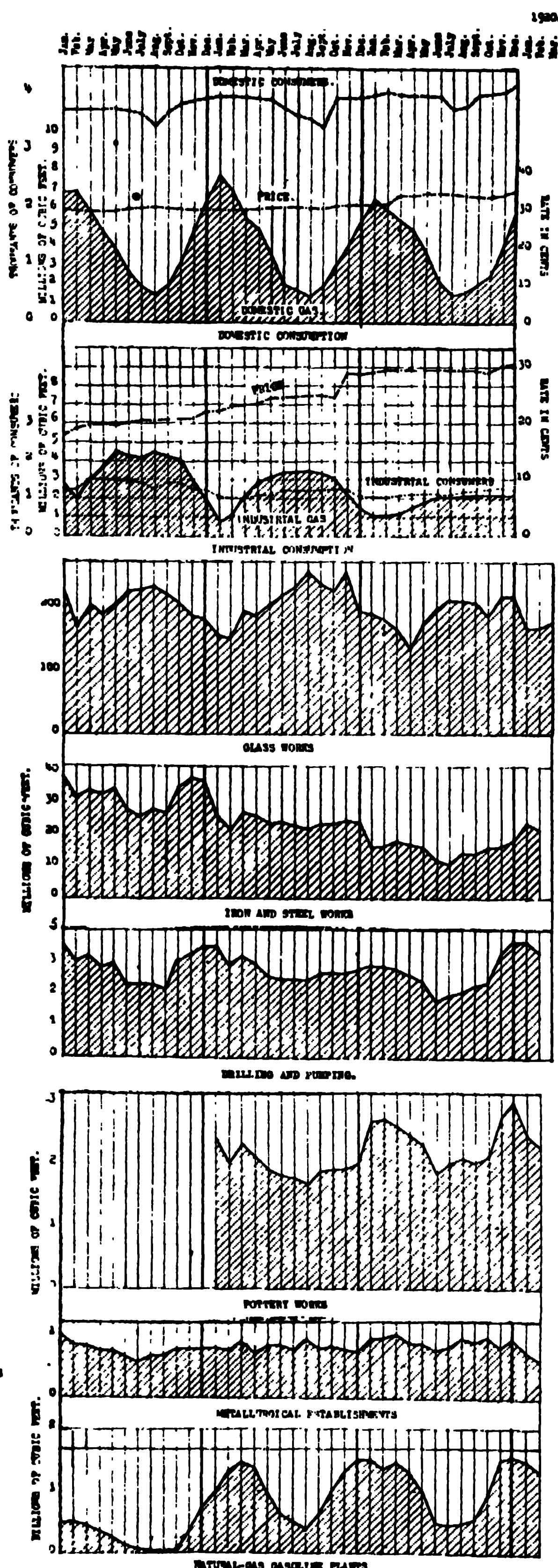


A MODERN VERTICAL RETORT PLANT

This installation shows diagrammatically a typical bench of six or nine retorts with waste-heat boiler, fuel handling, ash handling and producer gas heating accessories as built by the U.G.I. Contracting Co. It is one of several modern types, using intermittent vertical retorts.

The technology of electric power transfer over distances of 200, 300 and more miles is producing a great stir these days. We are talking about superpower systems, with the dispatching of current from one generating system to another system normally supplied by others, thus achieving wonderful advances in generating efficiency and power supply. At the same time natural gas transmission technology has been advancing. Today we have interconnected natural gas-transmission lines covering parts of eight states. Gas actually moves regularly from West Virginia to supply the city of Cleveland, and yet little attention has been given to these achievements. They are equally worth talking about.

Today there exists in western Pennsylvania, West Virginia and adjoining territory a supply of billions of tons of coal. It is a problem how to move the energy which this coal affords us to the seaboard, and into large industrial centers. There are three means to be used. We may move the solid fuel itself; this, of course, will be for many years to come the backbone of the transmission of energy from natural resource to the appliance of the user. However, we must take into account the possibility of generating gas by coking the coal, by gasification of the coke or by other yet undiscovered processes and the transfer of this gas to the industrial and municipal centers. The technology of



FLUCTUATING GAS DEMANDS BY MONTHS AND INDUSTRIES

Figures for domestic consumption, industrial consumption, glass works, iron and steel works, drilling and pumping, pottery works, metallurgical establishments and natural-gas gasoline plants.

The monthly fluctuation in gas demand of various industries here shown - one of the serious difficulties encountered by the gas business. With such fluctuating demands, costs are, of course, correspondingly high.

These data were p[illegible]d by E. G. Sievers of the U. S. Geological Survey.

this business is still young, but it is a thrifty, sturdy youngster.

We can move the coal as above mentioned, but in doing this one pound out of each four is consumed on the way for locomotive fuel simply to haul the remaining three. Judged on the basis of thermal efficiency, this, together with the low yield of heat in the ordinary coal-burning equipment, does not give us any very encouraging result to consider. Suppose instead of this we convert the maximum feasible amount of our fuel into gas and transfer the gas, say, 150 miles. This transfer, according to present none too good natural gas technology, requires only about 5 per cent of the energy for the movement of the remaining 95 per cent such distances as 100 to 150 miles. With careful study of the transmission problems, taking advantage of the latest developments in our knowledge of the physics of the flow of gas and of compression and with the mechanical engineering achievements surely to be expected in the coming decade, it is not too much to expect that the problem of energy transfer from resource to municipal supply will be accomplished by means of gas with an efficiency as great as if not greater than by any other medium. We have similar problems in the electrical business, where the finest of engineering talent is studying just how the balancing of loads, adjustment of load factor and power factor, and power line design will give us the greatest energy efficiency possible. The gas man may well take heed of this sort of investigation and development. With the fundamental advantage that gas can be generated with much higher thermal efficiencies than electric current can be generated by the use of any known processes of today, the gas engineer has much to encourge him.

Of course it would be foolhardy to assume that gas is destined to displace electricity. There is no need for such thought. The proper attitude is that gas and electricity are naturally supplementary, the one of the other. You might even call them "the gold-dust twins" of municipal energy and fuel supply. We need municipal fuel surveys in every large community or district. The total heating and power demands should be analyzed and the most effective means determined for meeting these needs. Gas, electricity and solid fuel will all have their share, of course, and it is important that they should work together to this end. For example, it is recognized as foolish in the present day for the gas industry to waste much time in the house- or industrial-lighting field. First of all, in this business we must have convenience, and there is no immediate prospect that gas can afford anything like the convenience of electricity in this particular work. Why, therefore, waste effort in trying to substitute gas for a more effective, more directly applicable medium? It is admitted to be far better to expend the effort which might thus be wasted on gas in persuading the householder or industrial plant manager to spend the money for any gas-burning equipment in lines where gas is an ideal fuel. For example, the cost of piping a house for gas light can much better be directed to the purchase of gas water-heating equipment or other modern effective devices that can be defended against all comers on the score of both efficiency and convenience.

Gas Utilization an Important Step

It is estimated that not more than 35 per cent of the natural gas delivered in the household is used effectively. In other words, nearly three times as much

service could be obtained from existing gaseous fuel supply in natural-gas territory were proper modern utilization methods pursued. From recent work done in several disinterested laboratories, it appears that this estimate and conclusion is amply justified. The reason for this rather appalling situation is not far to seek.

Until quite recently there has been no effort made in the scientific design of natural gas-burning equipment. A typical industrial-gas burner was a piece of pipe with a pipe cap on one end, a few holes drilled irregularly along its length and a smaller pipe projecting through the other end to supply the gas, perhaps with some means for controlling the air which entered between the smaller and larger pipes, very often no means at all being used for air control. Such device is a gas burner; it is more than this. It is a wonderful gas waster. Manufactured gas appliance manufacturers have not built quite as blindly as this, but some have almost done so. However, all are beginning to recognize that an appliance really does not burn gas. It burns a gas-air mixture. This at once impresses them with the fact that the appliance is a machine to make a mixture which it then subsequently delivers at the point where it is to be burned.

When appliance design reached this stage of interest in the production of air-gas mixtures, it was found that there was no information whatsoever as to the principles of air-mixer design. A few appliance makers have apparently studied the problem a little and have varied their appliance enough to give great improvement, but only recently have the fundamentals been considered. Within the past two years the first comprehensive, thorough work on this problem has been undertaken.

This work took up burner design in three parts. First, how to introduce the gas into the burner, maintaining in the gas stream the maximum of the kinetic energy possible; second, how to use this kinetic energy in building up a mixture, and third, under what conditions this mixture should be delivered to be most effectively burned and the energy of the flame utilized.

This work is only a beginning, however. It illustrates the necessity for study of viscosity, stream-line flow and momentum relations in burner design. The throat design must take into account both theoretical factors and practical matters of convenience in operation, ability of the operator to keep the appliance clean, etc. Already as a result of this work the appliance manufacturer can produce and handle almost "ideal" air-gas mixtures with low pressure gas. Formerly these possibilities were considered impossible without the use of air or gas under high pressure. By means such as this it will be possible to double or treble the efficiency of gas burning under many conditions, and as a result gas will be made available in many fields where before its relative higher cost per heat unit made it unavailable. Then, too, by simply better burner design, moving the burner closer to the kettle and teaching the householder a few simple principles, we shall find that manufactured gas at its much higher cost can replace natural gas, as these supplies decrease and finally disappear, without any increase in cost per month for service rendered above the expense to the householder for natural gas used as now so carelessly and inefficiently.

Gas an Industrial Fuel

Problems of industrial gas application are not limited alone to matters of appliance design. Here we have much the same situation as was described in the coking of coal. We need first to study the fundamentals of the industrial process. We must find out the thermal history to which we wish to subject our materials and then it will be possible quite easily to apply the gas for the production of the temperature-time relations which are desired. Metal melting, metal heat treatment, enameling, baking, boiling or heating the tea kettle all have their problems to be solved. When it is known just how these operations should proceed for perfect satisfaction, the means for accomplishment will quickly follow both in appliance design and in effective gas merchandising. Not only shall we find increased thermal efficiency resulting but it is not too much to expect that actual decreases in fuel cost will come despite the continued rise in the price of fuel raw material, and not only will these fuel advantages occur but there will also be built up opportunities for better quality of product, more uniform plant operation, more satisfactory conditions for work of the furnace and appliance operators, cleanliness of surroundings and numerous other advantages that always follow replacement of solid fuel by gas.

Present Limitations

It would be foolish to close a discussion like this without pointing out one limitation which is just as serious as that of our present limitation of scientific knowledge. In this the matter of construction cost and the high cost of money are referred to. At the present time, even if we wished, it would be foolish to undertake to replace solid fuel by gas for extensive house heating or for other operations where the seasonal load curve is bad. Today it costs $2, $2.50 or $3 to build a plant where previously $1 sufficed. The public utilities that used to get money for such construction at 5 or 6 per cent because of the stable nature of their business now are fortunate if they can secure the money for 7 or 8 per cent. As a result, we have today capital charges, interest, amortization, taxes, all on a basis of about three times as much per unit of gas output. This, of course, places severe limitation upon the expansion of the gas manufacturing industry today, for it makes the capital charge element of gas cost almost as much as the total delivered price was formerly; and the operating expenses, too, are higher today than ever before.

On the other hand, solid and liquid fuel costs have advanced similarly. It is an old story to discuss our "thirty-cent" or "forty-cent" dollar in any market. It is not to be expected, therefore, that this financial limitation will permanently prevent improvement of the opportunity in the gas business. It is high time, therefore, to undertake all of that essential investigation in development work on fundamentals which will permit construction along right lines as soon as construction of any sort begins.

It should be recognized, too, that today the gas plants of the country are called upon to supply all or more than they can produce at seasons of maximum demand. Construction for the future, therefore, will be largely to supplement present capacities. We should not expect it for some years to come to be primarily a replacement of existing processes.

It is none too soon, however, to think of the new developments as being those which will be the backbone of the industry a decade or two from now. The great importance of their proper direction is thus at once evident.

Extraction of Calcium Oxide From Calcined Magnesite

L. H. DUSCHAK, chemical engineer, Bureau of Mines, has recently made a laboratory study of the extraction of the free CaO with water free from CO_2 from calcined magnesite. From the solubilities of $Ca(OH)_2$ and $Mg(OH)_2$, Seidell, "Solubility of Inorganic and Organic Compounds" (2nd Edition, 1919), it is estimated that at ordinary temperatures calcium hydroxide is fifteen to twenty times as soluble as magnesium hydroxide. It should, therefore, be possible to obtain a separation good enough for the purpose indicated by extraction with water.

SOLUBILITY OF $Ca(OH)_2$

Temp., Deg. C.	Grams per 100 g. H_2O $Ca(OH)_2$	CaO
0	0 185	0 140
20	0 176	0 132
30	0 159	0.120
50	0 128	0 097
100	0 077	0.058

SOLUBILITY OF $Mg(OH)_2$ IN GRAMS PER LITER AT 18 DEG. C. BY CONDUCTIVITY METHOD

Solubility	Authority	Date
0 009	Kohlrausch & Rose	1893
0 008 0 009	Dupre & Brutus	1905
0 012	Tamm	1910

As some preliminary experiments indicated that the availability of the lime varied with the temperature of calcination, the majority of the extraction tests were made on material obtained by calcining portions of magnesite in a porcelain crucible at a fixed temperature for a definite time. The procedure commonly used for extracting the lime was to transfer the calcined material to a 200 c.c. graduated flask and add distilled water which had been freshly boiled to free it from CO_2. The flask was allowed to stand with occasional agitation for a fixed time, usually over night. The liquid was filtered if necessary, and a suitable volume, usually 100 c.c., was titrated with standard hydrochloric acid using phenolphthalein as indicator.

With the exception of a few experiments which will be noted below, the results in the accompanying table were obtained by the method just outlined.

A portion of the solution from test 14 was analyzed gravimetrically for CaO and gave a result corresponding to 4.5 per cent CaO. This shows that the alkalinity found by titration is due almost entirely to the $Ca(OH)_2$ in solution. This was confirmed by an experiment in which 3 g. of pure $MgCO_3$ and 0.150 g. $CaCO_3$ were mixed and calcined for one hour at 950 deg. C. The product was then leached with 300 c.c. water. Gravimetric analysis and titration on a 100-c.c. portion of this solution yielded the following results:

	Grams		Grams
MgO by grav	0 0008	CaO by grav	0 0280
CaO by titr	0 0307	CaO by calc	0 0280

In test 3 the calcined material was agitated with water for 3 hr. with CO_2 free air, and in test 15 there was similar agitation for 2 hr. It is evident that agitation in this way for 2 or 3 hr. is the equivalent of considerably longer leaching without agitation.

It will be noted that with the dead-burned magnesia and the magnesia bricks only a small portion of the CaO was found to be available, due, no doubt, to the high temperature of calcination. This influence on the temperature of calcination is also indicated in some of the tests at 1,000 and 1,050 deg. C. In order to determine whether the effect of calcination at high temperature was simply to decrease the rate of solution of the lime, a duplicate of test 13 was run, in which the calcined material was rolled with water for 5 hr. in a glass bottle containing glass marbles. The result was 1.76 per cent CaO, only 0.02 per cent greater than with the ordinary method of leaching. Grinding in this way was tried with several other samples, including some of the dead-burned material, without increasing the amount of soluble lime. This would indicate that calcination at high temperature causes the CaO to enter into some compound which is not decomposible by water.

Test No.	Material	Temp. Deg. C.	Time, Hours	Extraction of CaO, Solvent	Time, Hours	CaO Obtained	Total Present
1	Magnesite M-1 (Northwest)	900	½	H_2O	16	2.13	2.76
2	do.	900	¼	H_2O	16	2.6	2.76
3	do.	900	1	H_2O	3	2.6	2.76
4	do.	900	1	5% NaCl	16	2.7	2.76
5	do.	900	1	5% NaCl	18	2.9	2.76
6	do.	900	1	5% NaCl	18	2.9	2.76
7	do.	900	2	H_2O	16	2.7	2.76
8	do.	900	2	H_2O	16	2.6	2.76
9	do.	950	½	H_2O	16	2.66	2.76
10	do	950 1,000	1	H_2O	16	2.26	2.76
11	do	950 1,000	1	H_2O	16	2.32	2.76
12	do.	1,000	½	H_2O	16	2.05	2.76
13	do.	1,050	½	H_2O	16	1.74	2.76
14	Calcined Magn. M-1-c	950	2	H_2O	16	4.6	5.3
15	do.	950	2	2% NaCl	16	4 5	5.3
16	do.	950	2	2% NaCl	16	4.7	5.3
17	do.	950	2	2% NaCl	16	4.6	5.3
18	Calcined Magn. M-4 (Hoff)	950-1,000	1	H_2O	16	3.13	4.28
19	do.	950 1,000	1	H_2O	16	3.07	4.28
20	Magnesite M-13 (Northwest)	900	½	H_2O	16	1.15	1.1
21	Magnesite M-13 (Northwest)	950	½	H_2O	16	1.23	1.1
22	do.	1,000	½	H_2O	16	0.98	1.1
23	do.	1,050	½	H_2O	16	1.19	1.1
24	Magnesite M-16 (Northwest)	950-1,000	1	H_2O	16	0 3	0.4
25	do.	950-1,000	1	H_2O	16	0.5	0.4
26	Magnesite M-18 Tulare	900	½	H_2O	16	0.76	0.6
27	do.	950	½	H_2O	16	0.67	0 6
28	do.	1,000	½	H_2O	16	0.72	0.6
29	do	1,050	½	H_2O	16	0.63	0 6
30	White Rock	900	2	H_2O	16	0.87	0.7
31	Dead Burned MgO (White Rock)	1,400		H_2O	16	0.33	1.5
32	do.	1,400		H_2O	16	0.31	0.93
33	Magnesite Brick	1,500		H_2O	16	0.23	1.06
34	do.	1,500		H_2O	16	0 24	0.6

ANALYSES OF MAGNESITE SAMPLE USED FOR ABOVE TESTS

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO by Diff	Ignition Loss
M-1	4 65	0 41	0 96	2 76	42.52	48.64
M-4	1 70	0.32	0 36	4 28	87.77	5.73
M-13	1.2	0 01	0.43	1 10	46 8	50.4
M-16	1 73	0 28	0 72	0 4	46 57	50.30
M-18	1 35	0 06	0.14	0.6	47.7	50.16

Research and the Production of Leather Belting

Tribute is paid to the service the chemist has performed in the manufacture of leather belting, in a recent issue of the *G. W. W. Bulletin*, the house organ published by Gaston, Williams & Wigmore, Inc. Speaking of the Graton & Knight Manufacturing Co., of Worcester, Mass., the *Bulletin* says:

"A large and completely equipped chemical laboratory was established by this company a number of years ago and has consistently availed itself of every scientific discovery tending to increase quality. A staff of chemists under a chemical authority on tanning is constantly at work. All raw material is tested and in addition much work of an experimental nature is done in tannage, currying and other processes."

The Post-War Status of the Ceramic Industries*

An Outline of the Need for Reducing the Fuel Consumption and for the Introduction of Labor-Saving Devices, With a Short Review of the Economic Status in the Manufacture of the Various Clay Products

BY A. V. BLEININGER

THE general perplexed condition of American industry extends of course to the silicate industries, dealing with the manufacture of the various clay products, glass and enamel metal ware. The railroad situation, the lack and high cost of fuel and the acute labor conditions are responsible for the most difficult situation which has ever confronted these industries. The two primary aims of the manufacturers must of necessity be to reduce the fuel consumption and to strive for the introduction of labor-saving devices. The first part of this program is being attacked through the use of the continuous and especially the tunnel-car kiln. Rapid progress is being made along these lines and a considerable number of such kilns are being built. The adaption of the tunnel kiln to the manufacture of heavy structural products in large tonnages has not yet been completed and the problems of the successful water-smoking and oxidation of such products still awaits complete solution.

The introduction of the tunnel kiln is undoubtedly one of the most important advances ever made by the industry and means not only a saving in fuel of not less than 50 per cent but a reduction in the labor cost as well. It is interesting to note that the metallurgical and allied industries are awakening to the advantages of this type of furnace and are adopting it for calcining and annealing operations.

There are two types of tunnel kilns to be considered —one in which the gases come in direct contact with the charge and the other in which the heat is transmitted through the walls of combustion chambers. The former type requires the use of saggers for the burning of glazed ware, but in the latter the articles may be set unprotected. These kilns have also been built of the twin type consisting of two adjoining tunnels through which the cars pass in opposite directions. Progress is being made with reference to the use of producer furnaces attached to the kilns and the employment of mechanical stokers. A considerable number of tunnel kilns are now in operation and maintain temperatures as high as 1,450 deg. C.

Labor-saving devices, especially with reference to the more economic handling of raw materials, mechanical driers, automatic molding machines, etc., are being introduced rapidly in the different industries.

BUILDING AND PAVING BRICK

The high cost and scarcity of labor, the difficult freight situation and the extraordinary increase in the price of coal have had a strong depressive influence especially on the plants compelled to ship their product. The prices of the product have gone up to unprecedented levels through the enormous increase in the cost of manufacture. The difficulty of securing labor has been a very important factor, since the hard manual labor of the brick yards does not attract the best workmen. Altogether the building and paving brick industries are laboring under serious difficulties. This applies still more strongly to the paving brick industry, dependent as it is upon road improvements and new projects for which municipalities find it difficult to obtain the money. The demand for brick products is fundamentally strong and is bound to be great for at least the next five or ten years.

BUILDING TILE AND SEWER PIPE

The demand for hollow building tile is increasing very rapidly with the enlarged use of stucco construction and the plants have ample orders. They, like the other structural clay products industries, are seriously handicapped by the prevailing conditions.

The sewer pipe industry, like the manufacture of paving brick, is hampered by the difficulties in the way of carrying out municipal improvements.

TERRA COTTA

This industry after its dormant existence during the war has revived considerably and is certain to regain its pre-war status as soon as the conditions permit it. The manufacturers are making rapid progress in the development of superior bodies and techniques. In one establishment the tunnel car kiln is being used, a step which is being watched with considerable interest.

In the Middle West States the question as to the feasibility of washing the terra cotta clays is being discussed and may lead to the erection of central preparing plants.

FLOOR AND WALL TILES—POTTERY

Manufacturers of floor and wall tiles have been considerably hampered by the general obstructions to industrial activity and the labor situation, so that it has been difficult to maintain even approximately normal conditions.

The pottery industries have suffered particularly with reference to their supply of raw materials, especially feldspar. This condition has become very serious, and for this reason increasingly large quantities of soda feldspar are being introduced in the body. In addition to these difficulties the question of the fuel supply has become very critical, especially in the districts where natural gas is no longer available. Unheard-of prices are being paid for coal in the eastern pottery districts.

A report issued some time ago jointly by the U. S. Potters' Association and the Bureau of Standards brings out the fact that the domestic kaolins are suitable for the manufacture of white ware pottery, but that at the present time the supply of primary kaolin is not sufficient

*Published by permission of the Director, Bureau of Standards.

to meet the needs of the industry. The use of imported English china clay therefore cannot be dispensed with until additional sources are developed in this country.

The demand for high-grade domestic porcelain tableware is constantly increasing and is being met by the enlargement of a number of potteries and the erection of new plants.

The tunnel kiln is rapidly establishing itself as a permanent feature of potteries, a situation very much to be desired.

Electrical Porcelain

The newer developments tend toward the more extensive introduction of the casting process in the making of high tension porcelain and the employment of somewhat higher burning temperatures.

More critical tests are being employed in the examination of the porcelain structure, such as by the penetration of alcoholic eosine solution under pressure, and the quality of the material is being raised generally. Extensive researches are being conducted by a number of concerns which strive for improvement in the product.

In the manufacture of spark plugs the quality has been pushed to a high degree of perfection and there is no doubt that these motor accessories are decidedly superior to the European product. High temperatures, about 1,450 deg. C., are employed in the firing, and tunnel kilns have been successfully adapted to this purpose.

Chemical Stone Ware

This industry has been established on a firm basis and has made the United States independent of European products. Both as to quality of the material and the technique of producing intricate shapes the standards are very high.

The Glass Industries

The demand for glass products of all kinds is very great and is not being adequately supplied, due to conditions beyond the control of the industry. The deficiency in fuel supply has been a serious drawback to production. The elimination of natural gas has made it necessary to equip many plants with exceedingly large and expensive producer gas plants and to adapt the tank practice to this fuel.

The activity in developing new mechanical processes has been particularly marked, especially in the manufacture of window glass and hollow ware. The methods of drawing straight sheets from the molten glass, the automatic feeders and presses, and tube drawing machines have all contributed toward lowering the excessive labor cost connected with the old practices. Incidentally it might be said that the wages of the glass operatives have gone up to high figures, so that it is not unusual to find gathering boys receiving earnings at the rate of $2,000 per year. Improvements have also been made in the preheating of the pots and the installation of the tunnel kiln for this purpose.

Enameled Metals

The manufacture of enameled cast-iron and steel products has been handicapped by difficulties in securing raw materials, especially feldspar and cryolite. Enameling processes are being applied to an ever-increasing number of articles, and as a result the industry is expanding rapidly. From the research point the results of the work done by the Bureau of Standards on the subject of "fish scaling," a common defect, are of importance and it can be safely predicted that this source of loss can soon be eliminated.

Refractories

As compared with war-time activities the demand for these products is small in volume, though the plants are continuing operations as regularly as is possible under the prevailing conditions. The demand for special refractories of high quality is very good and there are strong indications that considerations of quality will in the future govern sales to a much greater extent than they did in the past. It is being realized more and more that the first cost of refractory materials is secondary to quality. The work of such organizations as the American Society for Testing Materials in advocating specifications for refractories is bringing returns and users are coming to realize the importance of having definite requirements.

Basic refractories are still being made from American magnesite and the prospects are fair that the Washington deposits will remain a permanent source.

Work in connection with the further development of improved materials for electric furnaces is in progress. The use of silicon carbide as a refractory has made rapid strides.

In the manufacture of graphite crucibles it has been shown by the Bureau of Mines that American clays of the ball clay type are as well suited for the purpose as those formerly imported from Germany and in some respects are superior.

The refractories used in the glass industry are still being made to a large extent from domestic raw materials, though some shipments of Gross Almerode clay have been received. Considerable progress has been made in connection with the improvement of tank block compositions and firing treatments which should yield longer tank life.

Research Work

It is gratifying to note the realization on the part of the manufacturers that industrial research has a real money value and the demand on the part of the industries for young men trained in ceramic engineering has been greater than the supply. Many concerns have established works laboratories when formerly they could not be interested in activities of this kind. In several instances associations of manufacturers have established either a joint laboratory or are supporting research fellowships.

Associations

A very important factor in developing the new spirit of co-operation has been the associations of manufacturers, such as the National Terra Cotta Society, the National Paving Brick Association, the Hollow Tile Association, the Common Brick Manufacturers' Association, the U. S. Potters' Association and others.

From the standpoint of technical development the American Ceramic Society has undoubtedly been the most important factor. The creation of divisions representing the several branches of industry has been a notable step in bringing about closer co-operation between the manufacturer and the technical man and the scheme is already yielding good returns. The society has been fortunate in the wide vision of its officers, who have seen the opportunities for greater service and have grasped them.

Products From Dry Distillation of Matita Asphaltum*

BY C. NICOLESCU-OTIN

BITUMEN is a very complex substance, and to be able to examine the properties of its constituent parts, it must be subjected to a distillation process. Materials are thereby obtained which do not exist as such in the original, but are split off during the course of the destructive distillation and which permit us to see the nature of the complexity of the bitumen.

The distillation took place in retorts, made of earthenware and iron, and the temperature was measured with a Le Chatelier pyrometer. Various gaseous, liquid and solid products were obtained. At the beginning of the distillation, the evolution of much water vapor was remarked, which comes from the water that is mechanically combined. Then, when the temperature increased to 400 to 460 deg. C., large quantities of a bluish-gray gas were produced. This gas contained considerable H_2S.

As the temperature increased, the gas gradually lost its color, and around 730 deg. C. its content in H_2S and water vapor had changed, due to the molecular decomposition that had taken place.

The gas contains about 1,500 l. of H_2S in 180 cu.m. —the quantity obtained from one ton of the bitumen— and possesses the following composition: 12.1 per cent CO_2, 2.6 per cent C_nH_{2n}, 1.9 per cent O, 13.1 per cent CO, 29.8 per cent H, 34.7 per cent CH_4 and 5.4 per cent N.

The asphaltum contains 0.88 per cent N, of which 24 per cent is recovered in the ammoniacal liquors as NH_3. This means that for every ton of bitumen there is obtained 2.5 kg. of NH_3 or 10 kg. of sulphate of ammonia. This quantity is almost equal to the yield procured from coal.

The solid residue, left in the retort after distillation, consists of the mineral part of the asphaltum, mixed with 5.6 per cent very fine carbon. The most valuable product of the distillation is the tar, which represents about 46.6 per cent of the weight of the bitumen. The tar is olive colored and holds in suspension very finely divided carbon. It has been noticed that the iron of the retort facilitates the decomposition of the tarry vapors, producing thereby a lesser quantity of tar—47 per cent—with more carbon in suspension—1.7 per cent—in comparison with the yield obtained in an earthenware retort, 56 per cent tar and 0.6 per cent carbon in suspension. The tar has a specific gravity below unity, varying between 0.908 and 0.930 at 18 deg. C., indicating that it must contain a large quantity of hydrocarbon oils and paraffines.

FRACTIONAL DISTILLATION OF THE TAR

The fractional distillation of the tar, first up to 310 deg. C. under normal pressure and then between 200-275 and 275-310 deg. C. under a vacuum, yielded fractions, with the corresponding specific gravities, are given in Table I.

Furthermore, these fractions were analyzed to find their ultimate composition and the iodine, saponification and total acidity numbers were determined. The results are given in Table II.

*Abstracted and translated from *Bulletin de la Section Scientifique de l'Académie Roumaine*, vol. 5, pp. 129-38.

TABLE I

Fraction	Per Cent of Tar	Specific Gravity
Up to 170°C	6.23	0.7900 at 20 C
170-230°	9.73	0.8420 at 20 C
230-270°	9.45	0.8770 at 20 C
270-310°	10.70	0.8990 at 20 C
200-275°	15.90	0.9425 at 25 C
275-310°	5.55	0.9725 at 25 C
Above 310°	23.96	1.0060 at 15 C

TABLE II

Fraction	% C	% H	% N	% S	% O	Numbers — Iodine	Numbers — Sapon.	Total Acidity
Up to 170°C	83.73	12.66	0.41	0.11	3.09	150.85	12.31	2.74
170-230°C	84.94	11.51	2.52	0.06	1.42	101.06	14.65	4.71
230-270°C	85.28	11.86	0.87	0.09	1.90	62.47	20.12	10.12
270-310°C	84.27	10.96	1.24	0.09	3.44	51.29	12.34	0.68
200-275°C	81.67	11.57	2.42	0.38	3.96	34.54		
275-310°C	85.18	10.89	1.22	0.42	2.29	31.63		

The oxygen was determined by difference.

These results indicated that the elements entering into the composition of the bitumen, namely, C, H, S, N and O, are found in all the fractions; that the saponification and acid numbers are relatively small, but that the iodine numbers are large, indicating a considerable proportion of non-saturated cyclic and aliphatic hydrocarbons; that the quantity of these compounds present diminishes as the ebullition point increases.

To determine the quantity of non-saturated cyclic hydrocarbons in relation to the non-saturated aliphatic hydrocarbons contained in the fractions, the Nastjukoff reaction was used, whereby the formolite number was found by means of formaldehyde. The formolites themselves were also analyzed and the combined results are given in Table III. As in Table II the O percentages are found by difference:

TABLE III

Fractions	Formolite Number	Composition of the Formolites, per Cent — C	H	N	S	O
Up to 170°C	42.55	71.50	10.01	2.90	1.58	14.01
170-230°	36.25	73.37	11.64	4.11	1.57	9.31
230-270°	48.50	74.25	10.35	5.38	0.97	9.05
270-310°	72.16	77.15	11.58	4.67	0.96	5.64
200-275°	35.33	73.88	10.67	3.50	1.30	10.65
275-310°	38.90	78.25	10.35	4.15	1.03	6.22

From the above, it is seen that the formolite numbers are relatively small and that the formolites contain the five elements C, H, S, N and O, which are found in the sulphonated derivatives of the original products, which substances contained S and N and probably O as well in their molecules.

In order to substantiate our conclusion that the formolite reaction eliminates all the compounds containing N, S and O from the fractions, the liquid residues were analyzed and were found to contain C and H only. The results are given in Table IV.

TABLE IV

Fraction	up to 170° C	170-230°	230-270°	270-310°	200-275	275-310
Per cent C	86.90	87.27	87.12	87.35	86.62	86.12
Per cent H	12.82	12.62	12.76	12.39	12.92	13.36

The exact ratios between the cyclic and non-cyclic unsaturated hydrocarbons present in the original fraction can be determined by means of the iodine numbers of these very residues, by taking the difference between these numbers and the iodine numbers of the fractions. They are given in Table V.

TABLE V

Fraction	Up to 170°C.	170 230°	230 270°	270 310°	200 275°	275 310°
Iodine number of original fraction	150 85	101 06	62 47	51 29	34.54	31 63
Iodine number after the formolite reaction	34 78 116 07	43 01	22 44	23 69 27 05	24 07 10 47	19 95

As may be seen from the above, the unsaturated cyclic hydrocarbons predominate in the fractions having the lower boiling points, while the unsaturated non-cyclic hydrocarbons are predominant in the higher boiling-point fractions.

The Composition of Matita Asphalt

The researches of Prof. Charitskoff of Tiflis (*Chem. Zeit.*, 1912, p. 1,402), who examined the fractionated products of asphaltic tar and petroleum from Grosny, led him to conclude that the petroleum was a decomposition product of the asphalt. The author undertook a series of researches to establish the relation between the origin of Matita asphalt and petroleums. The petroleum that was used had a specific gravity of 0.902 at 20 deg. C. and contained 85.60 per cent C., 13.64 per cent H, 0.35 per cent N and 0.07 per cent S. On fractionation, the following products were obtained:

Up to 150 deg. C., 35 per cent by volume was distilled over, with a specific gravity of 0.721 at 20 deg. C.

From 150 to 300 deg. C., 33 per cent by volume, specific gravity, 0.817 at 20 deg. C.

Residue above 300 deg. C., 32 per cent by volume, specific gravity, 0.948 at 20 deg. C.

As can very well be seen, the petroleum fractions differ radically from the tar fractions, both in quantity and density. However, to compare them better, the saponification and iodine members have been determined for the oil fractions as well and are given in Table VI.

TABLE VI

Fractions	Saponification Number	Iodine Number
Up to 150°C	1.30	1.88
150-300°C	6.87	3.27
Above 300°C	7.76	12.86

It is at once evident that the saponification and iodine members of the petroleum fractions—and hence of the oil itself—are much smaller than those of the corresponding tar fractions, indicating a very small proportion of saponifiable compounds and unsaturated cyclic and non-cyclic hydrocarbons. This constitutes the primary difference between the tar and the petroleum.

The Nastjukoff reaction was employed, as in the case of the tar, to determine the cyclic : non-cyclic ratio and the analysis of the formolites gave the results shown in Table VII.

TABLE VII

Fractions	Formolite Number	—Composition of the Formolites— %C	%H	%S	%N	% O (by Difference)
Crude oil	22 13	64.83	11 11	4.55	4 08	15.43
Up to 150°C	4 60	79 61	10 88	1 48	2 06	5.97
150 300°C	21 38	77.20	9 89	1 97	1.90	9.04

Here also it is seen that the formolite members are smaller than those of the corresponding tar fractions, but that, just as in the latter case, the formolites contain the five principal elements C, H, N, S and O found in the sulphonated derivatives of all the original products which have S, N and O in their molecules.

To corroborate our theory that formaldehyde refines the petroleum, an analysis was made of the liquid residue remaining after the treatment of crude oil with formaldehyde. The analysis showed the residue to contain only C and H (85.98 per cent C and 13.39 per cent H).

The ratio between the unsaturated aromatic and aliphatic hydrocarbons was found by taking the iodine numbers of the crude petroleum and of the liquid residue from the formolite reaction. The results follow:

	Iodine Number
Crude petroleu	6.02
Liquid residue	3.75
Difference	2.27

Hence the proportion of unsaturated aliphatic hydrocarbons (3.75) is greater than that of the aromatic (2.27), which is contrary to that of the tar, where the aromatic type is predominant. In the case of the lower boiling-point fraction, this difference is even more pronounced.

Conclusion From the Researches

The conclusions that may be derived from these researches are as follows:

1. The fractionated products of the tar are comparatively much less in quantity at the lower temperatures than in the case of the petroleum. This indicates that the original hydrocarbons in the petroleum have been subjected to a strong polymerization, which was caused by the oxygen in the air and was a gradual process, particularly facilitated by the fact that the petroleum, distributed throughout the sandy argillaceous rock, offers a very large reaction surface. Compounds of heavy molecular structure are formed in this way, which results in the elevation of the boiling point.

2. The same conclusion is reached from a consideration of the fact that the saponification numbers of the tar fractions are greater than those of the oil fractions. The oxygen in the air has polymerized the hydrocarbons, producing saponifiable compounds of various nitrogen bases, which characterize the bitumen.

3. The presence of large quantities of aromatic hydrocarbons in the tar fractions substantiates the contention that the bitumen is a product of the petroleum, for it is well known that by means of oxygen, pressure, temperature and especially time, saturated aliphatic hydrocarbons are transformed into non-saturated aromatic hydrocarbons. Such a transformation can be made to take place in the laboratory on the petroleum residues.

4. The tar products are characterized by relatively large proportions of S and N, which explains once more the molecular polymerization of the petroleum constituents.

From this study of the experimental results, it can be stated with certainty that Matita asphaltum was formed during the geologic ages by the polymerization of the hydrocarbons contained in Matita petroleum, distributed throughout the sandy argillaceous and shell-bearing marine deposits. Accordingly, its primordial origin is identical with that of the petroleum.

General Conclusions

The following general conclusions may be drawn from this general study of Matita asphaltum:

1. Matita asphaltum, found in quite large quantities

—valued at 30 to 35 million francs—should constitute a source of exploitation of the first rank, because of its superior qualities as an asphalt, its high bitumen content (29 per cent), as well as for the favorable transportation conditions.

2. Matita asphaltum, when dry distilled, produces a combustible gas, which resembles that obtained from lignites in composition and yield (about 180 cu.m. per ton of bitumen).

3. The dry distillation yields about 10 kg. of $(NH_4)_2SO_4$ per ton of bitumen, 24 per cent of the N in the bitumen being recovered as NH_3. The $(NH_4)_2SO_4$ yield is equal to that obtained from coal.

4. The coke procured in the dry distillation may be used in the refining of petroleum in place of florida earth. In any case it can be used as a ballast.

5. The tar has a specific gravity below unity and at least 120 kg. of it is obtained from every ton of asphaltic rock, or 450 kg. per ton of bitumen. This is an extraordinarily large quantity, and offers a fine source of profit, as it contains, especially in the lower boiling-point fractions, a high percentage of aromatic compounds, as well as a large amount of paraffine and hydrocarbon oils in the higher boiling-point fractions (the 200-275-deg. fraction contains 30 per cent paraffine). There is hence presented the possibility of manufacturing several explosives and there is here a precious source of paraffine, petrolatum and mineral oils of high quality.

6. The researches on the geo-chemistry of Matita petroleum and asphaltum have undoubtedly proved the latter to be a polymerization product of the former.

Steel Wizards, Past and Present

Professor Sauveur's Address Before the American Society for Steel Treating, in Which He Makes a Plea for More Important Contributions to the Art of Making Steel by American Metallurgists and Researchers

BY ALBERT SAUVEUR*

WE ARE rightly proud of our achievements, of the wonderful steel industry of our country, of our leading position as the greatest iron- and steel-producing nation in the world, but lest we forget what we owe to the steel wizards of other lands it will be salutary to recall their deeds. It will keep us from too complacent an attitude toward other metallurgical nations reporting smaller tonnage. It should stimulate in us a desire to contribute more substantially to the progress of the art in which we are interested.

We have been eminently successful. Our iron and steel industry has added vastly to the wealth of the nation. A book has been written entitled "The Romance of Steel; or, The Making of a Thousand Millionaires." Our business men, our captains of industry, our financial wizards have played their parts most successfully. Can the same tribute be paid to our scientific and technical wizards? Have they played their parts, or have they been satisfied with following the tracks of wizards of other nations? Can they be accused of parasitic tendencies?

I should first describe what I have in mind by steel wizards. I mean those men who have contributed the great basic inventions upon which the iron and steel industry is founded—men like Huntsman, Cort, Réaumur, Bessemer, Abraham Darby, Tschernoff, Osmond, Le Chatelier, Sorby, Howe— men whose discoveries, inventions or scientific contributions are epoch making.

OUR CONTRIBUTION CHIEFLY LABOR-SAVING DEVICES

Is it not true that although being by far the greatest iron- and steel-producing country we have not contributed our share of these great inventions, discoveries and scientific achievements? Is it not true that our contributions have been chiefly of a mechanical kind, that they have consisted in the main in labor-saving devices and machinery destined to cheapen and speed up production? In this we have been undoubtedly successful and the importance of speeding up and cheapening production is not to be denied or belittled, but should we be satisfied with great advances in this direction only?

American mechanical wizards have passed through our steel plants and have left their marks, but do we not look in vain for evidences of the passage of American metallurgical wizards?

Is it not true, and is not the thought somewhat humiliating, that if all the contributions of American metallurgists and scientists to the art of making steel had never been made, iron and steel would continue to be manufactured, worked and treated practically as they are today, in reduced proportions to be sure, but of unimpaired quality? Is it not also true that if the contributions of English metallurgists and scientists were withdrawn the entire structure of the iron and steel industry would ignominiously collapse? We would have neither puddling furnaces, nor crucible steel, nor bessemer steel, nor open-hearth steel, nor rolling or forging appliances.

We make more pig iron than any other country, but the blast furnace was neither invented nor developed in the United States. We have discarded the expensive fuel charcoal, but this was first done by the Englishman Dud Dudley in 1619. We make more coke and use more coke for iron making than any other nation, but coke was first made and first used as a blast-furnace fuel in England by Abraham Darby, who in 1735 had the inspiration of treating coal as the charcoal burners were treating wood.

More waste gases issue from our blast furnaces than in any other country, and possibly we utilize them

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more thoroughly, but this has been made possible by the invention of metallurgists of other nations: by Aubertot in France, who in 1811 took a patent for the utilization of the waste gases; by James Beaumont Neilson of Glasgow, who in 1828 first suggested the use of hot blast; by Robert du Four in France and James Palmer Budd in England, who in 1833 and 1845 respectively suggested the heating of the blast by burning waste gases; by Philip Taylor in England, who in 1840 suggested the closing of the top of the furnace that the waste gases might be collected; by G. Parry of England, who in 1850 invented the bell and hopper or cup and cone as a means of closing the top of the furnace; and by the Englishman E. A. Cowper, who in 1860 introduced the use of regenerative brick stoves. We have now, I believe, a greater number of gas blowing engines than any other country, but the internal-combustion engine using blast-furnace gas was developed at Seraing in Belgium and we were at first quite reluctant to adopt it.

As notable improvements in blast-furnace operations we may claim, I believe, the automatic loading by skip cars and inclined planes and the double bell and hopper which that method requires.

We make more wrought iron than any other country, but the reverberatory puddling furnace was invented in England in 1784 by Henry Cort and the wet puddling process was introduced in that country also by James Hall and S. B. Rogers about 1830.

In the Steel Industry

We have a very important crucible-steel industry, but crucible steel was first made by an English clock maker, Huntsman, in 1740, while the method we follow by which we do away with the necessity of using blister or converted steel was introduced by the Englishman Mushet in 1801.

We are making more bessemer steel than any other nation, but the bessemer converter and its necessary equipment was invented in 1856 by the illustrious Bessemer, an Englishman of French parentage, and the bessemer process was made successful by Robert Forrester Mushet, another Englishman who discovered the necessity of adding spiegeleisen or manganese in some other form.

The basic bessemer process, in which, to be sure, we are little interested, resulted from the masterly investigation and study of two Englishmen, Sidney Gilchrist Thomas and his cousin Percy C. Gilchrist, in 1878.

We make more open-hearth steel than any other country, but the regenerative furnace is not an American invention and open-hearth steel was first made by the French metallurgist Emile Martin in 1865.

We are, if I am not mistaken, making more electric steel than any other country, but we took practically no part in the development of the electric furnace for steel making, the furnace we most use being the invention of the French metallurgist Héroult.

We make more ferro-alloys and more special or alloy steels than any other nation, but the most important of these with the exception of high-speed steel we owe to the labor of metallurgists and scientists of other countries.

Our yearly tonnage of malleable castings is very much greater than that of any other nation, but the invention of the process is to be credited to the illustrious French chemist Réaumur, who described it in 1722. To him also we owe the first scientific study and disclosure of the cementation and case-hardening processes.

We roll and forge more steel than any other nation, but with the important exception of the three-high rolling mill, rolling and forging appliances were not invented by us. The two-high pull-over grooved mill was invented by Cort; the reversing mill in 1866 by Ramsbottom in England; the universal mill is a German invention; the continuous mill was invented in 1861 by the Englishman Charles While, although it has been much improved by the American engineers Bedson and Morgan. We owe the steam hammer to the genius of two Englishmen, James Watt and James Nasmyth, and hydraulic presses to the Englishmen Bessemer and Gledhill.

We treat a larger tonnage of steel than any other country, but can we claim that the scientific investigations which have lifted the art of treating steel to such high degree of perfection are due chiefly to American metallurgists and scientists? Is it not true that with the exception of the invaluable contributions of Prof. Howe the work has been done chiefly in Russia by Tschernoff, in England by Sorby, Roberts-Austen, Arnold, Stead and Rosenhain, and in France by Osmond, Le Chatelier, Guillet, Charpy, Portevin, Chevesnard and Grenet?

High-Speed Steel the Exception

The discovery of high-speed steel, or, if you prefer, of the treatment imparting high-speed properties to certain steels, by F. W. Taylor and Maunsel White, I am inclined to consider as our one epoch-making contribution to the metallurgy of steel. I am well aware that some have tried to throw doubts on the novelty of this discovery, but in my opinion their contentions are not only ungenerous but unjustified. It continues to shine as the brightest American star of the metallurgical sky.

America's Roll of Honor

On a roll of honor for notable inventions, discoveries or improvements in the art of making, working or heating iron and steel or for notable and fruitful scientific contributions to that art, the following Americans are, I believe, entitled to a place:

H. H. Campbell, for designing the first tilting open-hearth furnace.

John Fritz, for his invention of the three-high rolling mill.

James Gayley, for conceiving and executing the drying of the air blown into blast furnaces.

A. L. Holley, for notable improvements in the construction of bessemer mills.

Henry M. Howe, for his invaluable scientific contributions to our knowledge of steel.

Robert W. Hunt, for his pioneer work in bessemer steel and in steel-rail manufacture.

W. R. Jones, for introducing the use of mixers in steel making.

Julian Kennedy, for notable improvements in the construction of blast furnaces and of blast-furnace equipment.

F. W. Taylor and Maunsel White, for their epoch-making discovery of high-speed steel.

Samuel T. Wellman, for notable improvements in the construction of open-hearth furnaces, for designing and constructing charging machines and other useful appliances.

Frederick W. Wood, for his introduction of the car-casting method for steel ingots.

CONCLUSION

The natural conclusion of my remarks must be a wish that we may become more prolific in steel wizards of the first order—that is, in metallurgists who will not be satisfied in merely speeding up production through ingenious labor-saving and other devices, but who will bend their energy and talent toward the discovery of new and epoch-making methods of producing, working and treating steel that we may in future, as the leading metallurgical country, contribute our full share to metallurgical progress.

Additional Technical Papers From Steel Treaters' Convention

IN THE last issue of CHEMICAL & METALLURGICAL ENGINEERING (vol. 23, p. 565, Sept. 22, 1920) there were presented brief abstracts of a few of the papers read before the first meeting of the American Society for Steel Treating. Lack of space and exigencies of publication made it necessary to hold over Prof. Sauveur's address, as well as the following abstracts gathered during the technical sessions.

FATIGUE STRENGTH OF CARBON SPRING STEEL

An important paper on the effect of heat treatment on the fatigue strength of steel was read by E. P. STENGER and E. H. STENGER, covering an investigation of spring steel made at the Sheldon Spring & Axle Works. They notice that fatigue failures are somewhat similar to failures in brittle material in that they occur with suddenness and show no deformation. Brittle metals, however, have a uniform-grained fracture, while laboratory and service failures under fatigue show a larger or smaller area of fine-grained "detail" fracture near the point of maximum stress surrounded by coarser grain.

After defining fatigue strength as the number of repetitions required to produce failure at a given stress, the authors reviewed the literature and listed the following facts which are known about the fatigue strength of steel:

First, the number of repetitions required to cause failure has a logarithmic relation to the maximum unit fiber stress. It is especially noted that there is no break in the curve at the elastic limit.

Second, the number of repetitions to cause failure depends upon the range of stress—that is to say, upon the difference between the maximum and minimum stresses imposed upon the steel. There is a certain range which will allow an infinite number of repetitions without failure, but this range narrows as the maximum stress increases.

Third, the fatigue strength is independent of the speed up to 2,000 per minute.

Fourth, rest and repeated tempering below Ac, does not increase the endurance of unhardened steel.

Fifth, cold work affects the fatigue strength variously.

Sixth, endurance of metal shows a maximum when the metal is held at from 300 to 400 deg. C.

Seventh, the endurance of carbon steels is greatest with hardened eutectoid steel.

The authors describe in detail the heat treatment and preparation of samples in their research upon a carbon spring steel containing the following analysis: Carbon 1.03 per cent, manganese 0.45 per cent, sulphur 0.025 per cent, phosphorus 0.026 per cent. They conclude that the shape factor is of great importance because it gives a non-uniform disposition of internal loads with stresses highly concentrated at certain points. Again, the condition of the external surface, whether impaired by the gases of the heat-treating operation or ground clean, has an enormous influence upon the fatigue strength of the sample. Results of their systematic tests on this carbon steel are plotted in Fig. 1, from which many inferences may be drawn.

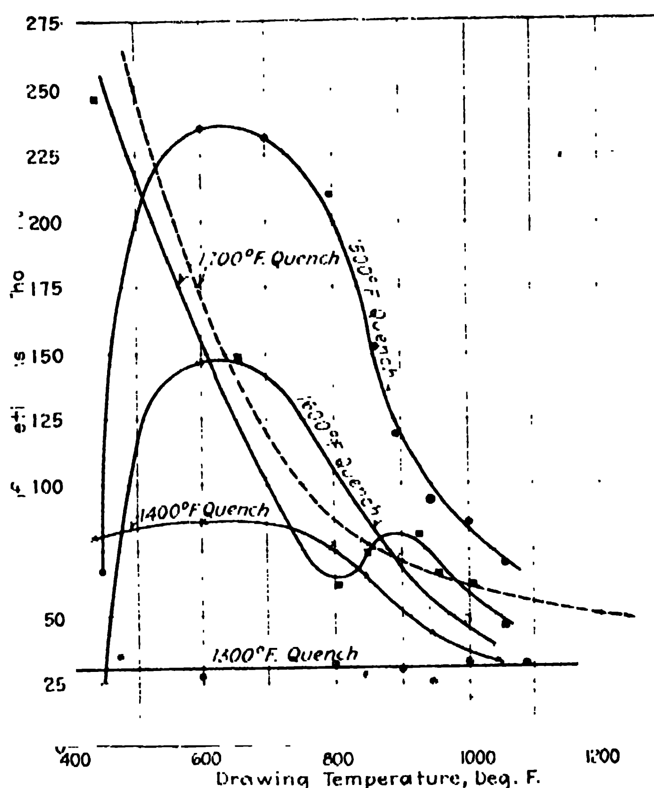


FIG. 1. ENDURANCE OF CARBON SPRING STEEL AFTER VARIOUS HEAT TREATMENTS

Two curves are shown for the 1,700 quench. The authors are of the opinion that a parabolic curve such as the dotted one may be more reliable than the full line following the points more closely, since one of the bars drawn at 450 deg. F. withstood nearly 8,000,000 repetitions. They also remark that it is very hard to get test pieces from a 1,700 quench free from a multitude of finest hardening cracks.

A complete study of their results from all angles appears to show that the maximum fatigue strength of this steel varies both with the quenching and with the drawing temperature. Apparently the sample has the best resistance when it has been quenched from just above Ac_{cm}, which obliterates the previous grain structure. They also found that bars hardened from this temperature showed the highest strength after drawing to a structure of troostite. A final important conclusion of the authors is that re-shaped springs fail very quickly; in other words, a duplication of regular heat treatment on springs that have been used for some time actually hastens fatigue failure.

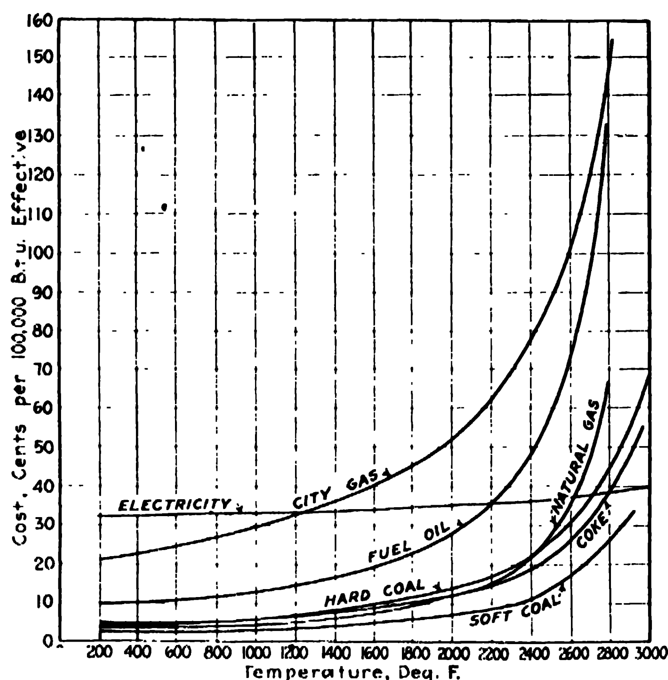


FIG. 2—COST OF MAINTAINING FURNACES AT VARIOUS TEMPERATURES AND WITH DIFFERENT FUELS

Economy in Electric Furnaces

E. F. Collins, of the General Electric Co., presented a paper on "Relative Themal Economy of Electric and Fuel-Fired Furnaces," containing the diagram reproduced in Fig. 2. This was plotted from data figured for perfect combustion with 50 per cent excess air, and regards nothing except cost of heat units involved.

DATA FOR CURVES

Points Figure 1 Deg. F.	Suitable for	Radiation Loss per Cent
400	Baking	15
1600	Heat treating	20
2300	Forging	30
2800	Melting	40

Source of Heat	Calorific Value	Rate
Coke	13,000 B.t.u. per lb.	$10.00 per ton
Electricity	3,415 B.t.u. per kw.-hr.	9.81 per kw.-hr.
City gas	593 B.t.u. per cu.ft.	1.00 per M
Fuel oil	19,000 B.t.u. per lb.	10 per gal.
Anthracite	12,000 B.t.u. per lb.	10.00 per ton
Bituminous	12,500 B.t.u. per lb.	5.00 per ton
Natural gas	1,100 B.t.u. per cu.ft.	30 per M

As a matter of fact, electric power is actually cheaper per B.t.u. at higher temperature, although convenience, ease in handling, automatic regulation, low repairs and overhead have favored electric heating even at low temperatures. Metallic resistor furnaces are therefore very popular in enameling ovens, core-baking ovens, drying and annealing furnaces and hardening furnaces. Arc, induction, or carbon resistor furnaces are also widely applied to forging and melting furnaces; in large installations their relative economy in cost of heat is less than inferred from the curves owing to the possibility of regenerating heat lost from carbon-fired furnaces in products of combustion.

Determining Comparative Efficiency of Combinations of Alloys in Steel

"A Suggested Method for Determining the Comparative Efficiency of Certain Combinations of Alloys in Steel" was given by J. D. Cutter, metallurgist for the Climax Molybdenum Co. His thesis is that if some value be assigned to the effect of a certain alloy addition (merit index), and this value be divided by the cost of the additions, then the quotient will be a figure which represents relatively the comparative value of the combination under discussion. Merit index should be proportional to the ability of steel to withstand work done upon unit quantity—i.e.,

$$\textit{merit index} \propto \textit{work} \div \textit{mass}$$

Work done to break a standard tension test piece is equal to the average pull times the distance it works through, the latter factor being of course the elongation. Lacking the complete stress-strain curve for integrations, the author assumes the average of elastic limit and the ultimate strength to be the average pull. That is to say, his expression proportional to the work is ½ (e.l. + ult.) elongation. Furthermore, since a piece which suffers pronounced necking usually has the deformation strictly localized, while a piece which breaks with little necking is ordinarily stretched throughout its entire length, the mass of deformed material is roughly proportional to 100 — reduction. Hence, Mr. Cutter proposes the formula

$$\textit{Efficiency} = \frac{\textit{merit index}}{\textit{expenditure}} = \frac{\tfrac{1}{2}(\textit{e.l.} + \textit{ult.}) \times \textit{elonga.}}{100 - \textit{red}} : (\textit{lb. ferro} \times \textit{unit cost})$$

which may be utilized to determine the relative economy of two alloys which might be used for the same purpose.

Electrical Heat Treatment of Steel

H. P. MacDonald, vice-president, Sneed & Co., in his paper, entitled "Electrical Heat Treatment of Steel," described an electrical resistance method he has been using to heat-treat long rods and tubes, particularly thin-walled nickel-steel tubing for lances and airplanes. When using fuel-fired furnaces soaking is necessary to insure uniform heating, and the tendency is toward too long a soaking time with its attendant surface deterioration and crystalline growth. Non-uniform heating is also a prime cause of warping. To obviate these difficulties the author has rigged up a pair of grips to clasp the ends of the pipe or bar to be treated, held vertically between them. A heavy current is thrown through the piece, using the grips as contact pieces, very much after the action of an electric butt welder. As the pipe or bar heats it expands, and this elongation is indicated by a pointer, whose movement is geared to the upper grip. When passing through the transformation the combination of volume change and heat absorption halts the movement of the pointer, and even reverses its motion; when finally transformed the pointer again resumes its movement. Shortly thereafter both grips are released, interrupting the electric current and dropping the bar into a vertical quenching tank immediately below. Obviously, quenching of pipe might be done while still in the grips by an internal stream of oil or water. About 1½ in. is unhardened and wasted, where the copper grips were in contact with the piece. Pieces may also be annealed in the same machine by a simple modification in the procedure. The method is rapid—requiring only a minute to heat each piece; it obviates scale formation, decarbonization, crystallization and warping; it is self-indicating; and finally it is cheap, due to the efficient application of the energy. On the other hand, it is limited to straight pieces of uniform cross-section.

Recent Chemical & Metallurgical Patents

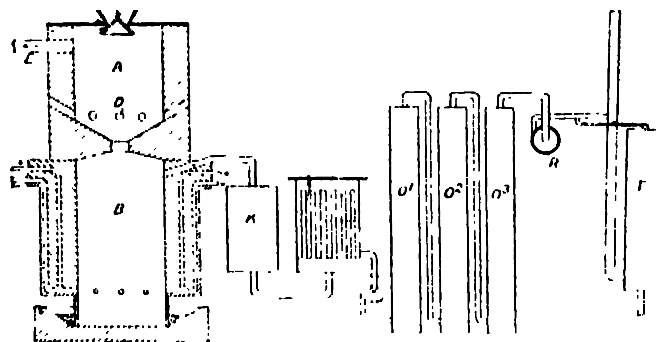
British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Copper and Its Alloys.—For deoxidizing and refining copper and its alloys, a copper cartridge containing potassium phosphide is first added to the metal heated above its melting point to convert the impurities, silicon, arsenic and protoxide of copper into phosphorus compounds; then, at a higher temperature, a second copper cartridge, containing one of the metals of the alkaline earths or lithium, is added for the purpose of decomposing the phosphorus compounds, which burn at the expense of the alkaline-earth metal, and the oxides formed float on the surface of the copper. (Br. Pat. 142,441—1919. A. STRASSER, Rorschach, Switzerland, July 7, 1920.)

Glucose, Furfurol, Methyl Alcohol.—In the manufacture of furfurol, methyl alcohol and easily fermentable glucose from materials containing cellulose, a larger yield is obtained by the addition of a small quantity of an acid or acids besides the acid required for the conversion purpose. Hydrochloric, sulphuric, sulphurous and hydrofluoric acids are suitable, or acid salts, or salts decomposed by excess of acid or hydrolytically—e.g., chlorides of magnesium, calcium, aluminum, zinc and manganese. When several additional acids are used, excess of one ingredient is preferable. When hydrochloric acid is employed as the conversion agent, a mixture of sulphuric and sulphurous acids is preferred as catalyst. The ligneous material is mixed with one-half to less than an equal volume of water in order to prevent formation of non-fermentable sugars. After the vapors from a preliminary steam-treatment in an autoclave have been removed, the requisite acids are introduced, the conversion acid being added in sufficient quantity to leave the treated material so that it can readily be disintegrated, and the pressure is raised to 7 or 8 atmospheres. Steam may be employed at lower pressure by the addition of special "protective" substances—e.g., metallic oxides. On completion of the conversion process, the contents are rapidly cooled by evacuation into a cooling-chamber, where the furfurol is condensed. Any furfurol or methyl alcohol remaining in the residues is removed by suction or by blowing in steam. The sugar solution is obtained from the residue by lixiviation. (Br. Pat. 142,480—1919. A. CLASSEN, Aachen, Germany, July 7, 1920.)

Ammonia.—In making mixtures of hydrogen and nitrogen for preparing ammonia by the Haber process, a mixture of air, oxygen and steam, or of air and steam is passed through coke in a gas-producer heated to 650-850 deg. C. at a rapid rate to avoid formation of much carbon monoxide. The resulting gas is treated to remove sulphur compounds, oxygen, water, etc., and to transform carbon monoxide to carbon dioxide, which is removed by treatment with ammonia. If necessary, hydrogen may be added to bring the mixture to the requisite composition. The coke is prepared by carbonizing coal which has been washed to remove iron pyrites and mixed iron oxide and calcium carbonate or other sulphur retainer, in a preliminary producer *A*. Air is introduced through openings *D*, and the gas withdrawn at *E* is purified and used for heating and power purposes. The hot coke is fed into the main producer *B* formed of a casing of sheet iron with a lining of hollow glazed bricks of silica in which passages are formed for preheating the gases. Owing to the low temperatures used and the rapid current of gas, the ash does not clinker, and much of it is carried by the gas into a separate settling-chamber (not shown). The hot gases are passed over limestone, magnesia, or magnesium limestone in a vessel *K* heated to about 700 deg. C. to remove sulphur compounds, are treated to remove dust and tar, and mixed with steam and passed over suitable known catalysts, such as iron oxide at about 450 deg. C to convert carbon monoxide into carbon dioxide with formation of hydrogen, and to convert carbon bisulphide



PRODUCER FOR NITROGEN-HYDROGEN MIXTURES

into sulphuretted hydrogen, which is removed by passage over iron oxide or by other means. The gases are mixed with air and passed over a low-temperature catalyst as described in Specification 127,609, to transform the residual carbon monoxide into carbon dioxide, and are compressed to 5-15 atmospheres to separate water, which is passed through a heat-exchanger and formed into steam at ordinary pressure and used in the earlier part of the process. Carbon dioxide is removed by treating the gases in towers O^1, O^2 with water and ammonia from the Haber plant or from another source. The ammonium bicarbonate formed is treated with sodium chloride to form sodium bicarbonate, or is passed over calcium sulphate to form ammonium sulphate. The towers may contain calcium sulphate to form ammonium sulphate directly. The gases are passed through a tower O^3 containing packing, water, and iron or copper to remove oxygen, and are compressed at *R* to 100-150 atmospheres. The water which separates is used to wash, in the tower *T*, the circulating gases in the Haber plants to remove the last traces of ammonia. The gases are mixed with the circulating gases, washed with water, and dried by passage through caustic soda or potash solution and over solid caustic potash or sodium wire. The final trace of carbon monoxide may be removed by adding oxygen and passing over a low-temperature catalyst as described in the above-mentioned specification, the carbon dioxide formed being removed by adding the gases to the catalyzed gases under pressure before removal of ammonia. (Br. Pat. 142,874—1919. J. HARGER, Liverpool, July 14, 1920.)

Current Events
in the Chemical and Metallurgical Industries

C.W.S. Officers Appointed

Results of the examinations for commissions in the Regular Army are now being announced. The following appointments as commissioned officers in the Chemical Warfare Service have been announced:

To be Majors, B. A. Brackenbury, San Francisco; A. M. Heritage, Washington, D. C.; H. H. Stickney, Jr., Lakehurst, N. J.

To be Captains: E. B. Blanchard, Charleston, S. C.; James H. Bogart, Boston; D. B. Bradner, Edgewood, Md.; Arthur Cobb, Lakehurst, N. J.; Harold Guiteras, Tyrone, N. M.; Stroud Jordan, Brooklyn; Lewis Latimer, Washington, D. C.; L. M. McBride, Chicago, Ill.; John G. McCoy, Edgewood, Md.; John A. MacLaughlin, Washington, D. C.; Earl Poppe, Fort Sam Houston, Tex.; Harry Scarborough, Cornwall-on-Hudson, N. Y.; Edward C. Tompson, Edgewood, Md.; William W. Wise, Camp Benning, Ga.; O. E. Roberts, Jr., Washington, D. C.; Edward Wolesensky, Cliffside, N. J.; Chester M. Scott, Edgewood, Md.

To be First Lieutenants: Joseph F. Battley, Edgewood, Md.; H. B. Bramlet, Camp Funston, Kan.; Guy L. Chamberlin, Lakehurst, N. J.; Patrick F. Craig, Lakehurst, N. J.; L. A. Elliott, Edgewood, Md.; Edwin L. Frederick, Catonsville, Md.; Arthur J. L. Hutchinson, Taft, Cal.; Harry A. Kuhn, Edgewood, Md.; Harry R. Lebkicker, Lakehurst, N. J.; George A. Mackay, Edgewood, Md.; Paul G. Miller, Alton, Ill.; David P. Miles, Redding, Cal.; Charles S. Moyer, Governor's Island, N. Y.; John E. Ott, Ocean View, Va.; Murray C. Wilson, Chicago; Howard Stokes, Lakewood, N. J.

To be Second Lieutenants: Fred M. Henley, Edgewood, Md.; Maurice E. Jennings, Seymour, Ind.; Harold A. Pelton, Camp Lewis, Washington; Paul R. Smith, Edgewood, Md.; M. E. Webber, St. Louis; Frank B. Gorin, Chicago; Shelby N. Griffith, Camp Dix; Ralph H. Tate, Owosso, Mich.

Further appointments are to be announced, but General Fries has been advised of the total number which have passed, which leaves thirty vacancies still to be filled. Additional examinations will be held.

Chemical Advisory Committee Named

General Amos A. Fries, head of the Chemical Warfare Service, states that he expects to lean heavily upon the committee of the American Chemical Society which is to co-operate with the Chemical Warfare Service in an advisory capacity. Charles H. Herty, who is to be chairman of the committee, has conferred at length with General Fries as to the assistance which the committee will be expected to give. The committee is to be divided into four sections. One is to be composed of research advisers, another of development advisers, a third of production advisers and a fourth physiological investigation advisers. The following personnel for these groups has been recommended:

Research advisers—W. D. Bancroft, Cornell University; R. C. Tolman, Fixed Nitrogen Research Laboratories, Washington, D. C.; A. B. Lamb, Harvard University; E. P. Kohler, Harvard University.

Development advisers—F. M. Dorsey, National Lamp Works, Cleveland; W. K. Lewis, Massachusetts Institute of Technology; L. T. Sutherland, New York.

Production advisers—L. C. Jones, National Aniline Co.; C. L. Reese, E. I. du Pont de Nemours & Co.; William H. Walker, Massachusetts Institute of Technology; Bradley Dewey.

Physiological investigation advisers—Reid Hunt, Harvard University; A. S. Loevenhart, University of Wisconsin; Julius Stieglitz, University of Chicago.

Nebraska Potash Situation Improves

Cessation of rains in Nebraska during recent weeks has greatly improved the potash situation at the evaporation plants in that state. The abnormal amount of rain earlier in the year had flooded the entire country and had so diluted the brine that evaporation costs were very high. A much larger recovery is being obtained from the same amount of fuel.

Despite rumors to the contrary, no plant in the Nebraska district has been closed, it is stated at the office of the United States Potash Producers' Association in Washington.

A recent report from France to that organization is to the effect that car shortage, strikes and the uncertainties pending the probable nationalization of the Alsatian mines makes it improbable that there will be any exports of Alsatian potash in the near future. As a matter of fact, delivery has not been completed on orders taken in the United States a year ago. It is not expected that the Alsatian production will offer any particular competition to Germany for a long time to come.

News of Alpha Chi Sigma

L. I. Shaw has resigned as national secretary and treasurer of the Alpha Chi Sigma fraternity. He is to be succeeded by B. H. Ball of Highland Park, Ill. Mr. Shaw has been appointed to succeed the late E. U. Titus as vice-president of the fraternity.

Mr. Shaw has held the office of secretary and treasurer since 1912. During that time he has seen the membership of the fraternity increase from 700 to 3,500. When he began his work as secretary there were seventeen chapters. The fraternity has expanded until it has become truly a national organization with thirty-one chapters. A chapter is now in existence at practically all the leading universities in the country.

The *Hexagon*, the official publication of the Alpha Chi Sigma fraternity, is to be published monthly in the future. Heretofore it has been appearing quarterly. Paul D. V. Manning, who recently succeeded R. S. McBride as editor of the *Hexagon*, will continue in charge of the paper.

Method for the Quantitative Measurement of Consistency

Some time ago the U. S. Bureau of Standards developed a method for the quantitative measurement of plasticity. This was described in Scientific Paper 278, and proved of great commercial value. Papers on the application of the method to paints have appeared in the *Proceedings* of the American Society for Testing Materials in 1919 and 1920.

The general method is to force the substance under investigation through a capillary tube by means of air pressure. The pressure is kept constant during any one run, but runs are made at various pressures with the same substance. The two values which are deduced from the readings thus obtained determine the consistency, but do not determine the plasticity as defined for mortars and plasters. In this latter sense, as described in Technologic Paper 169, plasticity depends upon other factors besides consistency.

At the present time an investigation is in progress at the Bureau in regard to the application of the plastometer, as used for paints, to adhesives such as starches and dextrines. This work is being done by an industrial associate under the general direction of a member of the Bureau's staff. The indications are that the quantitative measurement of the consistency of adhesives of definite concentration will do much to enable manufacturers to predict the exact behavior of their products in service.

Pulp and Paper Developments in Newfoundland

Grants to a British and a Norwegian pulp and paper company at the last session of the Colonial Legislature are indicative of important developments in the pulpwood timber resources of Newfoundland. Reports from St. John's, N. F., state that the British concern will locate its plant half way up the west coast at Bonne Bay, where there are large tracts of spruce and fir together with ample water facilities for power and transportation. The Norwegian company's site will be at Bonavista Bay, on the east coast.

At present the only pulp and paper mills on the island are at Grand Falls, established by the Anglo-Newfoundland Development Co. some years ago to supply the Northcliffe papers in England.

Negotiations are under way to exploit large tracts of spruce on the south coast. The extensive timber holdings of the Reid Newfoundland Co. are also expected to be utilized for pulp making in the near future. Another project contemplated is the establishment of paper and pulp mills, sawmills and veneer mills for the manufacture of birch into boxes and barrels at St. George's, on the west coast.

Philippine Vegetable Oil Companies Combine

It is reported by the San Francisco *Journal of Commerce* that the Philippine properties of the Visayan Refining Co., the Rizal Refining Co. and the Philippine Refining Co. have been consolidated into one company to be known as the Philippine Refining Corporation, with a capital of 20,000,000 pesos. Lever Bros. are large subscribers for the stock of the new corporation and Lord Leverhulme will be chairman of the board of directors. Lever Bros. are the largest consumers of coconut oil in the world and will monopolize practically the entire output of the consolidated company.

Anaconda to Manufacture Fertilizer

The Anaconda Copper Co. has decided to embark, with a plant of considerable size, in the manufacture of a super-phosphate fertilizer. It is the intention to market this fertilizer in the Middle West. A. E. Wells has just completed a survey of the markets for this type of fertilizer and is of the opinion that an outlet can be found for it throughout the farming regions of the upper Mississippi Valley.

Waste gases will be used for the manufacture of sulphuric acid. The phosphate rock will be obtained in Idaho and Montana. It is an intention of the Anaconda company to prepare a fertilizer which will contain 48 per cent of available phosphoric acid. In this way, it is believed, it will be possible to overcome the high transportation charge so as to enable the product to compete with the ordinary Eastern-made material which contains 16 per cent of available phosphoric acid.

Use of Etched Balls in the Brinell Test of Hardened Steels

At the request of the chairman of the Hardness Committee of the National Research Council, the device described by Hulgren for obtaining impressions with etched balls in the Brinell hardness test was examined in detail by the U. S. Bureau of Standards. Briefly this method of testing consists in etching the steel ball with which the impression is made for a minute or so in a weak (2 per cent) alcoholic-nitric acid solution, after which the test is performed as usual. If the specimen the hardness of which is to be determined is in a polished state, the impressions with the etched balls are very distinct, while those with an unetched ball are almost invisible when viewed at certain angles. If the specimen to be tested is not polished, however, preliminary etching of the ball does not appear to be of much advantage.

Wood Alcohol Causes Death of Nine Men

There was no admixture of poison gas with the alcohol which caused the death of nine employees of Edgewood Arsenal. General Amos A. Fries, head of the Chemical Warfare Service, investigated the matter personally immediately after the case was reported. General Fries found that some liquor had been secured off the arsenal grounds. The men who brought in the intoxicants gave a "party" to a number of their fellow-workers. The liquor soon ran out and to meet the demand for additional supplies resort was had to a steel drum of wood alcohol in one of the laboratories. Nine men drank the wood alcohol with fatal results.

The Problem of Scientific Abstracts

The Royal Society of London has called a conference in London beginning Sept. 28 to consider the future of the International Catalogue of Scientific Literature. Financial problems confront this publication and it is uncertain what further steps are necessary for its continuance or modification. American representatives will speak for the National Research Council, the Smithsonian Institution and the National Academy of Sciences. R. M. Yerkes and S. I. Franz will represent the Research Council; L. E. Dickson, professor of mathematics, University of Chicago, will represent the National Academy of Sciences; and L. C. Gunnell will represent the Smithsonian Institution.

Permeability of Concrete

Some preliminary tests have been made by the U. S. Bureau of Standards of a new apparatus for determining the rate of penetration of water through concrete and other permeable materials. The apparatus is so constructed that it is not necessary to mold the test piece in any particular shape, but any slab having one fairly smooth face may be tested. Only a few seconds are required for placing and adjusting the test specimen. This will permit specimens to be cut from walls or other portions of structures for tests. Tests so far made, while more in the nature of a try-out of the apparatus than the materials used, have furnished some rather interesting results.

In the following table the results of tests on samples of building stones from various quarries, as well as on some mortar and concrete specimens, are shown. The specimens varied from 1¼ in. to 2½ in. in thickness and 60-lb. water pressure was applied over an area of 25 square inches.

Test Specimen	Absorption, in 24-Hr., per Cent	Thickness, In.	Time Required for Penetration Through Wal
Limestone 50	5.80	1¾	10½ min.
Limestone 7E	3.10	1 5/16	11 min.
Limestone 8907	4.40	1¾	19 min.
Limestone 9c	4.60	1¾	2½ min
Limestone 14F	3.81	1¾	20 sec
Limestone 5G	3.48	1½	1½ min.
Sandstone	5.56	2½	10 sec.
1:6 portland cement mortar	7.8	2	3½ hr.
1:1½:2 concrete	5.8	2	Did not fail in 24 hr When broken througl water had penetrate

These results appear to bear out conclusions previously drawn in the Bureau's investigation of the durability of concrete in alkali soils that there is no apparent relation between absorption and permeability.

While considerable work must be done to standardize the method of making the permeability tests, it appears that this apparatus will assist in studying with a minimum of effort an important characteristic of concretes which has in the past been generally ignored, due to lack of suitable apparatus.

The Artificial Silk Industry

The end of June, 1920, saw the entry of the United States on a notable scale in artificial silk manufacture. The scarcity of the natural product and the increased demand for the artificial product have created a new industry.

As artificial silk was first invented and developed in the chemical laboratories abroad, Europe naturally took the lead in its production. In 1911, when artificial silk and its manufactures were first shown as a separate class on the import schedule, out of 1,947,423 lb. valued at $3,279,559 all but 12 lb. came from Europe. England was the chief shipper, followed by Germany, Austria-Hungary, Belgium, France and Switzerland.

The war greatly reduced the European production of artificial silk, stopping work in all the plants in Belgium and the invaded portion of France, while the shortage of labor and chemicals affected the industry in other countries. The great Tubize Co. in Belgium, in operation since 1900, with a pre-war production of about 10,000 lb. daily, dismantled its factories and buried or otherwise concealed its lead, copper and other metal fixtures, its electric motors, generators, wiring and belting, and escaped German confiscation. Shortly after the war closed, this factory was operating at the rate of its pre-war output, and showed a profit for the fiscal year of 1919 of 4,178,264 fr. This plant uses the Chardonnet process and is about to commence making silk by the viscose process. Recently it contracted with an American syndicate to erect a large artificial silk factory in the United States with an initial capital of $5,000,000.

Artificial silk exports from the United States were not shown separately in the report schedule prior to the fiscal year 1917. In that year $857,318 worth of American-made products were distributed to all parts of the world. Europe received $395,990 of this amount, North America $260,216, South America $56,653, Asia $19,033, Oceania $118,850 and Africa $6,576.

Prior to the war only the viscose process for making artificial silk had been used in the United States and before 1914 the bulk of the yarns used by American manufacturers was imported from Europe. In 1919 there were only two concerns in the United States actually producing artificial silk yarns on a commercial scale, one located at Marcus Hook, Pa., and one at Roanoke, Va. The latter is said to be producing 150,000 to 200,000 lb. per week at the present time. The extraordinary demand for this product has led to the recent formation of other corporations with abundant capital to establish large factories. Each of these large concerns is said to be allied with the largest producers in France, England and Belgium.

There are three varieties of artificial silk entering into our imports, according to their origin. They are classified as cellulose silk, collodion silk, and glue or gelatine silk. The products of the various processes differ from one another and from the natural silk in chemical composition. The artificial silk excels the natural product in luster only. France succeeded in making artificial silk bags to hold powder and wove certain parts of gas masks used on the front during the war. A Lyons factory is now producing a product called silk cellulose to be used in the manufacture of velvets, jerseys, satins, draperies, linings and other goods. The artificial silk textiles are also used in upholstery and carpet manufacture. Serviceable imitation horsehair hats are made of artificial silk braids, and novelties of this material appear each season in the millinery trade.

Non-Ferrous Metallurgical Research

Thanks to facilities afforded by one or two leading manufacturers, the association formed in Birmingham, England, for carrying on research work in connection with the non-ferrous metals is now getting into practic work, says the *Engineer* (London) of July 23, A specially installed electric furnace has been pl the disposal of Prof. Thomas Turner, of the uni for experimental work upon the casting of brass and copper ingots. The furnace, which is itself in the experimental stage, has been erected on the firm's premises, and tests are being made which, it is hoped, will solve problems that have long puzzled the brass-founders, particularly respecting ingot blow-holes. Another local firm has placed a laboratory at the disposal of the association for twelve months, and this concession is likely to prove of distinct aid to research. Though the association is now eighteen months old, it is practically unhoused. Research work can be delayed only at serious risk to the development of the industry's welfare.

British Cotton-Growing Research Association

The British Cotton-Growing Research Association has issued a report covering the first nine months of the work, of which a short abstract was lately published in *Science*. In order to co-ordinate the work of its various departments a property known as The Towers has been purchased for its headquarters in East Didsbury, near Manchester. Heads of the following departments either have been or are about to be appointed: Chemistry, physics, colloids, botany and technology. Dr. E. A. Oxley of Cambridge and Sheffield Universities has been named head of the department of physics; Dr. J. C. Withers has been appointed to direct the abstracting and indexing of technical information in the records bureau. It is said that information is so scattered that it will be some time before a comprehensive idea can be given of the work accomplished in the past.

The report adds that the chief aim will be to arrive at the principles or theory underlying the practice of the industry, leaving the application of the theory to those actively engaged in the industry. Applied research cannot, however, be entirely omitted, especially in respect of such matters as may be considered beyond the resources of individual firms.

In co-operation with the Empire Cotton-Growing Committee a joint committee has been appointed, with the immediate object of granting scholarships to graduate students, so as to secure a supply of trained men for the future. Three botanical research studentships have already been established. The total number of individual members of the association is 1,408. The income for the year, including £6,750 government grant, amounts to £17,150.

Canada's Paint Industry

More than $17,000,000 worth of paints and varnishes were manufactured in Canada during 1918, according to a report published recently from the Mining, Metallurgical and Chemical Division of the Dominion Bureau of Statistics. In the same time Canada imported more than $6,000,000 worth of paints, varnishes and materials used in the paint and varnish industry. Of this sum $1,000,000 was spent in gums, nearly $2,000,000 in white zinc and more than $1,000,000 in rosin. Forty-five establishments were operated during the year with an aggregate capital investment of $15,784,610.

The report gives detailed information regarding the numbers and compensation of the officers, superintendents, clerks and wage-earners according to classes, and also shows the quantities and values of materials used in the manufacture of the products, which are listed by quantities and values.

This report, one of a series of advance chapters dealing with the production of chemicals and allied products in Canada during the year 1918, is available for free distribution to those interested. Requests should be addressed to the Dominion Bureau of Statistics, Ottawa.

U. S. Bureau of Mines Establishes Experiment Station at Rolla, Mo.

The Mississippi Valley Experiment Station of the U. S. Bureau of Mines has been located at the Missouri School of Mines and Metallurgy, Rolla, Mo. A conference of operators of the Mississippi Valley section will be held in the Chamber of Commerce Building, St. Louis, Oct. 9, to discuss problems that should be considered by the new station.

Investigation of Combination of Aluminous and Siliceous Bond Clays Used in Making Crucibles

During the war the making of glass pots, crucibles and various other special refractories was seriously interfered with, owing to the lack of certain clays formerly imported from Germany, particularly plastic bond clay known as Gross Almerode. The Bureau of Standards conducted an investigation with the object of finding an American clay or combination of clays which could be used as a substitute for the German material. It was found that a mixture of three parts of Arkansas kaolin and one part of No. 4 Kentucky ball clay formed a satisfactory substitute for the Gross Almerode clay, and this combination was used extensively during the war. This investigation is now being extended and will soon be completed. Sixty small pots have been made and will be subjected to the corrosive action of various kinds of glasses. It has been found that when used with 50 per cent grog and Arkansas kaolin it has even a lower shrinkage and higher porosity than the German clay. These are very valuable properties for clays to be used in the making of glass-house refractories, and present indications are that this clay will be extremely important for this particular purpose.

Movement of Nitrate Through Panama Canal

The movement of nitrate of soda through the Panama Canal during July totaled 32,101 tons. Of that amount 14,801 tons was consigned to American ports. The remainder went to European ports.

Book Reviews

THE ORGANIZATION OF INDUSTRIAL SCIENTIFIC RESEARCH. By *C. E. Kenneth Mees, D. Sc.*, Director of the Research Laboratory of the Eastman Kodak Co., Rochester, N. Y. Pp., ix + 175; 10 figures. New York and London: McGraw-Hill Book Co., Inc., 1920. Price, $2.

This book is intended by its distinguished author as a contribution to the study of the best methods of organizing research work for industrial purposes and of the conditions under which such work should be conducted. It gives consideration to general principles, but, in addition, reflects throughout its nine chapters the effort of the author to be as definite in statement as the nature of the subject will allow. The following matters are discussed seriately: Types of research laboratories; co-operative laboratories; the position of the research laboratory in an industrial organization; the internal organization of industrial research laboratories; the staff of a research laboratory; the building and equipment of the laboratory; the direction of the work; and the design of a research laboratory for a specific industry. There is also a select bibliography, which is comprehensive and usefully valuable for reference.

The scope of the book and the method of presentment employed in its preparation are excellent, and both industrialists and scientific workers will find it interesting and informative. It is thought, however, that most of its readers will regret that the author has given such brief treatment to certain of the aspects of the subject, that no attention is accorded to the co-ordination of research, and that more space is not devoted to the systematic collection and distribution of scientific information, especially research findings. The book is intended principally for manufacturers who have had no occasion to consider in detail the planning and executive control of a research department; and while most manufacturers who will decide to read

it will be convinced in advance of the need for research in their specific industries, the author has passed by an opportunity to demonstrate in review the economic and social benefits of properly planned, well directed scientific inquiry, for the use of executives who may need this material for educational purposes. W. A. HAMOR.

PERSONNEL ADMINISTRATION; ITS PRINCIPLES AND PRACTICE. By *Ordway Tead* and *H. C. Metcalf.* 538 pp., index. New York: McGraw-Hill Book Co., 1920.

During the past half-century a complete change has come about in the viewpoint of industrial administration, a change so gradual that few people have any clear realization of its completeness. The change is further masked by the fact that it was theoretically unnecessary. What has happened is that actual practice has come to approximate the general principles of social relations which have long been publicly proclaimed. With the new viewpoint and practice has come a new literature; countless articles on how to prevent accidents by means physical and metaphysical, how to conserve health, how to prevent fatigue, how to do things with the least effort, how to pick the right man for the right job and how to make him satisfied with it after he has it, first began to trickle into periodical literature and then swelled to a flood that has led to the founding of journals primarily devoted to such matters. Some of this literature is the result of the application of trained minds to industrial and social problems, some of it is a hybrid of sentimentalism and half-baked social theories, and a modicum of it is little better than charlatanism run riot. There has been great need for the gathering together of what has appeared, the separation of the wheat from the chaff, and the presentation of that most worth while in orderly and systematic fashion so that the busy man (and busy man is almost a synonym for the worker in industrial fields nowadays) can easily acquire a grasp of the progress that has been made. This is what the authors have tried to do in their volume on personnel administration, and on the whole they have succeeded very well. Ten years from now, it is quite possible, their views will be regarded as somewhat conservative and old-fashioned; ten years ago they would have been regarded as dangerously radical and socialistic. In not a few quarters today the fact that the authors have ventured to quote at times from the *New Republic* will be taken as sufficient indication that they are not worthy of consideration by conservative business men.

The field of their task is defined by the authors as setting forth the principles and the best prevailing practice in the field of the administration of human relations in industry, and they take up *seriatim* the personnel department, employment methods, health and safety, education, research (job analysis, specifications, etc.), rewards, administrative correlation, and joint relations. In a book of this character it is not reasonable to expect anything new beyond the integration of material, much as writers in the *Literary Digest* collate a number of quotations into a complete story. In both cases the result is almost certain to be interesting and helpful; the only opportunity for criticism lies in the choice of material and the relative amount of space accorded to it. Thus the seven pages devoted to safety may be regarded by some as all too little for its importance, yet into that space the authors have compressed an admirable summary of the principal methods for accident prevention, and the economic pressure of workmen's compensation laws puts sufficient emphasis on such work in the average plant so its importance does not need to be stressed. The health of the workers is accorded twice as much space, fatigue being considered at some length, but with the usual defect of regarding it as chiefly a physiological problem, the mental factor being underestimated, though possibly the authors may have it in mind in suggesting the value of changing jobs. Much of the longer chapter on standards of physical working conditions is really a more extended discussion of the health of the worker, and accident prevention is again mentioned. The section on education takes up the training of executives, foremen and workers and goes on to consider the company magazine from its educational and other aspects, which leads naturally to the arousing of interest in work, to which twenty-five pages are devoted. Transfer and promotion are taken up from their educational aspects but in their development lead naturally into the next division, which the authors have designated as research—an inclusive term intended to cover the analytical and statistical study of the measurable factors in personnel problems. In their consideration of job analyses and job specifications, measurement of turnover and labor audit the authors display a humanness of view that is refreshing in comparison with the coldly statistical attack of most practitioners of scientific management. The question of rewards, wage payment, plans and methods, and meeting the industrial risks, is covered in fifty pages, which is all too little in proportion to its importance to the worker, but this is a topic which it is hard to make interesting to anyone except the recipient of the reward. The treatment is, on the whole, good, though the authors seem to share in some degree the common fallacy that pay can largely be based on what it costs a man to live rather than on an adjustment of shares in the value of the joint product which will insure a proper balance of labor and capital supply in the conduct of industry. So much discussion has been devoted to wages in the history of industry and so little of real enlightenment has emerged that the authors are perhaps wise in being brief. From this point the book grows steadily more "advanced." The boards of directors are still few that would accept the organization chart shown on page 375, where the production manager and personnel administrator are shown as co-equal in plant administration, and a subsequent chapter on the business value of the collective bargain, impartial as it is, will be regarded by many as too sympathetic to the employee. The chapter on national industrial councils will be interesting and useful to the many people who have been unable to get any clear comprehension of what has been afoot in England in the past few years, even though they may be inclined to raise more objections than the authors do to the general adoption of the plan in America. An unusually full index adds much to the usefulness of this valuable and timely volume. T. T. READ.



Personal

H. M. BOYLSTON, of Sauveur & Boylston, has accepted an appointment to the chair of metallurgy in the Case School of Applied Science, Cleveland, Ohio.

A. W. MANGUM has resigned as chemical supervisor of soap making in the Procter & Gamble Co. to accept a position in the chemical division of Lever Bros. Co., Cambridge, Mass.

PERRY N. MOORE has recently become associated with Parker C. McIlhiney, consulting engineer, of New York City.

KARL C. PARRISH, of Cartagena, Colombia, South America, a prominent engineer in the development of mining and business properties in that district, is in Chicago and other Western points on an extended business trip. Among other activities he is the representative in Colombia for Fairbanks, Morse & Co.

C. PRICE-GREEN, commissioner of the Canadian National Railways, spent the week at the Chemical Exposition in the interest of the development of Canadian resources.

Dr. S. P. SADTLER left this week for a trip to the West to make a study of the brine potash industry. He will be gone several months.

MARK L. SPERRY, president of the Scovill Manufacturing Co., Waterbury, Conn., who has been with the company fifty-eight years, has retired. Edward O. Goss, who has been general manager, succeeded Mr. Sperry.

Current Market Reports

The Iron and Steel Market

Pittsburgh, September 24, 1920.

The stagnation in the pig-iron, semi-finished steel and finished steel markets has grown more intense in the past week. The markets for prompt and forward deliveries are equally dull.

For the dullness in the markets for prompt material the much heavier deliveries of late, due to the loosening up in the rail transportation situation, are chiefly responsible. For the dullness in late deliveries, in forward buying, uncertainty as to the future of prices is chiefly responsible.

For four months, April to July inclusive, the steel mills were piling steel, semi-finished and finished, because they could not ship the entire product. At the present time the accumulations are not as much as one-third as heavy as at the maximum, and some observers assert that the stocks are practically all cleaned up. It is clear that the reduction in stocks at mills in the past few weeks has been at two or three or four times as rapid a rate as that by which the stocks were accumulated.

Price Readjustments

It is putting it delicately to say that the lightness of forward buying in pig-iron and steel products is due to uncertainty as to the future of prices. In the mind of the average buyer there seems really to be no uncertainty, but rather a conviction that prices are going to be lower. This does not mean, however, that prices of all steel producers are expected to be lower. There has been a wide range of prices. All the independents have had prices much above those of the Steel Corporation, but some much farther above than others. Nowhere in the trade is the opinion expressed that the Steel Corporation's prices are going to come down. The corporation itself certainly has no such expectation, for after adhering punctiliously to the Industrial Board price schedule of March 21, 1919, for seventeen months, last month the corporation made some slight advances, $5 per gross ton on wire rods to $57 and $5 per net ton on cold-rolled strip steel to 6.15c., while it adopted a new card of nail extras, increasing the cost of an average nail specification 15c. or 20c. a keg.

Pressure for Deliveries

In some lines there is still fairly heavy pressure for deliveries on old contracts, these lines including nails, tin plate, standard steel pipe, oil country goods, the smaller sizes of merchant bars, and sheets. The case of sheets is the most impressive, for the pressure in general exists despite the fact that a large proportion of the sheets due the automobile trade is the subject of suspension of deliveries or of direct cancellation, yet the other consumers want all the sheets that can be furnished.

In plates and structural shapes there is no pressure at all. There are fair deliveries of plates on old contracts. In shapes there is not much contract business on books. The monthly report of the Bridge Builders' and Structural Society shows August bookings of fabricated steel contracts to have represented 40 per cent of the shop fabricating capacity, against 50 per cent for July.

Semi-Finished Steel Softening

Demand for sheet bars has been light in the past week. On account of light deliveries on old contracts the mills have considerable tonnage due them for fourth quarter and they show little disposition to make fresh contracts. Conversion contracts have been impossible except in isolated cases and thus buying of sheet bars by sheet consumers has largely been absent. Some transactions have occurred, however, and these have been at about $65 Pittsburgh, or $2.50 decline. In one or two instances the f.o.b. mill price was $62.50 on account of the necessity of equalizing freight with Pittsburgh.

In billets the mill quotation remains at $60, but this quotation is practically nominal. Attractive lots of billets are offered at second hand at about $58 Pittsburgh, but there is no demand even for these.

The Case of Pig Iron

Nothing could be clearer than the showing made by pig iron that prices on the recent advance were carried up too far. In most districts pig iron is absolutely stagnant, while in none is there any healthy degree of activity. Deliveries are heavier, as merchant production has increased somewhat, while in addition there has been the movement of furnace stocks previously accumulated, when cars were in short supply. Consumption, on the other hand, shows a decreasing tendency in the case of not a few consumers and none seem to be increasing their melt. These conditions would naturally make for an easier market.

The plainest test, however, is secured by referring to Southern iron. The Birmingham producers were conservative and when their price got up to $42 Birmingham at the end of last April they did not advance farther. With foundry pig iron on a $50 level at valley and Cleveland furnaces, Southern iron can penetrate farther, even with the large freight rate advances of Aug. 26, than formerly. Yet the buying of Southern iron is very light, and thus Northern iron at $50 practically "stands no show."

The Chemical and Allied Industrial Markets

New York, September 24, 1920.

The continued depression in these markets is being attributed to several causes: The unsettled conditions that usually precede a Presidential election, the "waiting" attitude that many consumers have assumed, and a return to more normal and pre-war levels. The depression is felt not in any one particular line, but in all commodity markets, and for this reason tables have been prepared to show the trend.

It will be noticed, among the chemicals, that of the eight items listed four show declines, two have increased and two remain about the same. In the coal-tar bases and intermediates there are six lower prices, one unchanged and two decreases. There have been no increases lately among the naval stores, and prices have been steadily going down. As can be seen, there is a $5 difference in all grades of rosin between the two years.

CHEMICALS

	Today	Last Week	Last Month	Last Year
Hydrochloric acid, 20 deg.	$2 00 @ 2 50	$2 25 @ 3 00	$2 25 @ 3 00	$1.00 @ 1 50
Hydrofluoric acid, 52 per cent	15 @ 16	15 @ 16	13½@ .14	10 @ 11
Bleaching powder	7 25 @ 7 50	7 00 @ 7 25	6.50 @ 7 50	1 75 @ 1 80
Phosgene	1 25 @ 1 50	1 25 @ 1 50	80 @ 1 05	75
Soda ash, light	2 80 @ 3 00	3 20 @ 3 50	3 20 @ 3 50	1 85 @ 1 90
Soda ash, dense	3 25 @ 3 50	3 55 @ 3 65	3 55 @ 3 65	2 25 @ 2 50
Caustic soda	4 25 @ 4 50	5 60 @ 5 70	5 60 @ 5 70	2 75 @ 3 00
Sodium prussiate, yellow	25 @ 27	.23 @ 27	.23 @ 27	.18 @ .18½

COAL-TAR PRODUCTS

	Today	Last Week	Last Month	Last Year
Alpha-naphthol, crude	$1 30 @ 1 40	$1 35 @ 1 45	$1 40 @ 1 50	$1.00 @ 1 10
Benzene, pure water white	35 @ 40	38 @ 40	38 @ 40	24 @ 28
Cresylic acid, 97-99 per cent	1 10 @ 1 15	1 15 @ 1 20	1 15 @ 1 20	85 @ 90
Dichlorbenzene	07 @ 10	07 @ 10	08 @ 10	07 @ 10
Dimethylaniline	90 @ 1 00	95 @ 1 05	1 00 @ 1 05	.52 @ 57
Naphthalene, flake	16 @ 17	16 @ 17	19 @ 21	06½@ 07
Orthotoluidine	35 @ 38	30 @ 35	30 @ 35	30 @ 45
Solvent naphtha, water white	.20 @ 25	23 @ 26	33 @ 35½	22 @ .27
Salicylic acid, tech	.45 @ 50	.50 @ .52	50 @ 52	30 @ 40

CRUDE RUBBER

	Today	Last Week	Last Month	Last Year
Para-Up-river fine	$0.27 @ 0 28	$0 29 @ 0.31	$0 32½@ 0.34	$0.54 @ 0.55
Up-river coarse	.18 @ .19	.19 @ .20	20½@ .22	.31 @ 31½
Up-river caucho ball	.18½@ .19½	.20 @ .22	.21 @ .21½	.31 @ .31½
Plantation—First latex crepe	$0 25	$0.30	$0 33	.41 @ 41½
Ribbed smoked sheets	.23½	.28	.29¾	.40 @ 40½
Brown, crepe, thin, clean	.22½	.26	.27	.34 @ 36

NAVAL STORES

	Today	Last Week	Last Month	Last Year
Rosin B-D..........	$13.00	$14 00	$14.00@16.25	$18 00@18 25
Rosin E-I..........	13.10	14 50	16.60@16.75	18.50@20.50
Rosin W.L.-WW	12.50	15.00	17 25@17.50	23.50@25 50
Spirits of turpentine............	1.45	1.49	1.60	1.75@1.80

OILS

	Today	Last Week	Last Month	Last Year
Corn oil, crude...	$0.12 @ 0.13	$0 11½@0 12	$0.14½@0 15½	$0.24 @0.25
Cottonseed oil, crude..........	.10½@ .11	.10 @ 11	.10 @ .11	.21 @ .25
Linseed, raw, car lots............	$1.22	$1 25	1 40 @1 43	2 20 @2 25
Palm, Niger.....	.09½@ 10	.10 @ .10½	.11 @ .12	.16½@ .17½
Rapeseed, refined	1.30 @1 45	1 40 @1 50	1 40 @1 50	1.55 @1.60
Yellow bleached menhaden......	.87 @ .90	.90 @ 95	.95 @1 05	1 30 @1.37

The Baltimore Market

Baltimore, Md., September 23, 1920.

Buying activity on this market has not appreciably increased since the last writing. Because of the generally bearish situation, however, parcels of various raw materials are being quietly absorbed by the fertilizer manufacturers at lower prices than nominal quotations. It seems to be the general belief that the materials which have shown the most pronounced decline in prices have about reached the bottom.

Orders for bagged goods are coming in more rapidly and as a consequence the trade is feeling more optimistic than a few weeks ago for a good fall business. The demand, however, for mixed goods will probably show a curtailment, with the result that it will be necessary for some to carry over stocks of raw material until spring.

The local car situation has improved. It is estimated that shippers are now receiving about 75 per cent of their car requirements.

Acid Phosphate

There has been no appreciable weakness in the market for this commodity. Spot parcels are changing hands at prices in line with last quotations of $20 per ton, bulk acid phosphate, run of pile, basis 16 per cent A. P. A., f.o.b. Baltimore. Also a few sales for export have been noted. Spain has been receiving a fair sized tonnage from this port.

Nitrate of Soda

The market on nitrate is in a distinctly unsettled condition, with the general trend of the market downward.

Importers are quoting well above the actual market, though there is a report of one recent sale by an importer of a round lot of 95 per cent at $3.50 ex-vessel Atlantic port for November-December arrival. Spot parcels are being freely offered in the South as low as $3.50 and counter propositions are being solicited. Deliveries after Jan. 1 are held at higher figures.

Sulphate of Ammonia and Cyanamide

There has been but little change in chemical ammoniates. A few resale parcels of sulphate are being offered at $5.50 delivered in bulk with counter bids solicited. A sale of a round lot of cyanamide in bags has been reported at $4.50.

Potash

The potash market is unchanged. Kainit and manure salts may be had under $2 and muriate is being quoted nominal at $2.25. A rise in this market is dependent upon a curtailment of shipments from the German and Alsatian deposits.

Fish Scrap

Menhaden fish scrap has declined appreciably in price since the last report in this journal. The past week has brought local trading of several thousand tons at prices ranging from $7.50 per unit of ammonia to $6.50. This break was due largely to the tight money situation together with lack of storage space at the factories. It is thought that the entire accumulation of scrap on Chesapeake Bay has been cleaned up. It has also been noted that the market has begun to recover as a consequence.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	...... –	$0.65 – $0.75
Acetone	lb.	$0 15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4 50
Acetic, 56 per cent	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 – 16.00	16.25 – ......
Boric, crystals	lb.	.15½ – .16	.16½ – .19
Boric, powder	lb.	.15½ – .16½	.17 – .20
Citric	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal)	cwt.	2.00 – 2.50	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		...... –	...... – ......
Nitric, 40 deg	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.45 – .50	.52 – 55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	...... – ......
Sulphuric, 60 deg., drums	ton	...... –	...... – ......
Sulphuric, 66 deg., tank cars	ton	16.00 – 17.00	18.00 – 20.00
Sulphuric, 66 deg., drums	ton	26.00 – 28.00	...... – ......
Sulphuric, 66 deg., carboys	ton	...... –	...... – ......
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38 00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35 00	40 00 – ......
Tannic, U. S. P.	lb.	1.45 – 1.50	1.55 1.65
Tannic (tech.)	lb.	.60 – .70	.80 – .90
Tartaric, crystals	lb.	...... –	.74 – .77
Tungstic, per lb. of WO	lb.	...... –	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 – 5.75	6.00 – 7.00
Alcohol, Methyl (see methanol)		...... –	...... – ......
Alcohol, denatured, 188 proof (nominal)	gal.	...... –	1.12 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	...... –	1.05 – 1.10
Alum, ammonia lump	lb.	.05 – .05½	.05½ – .06
Alum, potash lump	lb.	.08½ – .08¾	.09 – .09½
Alum, chrome lump	lb.	...... – .17	.18 – .19
Aluminum sulphate, commercial	lb.	.04¾ –	...... – ......
Aluminum sulphate, iron free	lb.	.06 –	...... – ......
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09¾ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 – .35½	.36 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 .13½	.13½ – .14½
Ammonium nitrate	lb.	.09 – .10	.11 – .14
Ammonium sulphate	lb.	.07 – .07½	.08½ – ......
Amylacetate	gal.	...... –	5.00 ......
Amylacetate tech	gal.	...... –	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.14 – .16	.16½ – .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.17 – .18	.19 – .23
Barium chloride	ton	130.00 – 150.00	...... – ......
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .12	.12½ – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		...... –	...... – ......
Blue vitriol (see copper sulphate)		...... –	...... – ......
Borax (see sodium borate)		...... –	...... – ......
Brimstone (see sulphur, roll)		...... –	...... – ......
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	...... – ......
Calcium carbide	lb.	.04½ – .04½	.04½ – .05½
Calcium chloride, fused, lump	ton	33.00 – 34.00	35.00 – 45.00
Calcium chloride, granulated	lb.	.02 – .02½	.03 – .03½
Calcium hypochlorite (bleaching powder)	cwt.	7.25 – 7.50	8.00 – 8.50
Calcium peroxide	lb.	...... –	1.50 – 1.70
Calcium phosphate, monobasic	lb.	...... –	.75 – .80
Calcium sulphate, pure	lb.	...... –	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)	lb.	...... –	1.25 – 1 50
Caustic potash (see potassium hydroxide)		...... –	...... – ......
Caustic soda (see sodium hydroxide)		...... –	...... – ......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.40 – .43	.44 – .47
Cobalt oxide	lb.	...... –	2.00 – 2 05
Copperas (see iron sulphate)		...... –	...... – ......
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	...... –	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		...... –	...... – ......
Epsom salt (see magnesium sulphate)		...... –	...... – ......
Ethyl Acetate Com. 85%	gal.	1.10 – 1.30	1.40 –
Ethy Acetate pure (acetic ether 98% to 100%)		...... –	1.75 – ......
Formaldehyde, 40 per cent (nominal)	lb.	.48 – .50	...... – ......
Fusel oil, ref	gal.	...... –	5.25 – 6.00
Fusel oil, crude (nominal)	gal	...... –	...... – ......
Glauber's salt (see sodium sulphate)		...... –	...... – ......
Glycerine, C. P. drums extra	lb.	...... –	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	...... –	.03 – .20
Iron sulphate (copperas)	cwt.	2 00 – 2 25	2.35 – 2.75
Lead acetate, normal	lb.	...... –	.13½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	...... –	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	...... –	1.50 – ......
Magnesium carbonate, technical	lb.	.12½ – .13½	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 3.90	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	...... –	3 50 – 3.60
Methanol, 95%	gal.	...... –	3 25 – 3 30
Methanol, pure	gal.	...... –	3 50 – 4 50
Nickel salt, double	lb.	...... –	.14 – .16
Nickel salt, single	lb.	...... –	.13 – .14
Phosgene (see carbonyl chloride)		...... –	...... – ......
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	...... –	.35 – .37
Potassium bichromate	lb.	.34 – .36	.39 – .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 - $0 56	$0.57 - $0.58
Potassium bromide, granular	lb.	..... - ...	.70 - .73
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .21	.23 - .25
Potassium chlorate, crystals	lb.	.18 - .18½	.19 - .20
Potassium hydroxide (caustic potash)	lb.	.27 - 28	.29 - .33
Potassium iodide	lb.	......-......	3.35 - 3.60
Potassium nitrate	lb.	.17 - .17½	.19 - .21
Potassium permanganate	lb.	.75 - .80	.85 - .95
Potassium prussiate, red	lb.	.85 - .95	1.00 - 1.05
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$240.00 - 255.00	......-......
Rochelle salts (see sodium potas. tartrate)		......-......	......-......
Salammoniac (see ammonium chloride)		......-......	......-......
Sal soda (see sodium carbonate)		......-......	....
Salt cake	ton	......-...	48.00 - 50 00
Silver cyanide (nominal)	oz.	......-......	1.25 -.......
Silver nitrate (nominal)	oz.	......-......	.60 - .62
Soda ash, light	100 lb.	......-......	2.80 - 3.00
Soda ash, dense	100 lb.	......-......	3.25 - 3.50
Sodium acetate	lb.	10 - .15	.20 - .25
Sodium bicarbonate	100 lb.	2.50 - 2.75	3.00 - 3.50
Sodium bichromate	lb.	.22 - .24	.26 - .27
Sodium bisulphate (nitre cake)	ton	7.00 - 8.00	9.00 - 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½-...	.10 - .11
Sodium borate (borax)	lb.	.09 - .10	.11 - .12
Sodium carbonate (sal soda)	100 lb.	2.00 - 2.10	2.15 2.25
Sodium chlorate	lb.	.11 - .12	.12½ - .14
Sodium cyanide, 96-98 per cent	lb.	.25 - .30	.32 - .35
Sodium fluoride	lb.	.18 -......	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	5.60 - 5 70	5.75 - 6 00
Sodium hyposulphite	lb.	......-......	.03 .04
Sodium molybdate	lb.	2.50 -......	3.25½-....
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	.16 - .18	.19 - 20
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½- .04½	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.39 - .40
Sodium prussiate, yellow	lb.	.25 - .27	.31 - .32
Sodium silicate, solution (40 deg.)	lb.	.01½ .01¾	.02 .02½
Sodium silicate, solution (60 deg.)	lb	.02½ .03	.04 .05
Sodium sulphate, crystals (Glauber's salt)	cwt	1.60 1.70	1.75 - 2 50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½- 10	.10½- .11
Sodium sulphite, crystals	lb.	.04 - 0 4½	.04½ - .05
Strontium nitrate, powdered	lb.	15 - 18½	.19 - .20
Sulphur chloride red	lb.	.08 - .09	.10 .10½
Sulphur, crude	ton	16.00 20.00	.. ..
Sulphur dioxide, liquid, cylinders	lb	.09 -.. ..	.10 .12
Sulphur (sublimed), flour	100 lb	..-. ..	3.80 4.35
Sulphur, roll (brimstone)	100 lb.	..-. ..	3.40 3.90
Tin bichloride (stannous)	lb	.42½- .44	.45 - .46
Tin oxide	lb.	......-. ..	.55 - .65
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran	lb	.13 13½	.13½- .17
Zinc cyanide	lb	.47 .49	.50 - .60
Zinc dust	lb	.12 13	.13 .14
Zinc oxide, U. S. P.	lb	17 .25	-
Zinc sulphate	lb	.03½ 03¾	.04 - .06

Coal-Tar Products

NOTE The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb	$1 30		$1.40
Alpha naphthol, refined	lb	1 50		1.65
Alpha-naphthylamine	lb	.48		.52
Aniline oil, drums extra	lb.	30		.33
Aniline salts	lb	35		.40
Anthracene, 80%, in drums (100 lb.)	lb	.90		1.00
Benzaldehyde (f f c)	lb	2.00	-	2.10
Benzidine, base	lb	1.35		1.40
Benzidine sulphate	lb	1 15		1.25
Benzoic acid, U S P.	lb.	.85		90
Benzoate of soda, U S P	lb	80		90
Benzene, pure, water-white, in drums (100 gal.)	gal	.35	--	.40½
Benzene, 90%, in drums (100 gal)	gal	.33	--	.38½
Benzyl chloride, 95-97%, refined	lb	.35	--	40
Benzyl chloride, tech	lb	.25		.35
Beta-naphthol benzoate (nominal)	lb	3 50		4 00
Beta-naphthol, sublimed (nominal)	lb	.70	-	75
Beta-naphthol, tech (nominal)	lb	65		.70
Beta-naphthylamine, sublimed	lb	2.25	--	2.40
Cresol, U. S. P, in drums (100 lb.)	lb	.18		19
Ortho-cresol, in drums (100 lb.)	lb	.23		25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10		1 15
Cresylic acid, 95-97%, dark, in drums	gal	1.05	-	1 10
Cresylic acid, 50%, first quality, drums	gal	65		.75
Dichlorbenzene	lb	.07		.10
Diethylaniline	lb	1 50		1 60
Dimethylaniline	lb	90	-	1 00
Dinitrobenzene	lb	.30		37
Dinitroclorbenzene	lb	32	—	35
Dinitronaphthalene	lb.	.45		55
Dinitrophenol	lb	.40		45
Dinitrotoluene	lb			.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38		.40
Diphenylamine (nominal)	lb	80	-	.85
H-acid (nominal)	lb	1 90		2.05
Meta-phenylenediamine	lb	1.25		1.30
Monochlorbenzene	lb	.18		.20
Monoethylaniline	lb.	2.00		2.40
Naphthalene crushed, in bbls. (250 lb.)	lb	...	-	.
Naphthalene, flake	lb.	.16	—	.17
Naphthalene, balls	lb.	.16	—	.17
Naphthionic acid, crude	lb.	.75		.85
Nitrobenzene	lb.	.14		.19
Nitro-naphthalene	lb.	.40		.50
Nitro-toluene	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-benzene	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	85
Ortho-nitro-toluene	lb.	.25		.40
Ortho-toluidine	lb.	.35	—	.38
Para-amidophenol, base	lb.	2.50	—	3 00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlorbenzene	lb.	.08	—	.12
Paranitroaniline	lb.	1.10	—	1.15
Para-nitrotoluene	lb.	1 25	—	1.40
Para-phenylenediamine	lb.	2.50	—	2.65
Para-toluidine	lb.	2 00	—	2.25
Phthalic anhydride	lb.	60	-	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	12	-	20
Pyridine	gal	2 00	-	3 50
Resorcinol, technical	lb.	4.25		4.50
Resorcinol, pure	lb.	6 25	-	6 75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45		.50
Salicylic acid, U. S. P.	lb.	.45		.50
Salol	lb.	.90	-	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30	-	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.20	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Tolidine	lb.	1.70	--	2 50
Toluidine, mixed	lb	.45	--	.55
Toluene, in tank cars	gal.	.35	—	.....
Toluene, in drums	gal	.38½	—	.40½
Xylidines, drums, 100 gal.	lb	.50	—	.65
Xylene, pure, in drums	gal.	.47½	—	.50½
Xylene, pure, in tank cars	gal	.45	—	....
Xylene, commercial, in drums, 100 gal	gal.	32½	--	.35½
Xylene, commercial, in tank cars	gal.	30	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb	$0.36	--	$0.39
Beeswax, refined, light	lb	.37	-	.38
Beeswax, white pure	lb	63	—	.68
Carnauba, No. 1. (nominal)	lb.	.90	---	.95
Carnauba, No. 2, regular (nominal)	lb	.85	—	.86
Carnauba, No 3, North Country	lb	.35	--	.36
Japan	lb	.17	-	.18
Montan, crude	lb	.25		.26
Paraffine waxes, crude match wax (white) 105-110 m.p	lb.	.09	--	.09½
Paraffine waxes, crude, scale 124-126 m p.	lb.	.09½		10
Paraffine waxes, refined, 118-120 m p.	lb	.11	-	.11½
Paraffine waxes, refined, 125 m p	lb	12½	-	
Paraffine waxes, refined, 128-130 m p.	lb	.13		.15
Paraffine waxes, refined, 133-135 m p	lb	.16		17
Paraffine waxes, refined, 135-137 m p.	lb	.17½		18½
Stearic acid, single pressed	lb	.20		.21
Stearic acid, double pressed	lb	.22	-	.23
Stearic acid, triple pressed	lb.	.24	-	25

NOTE—Paraffine waxes very scarce

Flotation Oils

All prices are f o b New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp gr., 0 930-0 940	gal.	$2 15
Pine oil, pure, dest. dist	gal	1 80
Pine tar oil, ref., sp. gr. 1 025-1 035	gal	.48
Pine tar oil, crude, sp gr. 1 025-1 035 tank cars f o b Jacksonville, Fla	gal	.55
Pine tar oil, double ref., sp gr 0 965 0 990	gal	85
Pine tar, ref, thin, sp gr., 1 080-1 960	gal	.36
Turpentine, crude, sp gr., 0 900-0 970	gal	1 75
Hardwood oil, f o b Mich., sp gr., 0 960 0 990	gal	35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f o b, New York, for carload lots

Rosin B D, bbl	280 lb.	$13 00	
Rosin E-I	280 lb.	13 10	
Rosin K-N	280 lb.	13 15	..
Rosin W. G.-W. W.	280 lb.	13 75	.
Wood rosin, bbl	280 lb.	12 50	.
Spirits of turpentine	gal	1 45	
Wood turpentine, steam dist.	gal		
Wood turpentine, dest. dist	gal	.	
Pine tar pitch, bbl	200 lb.		8 50
Tar, kiln burned, bbl (500 lb.)	bbl	4 50	15 00
Retort tar, bbl	500 lb.	5 00	15 50
Rosin oil, first run	gal	72	.
Rosin oil, second run	gal	.75	.
Rosin oil, third run	gal	.92	...

Solvents

73-76 deg., steel bbls. (85 lb.)	gal	$0 40
70-72 deg., steel bbls. (85 lb.)	gal	.38
68-70 deg., steel bbls. (85 lb.)	gal	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para — Upriver fine	lb	$0.27	-$0 28
Upriver coarse	lb	18	19
Upriver caucho ball	lb	.18½	19½
Plantation—First latex crepe	lb	.25	- ..
Ribbed smoked sheets	lb	.23½	
Brown crepe, thin, clean	lb	22½	--
Amber crepe No. 1	lb	.22	-

Oils

VEGETABLE

The following prices are f o b, New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0 16½		$0.18
Castor oil, AA, in bbls	lb.	17		.17½
China wood oil, in bbls (f o b Pac coast)	lb	.17½		18
Coconut oil, Ceylon grade, in bbls.	lb.	.15	-	.16
Coconut oil, Cochin grade, in bbls (nominal)	lb	.16	--	.17½
Corn oil, crude, in bbls	lb	12	--	.13
Cottonseed oil, crude (f.o.b. mill)	lb	.10½	--	.11
Cottonseed oil, summer yellow	lb	.14	—	.15
Cottonseed oil, winter yellow	lb.		—	½....
Linseed oil, raw, car lots (domestic)	gal	1.22	—	....
Linseed oil, raw, tank cars (domestic)	gal	1.16	—	...
Linseed oil, boiled, car lots (domestic)	gal	1.24	-	...

Olive oil, commercial	gal.	3.00 —	3 50
Palm, Lagos	lb.	.10½ —	.
Palm, bright red	lb.	... —	..
Palm, Niger	lb.	.09½ —	.10
Peanut oil, crude, tank cars (f.o.b. mill)	lb	.10½ —	.12½
Peanut oil, refined, in bbls	lb	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.30 ·	1 45
Rapeseed oil, blown, in bbls	gal	1.60	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	.11

FISH

Winter pressed Menhaden	gal.	$0.85	$0 90
Yellow bleached Menhaden	gal.	.87 —	90
White bleached Menhaden	gal	.90 —	.92
Blown Menhaden	gal.	1.05 —	....

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22 00	$25 00
Barytes, ground, off color, f o b. Kings Creek	net ton	18 00	20.00
Barytes, crude, 88%@94% ba, Kings Creek	net ton	8 00	- 10 00
Barytes, ground, white, f o b. Cartersville, Ga.	net ton	23 00	- 25 00
Barytes, ground, off-color, f o b Cartersville	net ton	16 00	— 19 00
Barytes, crude, 88%@94% ba, Cartersville	net ton	12 00	-
Barytes, floated, f.o.b. St Louis	net ton	26 50	- 28 00
Barytes, crude, min. 98% ba, Missouri	net ton	11 00	11 25
Blanc fixe, dry	lb	.05½ —	.06
Blanc fixe, pulp	net ton	60 00	80.00½
Casein	lb.	15 —	.18
Chalk, domestic, extra light	lb.	.05 -	.06
Chalk, domestic, light	lb	.04½	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 -	.07
Chalk, English, light	lb.	.05	.06
Chalk, English, dense	lb.	.04½	05
China clay, (Kaolin) crude, f o.b. mines, Georgia	net ton	9 00	12 00
China clay (Kaolin) washed, f o.b Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	12 00
China clay (Kaolin) ground, f.o b Virginia points.	net ton	15 00 -	40 00
China clay (Kaolin), imported, lump.	net ton	25 00	35 00
China clay (Kaolin), imported, powdered.	net ton	30 00	60 00
Feldspar, crude, f.o b Maryland and North Carolina points	gross ton	7 50	8 00
Feldspar, crude, f.o.b. Maine	net ton	7 50	10 00
Feldspar, ground, f o.b. Maine	net ton	21 00	23 00
Feldspar, ground, f o b North Carolina.	net ton	17.00	- - 21 00
Feldspar, ground, f o b. N Y State	net ton	17 00	- - 21 00
Feldspar, ground, f o b Baltimore	net ton	30 00	- - 35 00
Fuller's earth, granular, f o.b Fla.	net ton	25 00	—
Fuller's earth, powdered, f o b Fla.	net ton	18 00	—
Fuller's earth, imported, powdered	net ton	35.00	— 40 00
Graphite (dust polish grade 30%) Ashland, Ala	lb	.	— 01
Graphite (dust facing grade 50%) Ashland, Ala	lb		-- 02
Graphite, crucible, 80%, carbon Ashland, Ala	lb	....	— .05
Graphite, crucible, 90%, carbon Ashland, Ala	lb		- 10
Graphite, crucible, 85%, carbon	lb		- 08
Graphite, crucible, 88%, carbon	lb	.	- 09½
Graphite, crucible, 90%, carbon	lb		- 10½
Pumice stone, imported, lump	lb	04	50
Pumice stone, domestic, lump	lb	06	
Pumice stone, ground	lb	04	07
Quartz (acid tower) fist to head, f o b Baltimore	net ton		10 00
Quartz (acid tower) 1½@2 in, f o b Baltimore	net ton		14 00
Quartz (acid tower) rice, f o b Baltimore	net ton		17 00
Quartz, lump, f o b North Carolina	net ton	5 00	7 50
Shellac, orange fine	lb	1 35	1 40
Shellac, orange superfine	lb	1 40	1.45
Shellac, A C garnet	lb	1 10	- 1 15
Shellac, T. N	lb.	1 15	- 1 20
Soapstone	ton	15 00	25.00
Talc paper-making grades, f o b Vermont	ton	12.00	— 22 00
Talc roofing grades, f o b. Vermont	ton	9.50	15 00
Talc rubber grades, f o b. Vermont	ton	12 00	18 00
Talc powdered, Southern, f o b. cars	ton	12 00	15 00
Talc imported	ton	60 00	70 00
Talc California Talcum Powder grade	ton	20 00	25 00

Refractories

Chrome brick, f.o.b. Chester, Pa, carlots	net ton	100	110
Chrome brick, 9-in. strs and sizes, f o b. Baltimore	net ton	100	105
Fire clay brick, 1st quality, 9-in. shapes, f.o b. Pennsylvania, Ohio and Kentucky works	1,000	55	60
Fire clay brick, 1st quality, f o b. St. Louis	1,000	45	
Fire clay brick, 1st quality, f o b. New Jersey	1,000	75	
Fire clay brick, 2d quality, 9 in. shapes f o b Pennsylvania, Ohio and Kentucky works	1,000	50 -	55
Magnesite brick, 9 in. straights, f o b. Baltimore	net ton	110	120
Magnesite brick, 9-in. sizes and shapes larger than 9-in		Regular extras	
Magnesite brick, f o b. Chester	net ton	90 -	100
Silica brick, 9-in. and 9 in. sizes, Chicago district	1,000	65 -	70
Silica brick, f o b. Birmingham	1,000	56 -	61
Silica brick, f.o b. Mt. Union, Pa.	1,000	65	.

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f o b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	18 —	19
Ferro-chrome, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.20	21
Ferro-manganese, 76-80% Mn, domestic	gross ton	195.00 -	200.00
Ferro-manganese, 76-80% Mn, English	gross ton	170.00 -	175 00
Spiegeleisen, 18-22% Mn.	gross ton	80.00 -	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.25 -	2.75
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gros	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7 00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20½% silica, not more than 11% moisture	gross ton	$10 00	- $11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.65 —	.70
*Coke, foundry, f.o.b. ovens	net ton	18.00 —	20 00
*Coke, furnace, f.o.b. ovens	net ton	17.00 —	18 00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 -	.
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00 —	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½—	85.02
Manganese Ore, 50% Mn, c i.f. Atlantic seaport	unit	.65 -	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.70 —	75
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 -	...
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½—	....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 -	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	5.00 —	
Uranium Ore (Carnotite) per lb of U_3O_8	lb	2.75 —	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	.
Zircon, washed, iron free	lb	.10 —	...

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	18 50
Aluminum, 98 to 99 per cent	34.80
Antimony, wholesale lots, Chinese and Japanese	7 00@7 50
Nickel, ordinary (Ingot)	43 00
Nickel, electrolytic	45 00
Tin, 5-ton lots	45 50
Lead, New York, spot	8 40
Lead, E. St. Louis, spot	8 20
Zinc, spot, New York	8 00
Zinc, spot, E. St. Louis	7 70@8.05

OTHER METALS

Silver (Commercial)	oz	$0 99½
Cadmium	lb.	1 40@1 50
Bismuth (500 lb. lots)	lb	2 70
Cobalt	lb	4 00@6.00
Magnesium (f.o b. Niagara Falls)	lb	1 75
Platinum	oz.	115 00
Iridium	oz.	350 00
Palladium	oz	100 00@110 00
Mercury	.75 lb	83 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33 50
Copper bottoms	38 00
Copper rods	38 00@40 00
High brass wire and sheets	30.25
High brass rods	27 00
Low brass wire and sheets	28 50
Low brass rods	29 00
Brazed brass tubing	38 25
Brazed bronze tubing	41.75
Seamless copper tubing	34 00
Seamless high brass tubing	33 00

OLD METALS -The following are the dealers' purchasing prices in cents per pound

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.	15 00	17 00	14 00	15 00
Copper, heavy and wire	14 00	16 00	13 50	14 50
Copper, light and bottoms	12 50	14 00	12 00	13 00
Lead, heavy	7 00	4 75	7.00	7 00
Lead, tea	5 00	3 75	4 00	6 00
Brass, heavy	9 50	10 50	10 00	14 50
Brass, light	7 00	7 50	7.00	8 00
No. 1 yellow brass turnings.	8 50	10 00	7 50	8 00
Zinc	5 00	5 00	4 50	5 50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.58	$4.47	$3.47	$5.00	$3.37	$4 08	$3.47
Soft steel bars	4.73	4.62	3.37	4.50	3.27	3.98	3.37
Soft steel bar shapes	4.73	4.62	3.37	...	3.27	3.98	3.37
Soft steel bands	6.43	6.32	4.07	6.25	....	....	....
Plates, ¼ to 1 in. thick	4.78	4.67	3.67	4 50	3.57	4.28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SAN FRANCISCO—The Federal Rubber Co., Cudahy, Wis., will soon award the contract for the construction of a 5-story factory for the manufacture of tires, etc. Estimated cost, $150,000. G. B. Allen, archt. and engr.

Connecticut

NAUGATUCK—The Rubber Regenerating Co., Elm St., has awarded the contract for the construction of a 1-story addition to machine shop and alterations to other buildings at plant to the F. T. Ley Co., Inc., 499 Main St., Springfield, Mass. Estimated cost, $50,000.

NEW HAVEN—The Nustone Products Corp., Waterfront St., will build a 1-story, 95x100-ft. stone products factory. Estimated cost, $12,000. Work will be done by day labor.

UNION CITY (Naugatuck P. O.)—The Eastern Malleable Iron Co. has awarded the contract for altering and building additions to the present plant to the Fred T. Ley Co., Inc., 499 Main St., Springfield, Mass. Estimated cost, $50,000.

VERSAILLES—The Versailles Sanitary Fibre Mills has awarded the contract for the construction of a paper factory to the H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $100,000.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. plans to build a sugar refinery. Estimated cost, $2,000,000. W. Higginson, 18 East 41st St., New York City, archt. and engr.

Illinois

CHICAGO—The Coca-Cola Co. plans to build a plant on Crawford and Karlov Aves. Estimated cost, $750,000.

CHICAGO—The Sherwin-Williams Co., 116th St. and Stephenson Ave., is building a white lead manufacturing plant and is in the market for equipment for the manufacture of litharge and red lead.

Kansas

CHANUTE—The Mutual Oil Co., Mutual Bldg., Kansas City, Mo., will build a 3-story, 35x90-ft. wax plant for the manufacture of lubricating oil. Estimated cost, $100,000. Work will be done by day labor.

TOPEKA—The Topeka Fdry. & Iron Co., 318-322 Jackson Ave., plans to construct 3 buildings, including a foundry and machine shop. Estimated cost, $100,000.

Maine

WATERVILLE—The Keyes Fibre Co. has awarded the contract for the construction of a paper factory to the Aberthaw Constr. Co., 27 School St., Boston. Estimated cost, $100,000. Webster & Leroy, 534 Congress St., Portland, engrs.

Maryland

BALTIMORE—The Bd. of Awards has awarded the contract for the construction of a hydrolytic tank, sludge digestion tank, etc., at the sewage disposal works, west shore Back River, to the Robertson Bros., 106 Hopkins Pl.

BALTIMORE—The Interocean Oil Co., East Lexington St., plans to build a 1-story, 80x38-ft. chemical laboratory. Estimated cost, $7,788. O. F. Adams, archt.

BALTIMORE—The Whitaker Paper Co., 415 Guilford Ave., has awarded the contract for the construction of an 8-story, 100x186-ft. warehouse on Guilford Ave., Saratoga and Davis Sts. to the Turner Constr. Co., 244 Madison Ave., New York City. Estimated cost, $600,000.

Massachusetts

EAST PEPPERELL—The Nashua River Paper Co. plans to build a paper factory addition. Estimated cost, $100,000.

HOLYOKE—The Perfect Safety Paper Co., Winter St., plans to build a 60x100-ft. paper factory addition on Appleton and Winter Sts. Estimated cost, from $75,000 to $100,000. Howes & Howes, 243 High Sts., archts.

Michigan

MARYSVILLE—The Aluminum Castings Co., c/o E. E. Allyne, 2800 Harward Ave., Cleveland, O., plans to build a 2-story factory. Estimated cost, $75,000.

ONTONAGON—The Northern Fibre Co. has awarded the contract for the construction of a 2-story pulp mill to W. E. Ulo, Stevens Point, Wis. Estimated cost, $350,000.

OWOSSO—The city has awarded the contract for furnishing labor and material for the construction of a water filtration plant with 1,000,000 gal. capacity to the Ann Arbor Asphalt Constr. Co., Ann Arbor. Estimated cost, $75,000.

Minnesota

WABASSO—The city rejected all bids for the construction of a sewage treatment plant and general sewer. Estimated cost, $15,000. J. F. Druar, 512 Globe Bldg., St. Paul, engr. Noted Sept. 1.

Missouri

EXCELSIOR SPRINGS—The city plans an election Oct. 4 to vote on $25,000 bonds to construct a disposal plant, etc. Shockley Eng. Co., Kansas City, engr.

MOBERLY—The city is having plans prepared for the construction of an impounding dam, filter plant, etc. Estimated cost, $350,000. Fuller & Beard, Chemical Bldg., St. Louis, engrs. Noted July 14.

SPRINGFIELD—The Wood Everett Stove Co. plans to build a 2-story foundry. Estimated cost, $100,000.

WEBB CITY—The Rock Paint & Cloth Co. is having plans prepared for the construction of a 2-story, 61x150-ft. paint factory. Estimated cost, $150,000. Bucy Miller Eng. Co., Joplin, engrs.

Nebraska

CHAPPELL—The city plans to build a sewage disposal plant and sewer system. Sewage treatment and Imhoff tank and sand filters will be installed in same. Estimated cost, $90,000. Hensingson Eng. Co., 12th and Harney Sts., Omaha, engrs.

North Dakota

HURDSFIELD—The Bd. Educ. will soon award the contract for the construction of a 2-story, 68x89-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. R. H. Corson, clk. W. D. Gillespie, Fargo, archt.

Ohio

AKRON—The Miller Rubber Co., South High St., will build a 3-story, 60x210-ft. factory. Estimated cost, $100,000. Work will be done by day labor.

CLEVELAND—The Bd. Educ. will receive bids until October 1 for the construction of a 1-story sewage treatment and water pumping plant. Estimated cost, $50,000. C. W. Bates, Natl. Bank Bldg., Wheeling, W. Va., archt.

CLEVELAND—The Peerless Motor Car Co., East 93rd St. and Quincy Ave., rejected bids for the construction of a 1-story, 60x100-ft. japanning building. Estimated cost, $100,000. Carter, Richards, Griffith Co., Illuminating Bldg., archts and engrs.

COLUMBUS—The city will receive bids until Oct. 4 for the construction of additions and repairs to the sewage disposal plant on Dawson Ave. P. N. Roderick, village clk.

TOLEDO—The Maumee Tire & Rubber Co., 705 Madison Ave., is having plans prepared for the construction of a 3-story, 100x300-ft. rubber tire factory on Lackey Rd. Estimated cost, $300,000. G. G. Morrison, pres. Osborn Eng. Co., 2848 Prospect Ave., archt. and engr.

Oklahoma

DOUGHERTY—The Continental Asphalt & Refining Co., Oklahoma City, will build a refinery here. Estimated cost, $1,000,000. Work will be done by day labor.

OKLAHOMA CITY—The city will soon receive bids for the construction of a sewage disposal plant. Estimated cost, $1,000,000. Pierce, Greeley & Hansen, 39 West Adams St., Chicago, Ill., engrs. Noted July 14.

SPIRO—The city plans an election Nov. 4 to vote on $50,000 bonds to construct a sewage disposal plant, etc.

Pennsylvania

PHILADELPHIA—E. Hubschman, Orianna and Willow Sts., has awarded the contract for the construction of a 1-story, 60x90-ft. leather factory addition, to Mongahan & Losse, 3016 Chestnut St.

PHILADELPHIA—McIlvain Bros., 15th and Hamilton Sts., will soon award the contract for altering their drug factory. Ballinger & Perrot, 329 South Broad St., archts.

Rhode Island

PROVIDENCE—Brown University, Prospect St., will soon award the contract for the construction of a 3-story, 50x200-ft. laboratory. Estimated cost, $250,000. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., archts. and engrs. Noted Aug. 25.

Texas

WICHITA FALLS—The State Bd. of Control, Austin, will receive bids until Oct. 4 for the construction of a sewage disposal plant, etc., at the Northwest Texas Insane Asylum, here. C. H. Page & Bros., Austin Natl. Bank Bldg., Austin, archts.

Wisconsin

BELGIUM—The city had plans prepared for the installation of septic tank, etc. Estimated cost, $25,000. J. Donohue, 8th St., Sheboygan, engr.

HARTFORD—The city is having plans prepared for the installation of sewage disposal tanks, etc. Estimated cost, $25,000. C. Leins, West Bend, engr.

MILWAUKEE—The Natl Brake & Electric Co., Belleview Pl., has awarded the contract for the construction of a 1-story, 164x180-ft. foundry addition to Paul Riesen's Sons, 1000 Humboldt Ave. Estimated cost, $250,000. Noted April 21.

OSHKOSH—The Mercy Hospital, 185 Hazel St., is having plans prepared for the construction of a 4-story hospital addition and nurses' home on Hazel St. Chemical laboratories will be installed in same. Estimated cost, $600,000. E. Brielmoler & Sons, University Bldg., Milwaukee, archts and engrs.

SHEBOYGAN—The Columbia Rubber Mills, 176 16th St., Milwaukee, has awarded the contract for the construction of a 2-story, 100x170-ft. factory to Herman Loesing, 914 Superior St. Estimated cost, $60,000. Noted Aug. 11.

SHEBOYGAN—The Tomah Rubber Co., 176 16th St., Milwaukee, has awarded the contract for the construction of a 2-story, 70x100-ft. rubber factory on Lymans Ave. to H. Loesing, 914 Superior St. Estimated cost, from $50,000 to $60,000. Noted Aug. 4.

Ontario

LONDON—The Daughters of the Empire has awarded the contract for the construction of a 3-story, 100x280-ft. children's hospital on Ottawa Ave., to John Putherbough, 272 Regent St. Special laboratory equipment will be installed in same. Estimated cost, $250,000.

OTTAWA—The Ottawa Paint Works, 687 Wellington St., has awarded the contract for altering paint factory on Wellington St. to A. Christie & Son, Kensington Apts., Elgin St. Estimated cost, $50,000.

SANDWICH EAST—The city plans an election to vote on $200,000 bonds to construct intercepting sewers, sewage disposal plant, etc. Morris Knowles, Ltd., Heintzman Bldg., Windsor, engr.

Coming Meetings and Events

American Association for the Advancement of Science will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

American Ceramic Society will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

American Electrochemical Society will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

American Engineering Council of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

American Foundrymen's Association will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

American Mining Congress will hold its next convention in Denver Nov. 15.

American Physical Society will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

American Society of Mechanical Engineers' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

Canadian Institute of Mining and Metallurgy will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

Electric Furnace Association will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

Engineering Council will hold its next meeting in Chicago, Thursday, Oct. 21.

Institute of Metals Division of the A. I. M. E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 1.

National Association of Purchasing Agents will hold its annual convention at the Congress Hotel, Chicago, Ill., Oct. 11, 12 and 13.

The Rubber Section of the National Safety Council will consider safety problems of especial interest to the rubber industry at a section conference to be held Sept. 29 to Oct. 1, in connection with the national session of the Council to be held in Chicago.

Society of Industrial Engineers will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

W. S. Rockwell Co., New York, calls attention to Bull. 217, dated June, 1920, on "Automatic and Semi-Automatic Furnaces for the Continuous Heat-Treatment of Metals." This bulletin is a review of methods and equipment that the company has developed in recent years and which have shown their value in practice.

Weller Mfg. Co., Chicago, Ill., is issuing a four-page folder on coal handling equipment which helps solve the labor problem.

Eugene Wuerz, Brooklyn, N. Y., designer and builder for the enamel, glass, iron and steel industries of patent recuperator system furnaces, has issued a booklet giving illustrations and descriptions of different furnaces, together with illustrations of actual installations.

Ross-Tacony Crucible Co., Philadelphia, Pa., has issued an illustrated booklet on its crucibles, phosphorizers, retorts, stirrers, skimmers, etc., special crucibles, stoppers, nozzles and sleeves.

Weston Dodson & Co., Inc., announces the appointment, as export sales manager, of F. R. Wadleigh, formerly consulting and export engineer, vice J. H. Davison, resigned, and of J. W. Sands as assistant export sales manager.

W. M. Humphrey has purchased the plant of the Gas Oil Chemical Co. of Hammond, Ind., and will enter immediately into the manufacture of dye intermediates, including paratoluidine, orthotoluidine and paranitrotoluol.

The Kewaunee Mfg. Co., Kewaunee, Wis., has elected C. G. Campbell a member of the board of directors and has appointed him general manager.

The Powers Regulating Co. has recently moved into a large modern fire-proof factory building having floor space of about 40,000 sq.ft. The company has grown to this size from the small beginnings in 1890 when W. P. Powers turned out the first house regulators in a small room 12 x 16 ft. Recently the older employees of the company, including one who has been with the organization from the beginning, presented W. P. Powers, their president, with a silver cup in token of their affection and esteem.

The Simonds Mfg. Co. has just completed an addition 40 x 50 to its research laboratory connected with its steel mills at Lockport, N. Y. Additional equipment consisting of a 300 to 500 lb. capacity special type electric melting furnace, several electric heating furnaces and other tools and equipment have been installed, with a view of greatly extending facilities for carrying on development and research work. New formulas and methods for making special steels will be worked out at the enlarged laboratory under the direction of an expert metallurgical staff.

The Westinghouse Electric & Mfg. Co.'s war memorial scholarship committee has announced as the winners of the four scholarships for the coming year, 1920-21, Alva C. Corrao, small motor drafting department; Henry Gardiner Symonds, son of N. G. Symonds, manager industrial sales division, Chicago office; J. Dale Seabert, transformer engineering department, and Herbert R. Hillman, son of William A. Hillman, who has been a machinist in the works of the R. D. Nuttall Co. for twenty-seven years. These memorial scholarships were established in 1919 as a means for perpetuating the memory of those employees of the Westinghouse company and its subsidiary companies who took part in the great war. Each scholarship carries with it the annual payment of $500 for a period not to exceed four years. The payment is to be applied towards an engineering education in any technical school or college selected by the successful candidate. Scholarships are granted for one year only, and approved by the scholarship committee, but are continued for the full course provided the scholar maintains the academic and other standards required by the institution. The awarding of the scholarships is based upon the personal character of the applicants and grades in examinations.

Abbot A. Hanks, who has long conducted an assay office and chemical laboratory at 630 Sacramento St., San Francisco, and testing laboratories in separate quarters, has recently moved into a new and larger building at 624 Sacramento St. The new building will house the entire laboratory equipment and contains a sampling room, an assay room, a chemical laboratory with dark room, a testing laboratory and a library. The more commodious quarters permit of the efficient arrangement of equipment and allow space for additional apparatus. The testing laboratory is thoroughly equipped to handle materials of construction and commerce. There is a growing demand for this class of work both in volume and variety due to the increase in foreign trade through the port of San Francisco as well as because of the evident need of inspection of incoming and outgoing shipments. The testing laboratory has an experienced personnel and is in position to perform efficient service.

Charles Whiting Baker, for many years editor-in-chief of *Engineering News* and since 1917 consulting editor of *Engineering News-Record*, announces his resignation and the establishment, under his direction, of the Engineering Business Exchange, with offices at 30 Church St., New York City, an agency to bring together those desiring to sell any sound engineering or technical business manufacturing, constructing, selling or professional--and those seeking opportunities to purchase.

The Ajax Electrothermic Corp., Trenton, N. J., announces that Dr. E. F. Northrup has recently been elected vice-president of the company and is now engaged in perfecting the brass-melting furnace of the Ajax-Northrup type. Dr. Northrup has resigned his professorship at Princeton University in order to devote his entire time to the business of the company.

Manufacturers' Catalogs

The Pennsylvania Forge Co., Bridesburg, Philadelphia, Pa., has issued a 32-page booklet on Forges and Pressed Steel Die Blocks Made from Acid O.H. Steel. This booklet is known as Cat. No. 3.

The Monarch Mfg. Works, Inc., Philadelphia, Pa., has issued a 4-page folder, Cat. 6, Section C, on improved chemical sprays, which gives descriptive matter and illustrations.

The Warren Chemical Division of The Barrett Co., New York, calls attention to a small booklet on Alkali and Acid-Proof Anchor Rock Asphalt Floors.

The Mine & Smelter Supply Co., New York City, has just received from the press Bull. No. 63, on Massco Furnaces for melting, hardening, tempering, annealing, forging, assay work, ore roasting, etc., using oil, gas or gasoline fuel. This attractive 48-page booklet gives illustrations and descriptive matter of the following furnaces: crucible tilting; potless tilting; small stationary gas; gasoline melting; muffle; rod heating; pack hardening; billet forge; annealing; oil forge; die hardening; reverberatory and mechanical roasting, together with burners, accessories and motor blowers.

Mojonnier Bros. Co., engineer, Chicago, has just issued a new 160-page catalog on Scientific Dairy Apparatus and Supplies, wherein is shown a comprehensive line of the company's own apparatus, also a very complete line of laboratory accessories for the chemical and bacteriological control of milk and milk products. The second section of the catalog is devoted to vacuum pans, sterilizers, pumps and a complete line of heavy machinery used in condensed and evaporated milk plants.

Leeds & Northrup Co., Philadelphia, Pa., has issued Cat. No. 75, entitled "Electrometric Methods and Apparatus for Determining Hydrogen Ion Concentrations." This booklet contains the following: General Considerations, The Working Formulas, Electrometric Methods Applicable to Hydrogen Ion Measurements, Methods Employing Potentiometer Principle, Practical Considerations in Applying Working Formulas, Applications of the Gas Chain to Titration Analysis, Industrial Applications of Gas Chain Methods, Bibliography and Price List.

The Yarnall-Waring Co., Philadelphia, Pa., is distributing Bull. No. 410, descriptive of the Yarway seatless and double tightening blow off valves, both separately and in combination. The Yarway double tightening valve is a new development, having been designed primarily to use in conjunction with the seatless valves in certain states where boiler laws require use of either two valves or a blow-off valve and a cock on each individual blow-off line. This conforms with the A.S.M.E. boiler code. A copy will be sent upon request.

The Oxweld Acetylene Co., Chicago, Ill., has its new "Eveready" catalog ready for the public. The catalog is issued in sections, each devoted to a particular phase of "Eveready" equipment -welding and cutting blowpipes, regulators, accessories, etc. The "Eveready" line was formerly manufactured under the name of "Prest-O-Lite" apparatus by the Prest-O-Lite Co., and was extensively used in the metal trades. The Oxweld company took over the production and sales under the present name—Eveready—early in 1920, incorporating certain improvements in design lately developed in oxy-acetylene engineering. For the benefit of users of Eveready welding and cutting apparatus who desire special information on any particular phase of the industry, a series of small printed pamphlets containing matter excerpted from the Eveready instruction book and catalog. Among the subjects ready for distribution are: Directions for Operating Lead Burning Equipment, 12 pages; Directions for Operating Welding Equipment, 12 pages; Directions for Operating Cutting Equipment, 8 pages. Each pamphlet contains a detailed list of parts comprising the equipment treated. Copies are mailed free on request.

The Loomis-Manning Filter Distributing Co., Philadelphia, Pa., calls attention to a new catalog on its filters, which insure clean, safe, freshly-filtered water for all uses.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Choosing a Director For the Bureau of Mines

DESPITE the limitations of its name, the United States Bureau of Mines has a very definite and practical interest for the chemical and metallurgical industries. Mines belie their name unless they yield ores, and ores are without value unless metals can be produced from them economically. Nor is it the metallic minerals alone in which our industries are concerned; the non-metallics form the basis for the wide range of chemically-controlled industrial processes. The Bureau, therefore, serves a wide clientèle and our interest in its welfare is almost personal in so far as we serve the chemical and metallurgical industries.

It has been an open secret for some time past that the present director of the Bureau, Dr. FREDERICK G. COTTRELL, plans to retire at an early date. His appointment on the resignation of the previous director, Mr. MANNING, was a merited honor. Moreover, it was advisable in the interest of maintaining the spirit of the organization and continuing its work until the proper man could be found to take the post permanently. Dr. COTTRELL neither sought nor desired the position, realizing that its administrative nature would not be wholly to his liking. His friends, likewise, felt that he would be wasting unusual talents of a high order in a place which offered little opportunity for the exercise of them.

Thus we are confronted with the necessity of securing a new director for one of the most important bureaus in the Department of the Interior. All will agree that the greatest care should be exercised in making the choice. The position calls for certain qualifications that are quite obvious. Primarily, we suggest that it seems appropriate that the director of the Bureau of Mines should be a mining engineer—one experienced in the theory and practice of mining, skilled in administration and organization, sympathetic with the related subjects of chemistry and metallurgy and having a broad view of the mining industry and its relation to the welfare of the country. In addition to these qualifications the incumbent should be in a position to make that sacrifice which a Government salary entails, and yet he must not be so secure in his independence as to have lost ambition and initiative.

A number of men suggest themselves in this connection—men of the type of POPE YEATMAN, R. M. RAYMOND, A. H. ROGERS or ARTHUR THACHER. Any one of these would bring to the office administrative ability and technical knowledge of a high order, combined with familiarity with all phases of the mining industry and a salutary knowledge of business.

We commend their consideration to those officials of the Government on whom will fall the responsibility of making the appointment.

Competitive Conditions In Commodity Markets

FOR many months past there has been what is commonly called a "sellers' market" in the majority of commodities. There has been competition, but it has been competition among buyers rather than competition among sellers. We cannot forget, however, how suddenly market conditions have changed at times in the past and there is reason therefore to expect that as many commodities are now swinging from the sellers' to the buyers' side the swing will be more or less violent.

If there had not been compensating influences the resulting tendency in recent times would have been for competition among manufacturers to become more violent each time the market turned against the sellers. One great compensating influence has been the growth of a feeling on the part of manufacturers that the individual must not do something that will prove harmful to the class. This is a substitute for the price agreements that are interdicted by the common law, written specifically into the statutes by the Sherman "anti-trust" act of 1890.

There is a serious question whether this co-operative feeling will be as prominent in the competition that is to come as it has been in the recent past. Some new influences have arisen. There has been much of what is called "profiteering" and in a given industry the amount of "profiteering" attempted by the individual sellers has varied.

In some industries there has been a wide division, some sellers having very plainly been profiteers, or seekers after the maximum prices obtainable from anxious and nervous buyers, while other sellers have been punctilious, even overscrupulous, in their efforts to avoid even the appearance of profiteering. As a result of these divergencies in attitude the men engaged in these industries are not in as close harmony with one another as was formerly the case, and the outcome of this situation may be a disposition to compete more keenly than in the last competitive period.

Another new condition is that both on account of profiteering and on account of the inability of some manufacturers to meet their customers' requirements in the past year or more many buyers are thoroughly disgruntled with their regular sources of supply and have registered vows that upon the first opportunity they will take their custom elsewhere. There will therefore be a great deal of "swapping" of customers. In many trade channels it has been the common practice among the majority of buyers to stick to a certain source of supply, their experience having been that thus they will best be "taken care of" in times of scarcity of the commodities involved. Many buyers now feel that instead of being taken care of they have been left entirely in the lurch or have been exploited to the limit—that in

other words the test has been pushed beyond the yield point and merely kept inside the breaking point, so that a permanent set has been acquired, and the permanent set means another source of supply for the future.

As to the attitude of sellers toward the buying trade, many have recognized frankly that after the period of famine and unreasonable prices they would have to buy their way into the trade again, and with large profits accumulated they are willing to devote a percentage of those profits to the buying process, to the selling of goods at a loss if necessary in order to purchase a clientèle.

From a consideration of these circumstances it may be concluded that there are distinct possibilities of our seeing keener competition in some of the commodity markets than has been witnessed for a long time past or than was ever expected to appear again.

Who Is A Chemist?

RECENTLY we noted in a valued contemporary of such high standing that it pains us to read them, two advertisements of chemical "positions vacant," which showed a striking lack of appreciation of what a chemist is.

One of these advertisements wanted "a graduate chemist or one who has *almost completed* the course" (the italics are ours); and then proceeded to state that analytical and investigation work in an almost unlimited field "in connection with manufacturing processes in many industries" was to provide "intensely interesting work, practically no routine." We wonder how that man who has only "almost completed the course" is to care for this field involving "manufacturing processes in many industries." He certainly would have to show unusual promise.

The other advertisement to which we refer wanted a chemist to do research work in one of our industries in which there is large opportunity for new investigation, but where extremely difficult problems are to be met. This position was to be filled by someone who was asked to state "age, education, past position, *if any*, etc." (Again the italics are ours.) We wonder how any man who has never held a position in chemical work before is to take advantage of the "good prospects" which this advertiser offers.

It is high time that our industries realized that a man fresh from college is not a full-fledged chemist. At this stage in ordinary circumstances he has not reached even the end of an apprenticeship. It is also high time that the chemists of the country made clear to the industries what they can do and who belongs within their learned cult.

It is almost a temptation to urge that no one should be permitted to style himself "chemist" unless he had passed certain qualifying tests. This very point was emphasized by Dr. M. L. CROSSLEY at the last meeting of the American Chemical Society in his address on "The Qualifications of Organic Chemists." Until we get some means of thus identifying the qualified members of our profession we are bound to be discredited in the eyes of industry, which inevitably through misunderstanding of the facts will seek out the man who has "almost completed the course" or will ask for the "previous position, if any," in the experience of one to engage in investigation work and in the solution of extremely difficult chemical problems.

Poor Fish

DR. JACQUES LOEB, of the Rockefeller Institute, has made many and profound studies of tropisms, and published several books on the subject. A tropism is a non-volitional act. Perhaps we can best explain it in the example of a species of fish with which Dr. LOEB was at one time experimenting. The fish were heliotropic— that is, the presence of light in a dark place compelled them to turn toward it. Thus if such fish are placed in a globe and if the globe be taken to a dark room into which a lighted candle or other light is brought they will forsake everything and keep their noses pressed against the side of the globe nearest the light. Move the light and all the fish will move to face it and stay right there as long as the light does; stay there until they float belly up on the surface with the life gone out of them. Disagreements, the search for food, love-making, and all the other joys and sorrows of fish life are forgotten or abandoned against what seems a grand passion of curiosity. Take the light away or make the whole room generally light again and the fish will swim about as before just as though nothing extraordinary had happened.

But if, while they are engaged in what seems like pop-eyed and perpetual wonder at the burning candle, we secretly lead into the water in which they swim a tube conducting carbon dioxide, we shall soon meet an amazing phenomenon. As the saturation of the water with CO_2 reaches a given point the apparent curiosity of the fish ceases, and one by one they give up their posts of observation and swim around and back and forth with no more reference to the burning candle or the single bright light than a society gold-fish. The little extra carbonic acid made them just like others. The phenomenon is an instructive example of photochemistry, and a demonstration of the theory of mass action in life.

Now suppose these fish were people and could talk. And suppose we should ask the biggest one why he looked at the candle.

"Why," he would reply, "I observed a new element in our world, and I didn't know what it was. So I made up my mind that I would not leave my post until I learned what it was, or at least what it would do. 'Here,' I said, 'is danger, and only death itself can drag me from my vigil until I know what it signifies!'"

Then we might ask him why he quit looking at it and gave up his quest. In reply he would declare that he finally reached the conclusion that the light was not dangerous; that it was a thing that did not concern the life of the colony. At this point he dismissed the subject from his mind and went about his business. Or he might offer any other reason *ex post facto*. An intimation as to the influence of carbon dioxide upon his opinions would offend him. He would want us to understand that he knew what he was about, that he was a fish of character, and not to be swayed in his opinions by carbon dioxide or anything else. If we were to ask him why the other fish also began to swim about freely at the same time as he, he would distend his chest and inform us with a dignified swish of his tail that he was probably not wholly without influence among his neighbors. Other fish would claim similar originality, fishy books would be written on the claims of the various leaders who brought the community back to "normalcy," and the history of the great light disturbance would become a subject of academic dispute and later a standard means of training the minds of young fish.

Now we're like that; very like it. For the past few years this country has been very prosperous and money has been easy to make. Thinking has hardly been necessary. We know of a young engineer who knew his business moderately well, but found it more profitable to work as a journeyman carpenter. Work has been very well paid. Hundreds of thousands of persons—men being scarce—have consequently declared that labor is the true source of all wealth; and there are tons of so-called literature to prove it. This means that, given a man, a horse and a cart, the cart and its earnings belong to the horse.

Gradually conditions are changing. The impossible has happened. American dollars have become so precious in comparison with foreign money that the foreigner refuses to buy of us. Ten dollars a day and bankers' hours—which are the hours banks are open rather than the hours bankers work—are still standards of payment for certain kinds of labor, but the jobs are getting scarce. Labor is beginning to underbid, and while we insist that labor is not a commodity and that every man and woman who works in an organization is part of its human staff, the fact remains that a little competition is a wholesome thing. There are limits to the earning power of a husky shoulder carrying a hod, especially in comparison with the earning power of thinking. Tropisms are less valuable than thoughts.

Now if our good dollars have got to be so valuable that the poor foreigner can't use them, then we must do something besides strut about and explain our glory and our might and our wisdom in making our dollars so valuable. When we do that we are merely displaying tropisms. What we need to do is some thinking, some real thinking, to get a line on the causes and to plan out a line of conduct that will be wise instead of foolish; intelligent instead of smart. A little season of meditation will do the best of us no harm. Then we may look inwardly and consider how much of what we think is mere tropism; conclusions reached because of influence, weather, situation, liking, etc., on the one hand, and on the other how much of our thinking is pure constructive thought. When hard times threaten it is impossible for us to get ahead by repeating old saws or by exercise of mere tropisms.

Need for Technical Advances In Carbon Black Technology

CARBON black is a highly important commodity. It is as essential as paper to the printing industry, every printed word almost being a composite of countless particles of it, which when mixed with linseed oil form an ink that is not tarry and instantly divides its oil with paper, giving a dry, adherent, black film over the wetted impression area. During the past five years the rubber industry has found it the superior compounding ingredient. The familiar black cord automobile tires are taking twenty million pounds, half the annual production and twice the amount consumed in printing inks, and promise an unlimited market.

West Virginia, the birthplace and home of the gas-black industry, as well as most all other states having natural-gas resources, does not welcome the prospect of having this fuel, so potential for industrial advancement and domestic comfort, all burned up in a few years to extract only one pound and a half of carbon black per 1,000 cu.ft. of gas. Legislation prohibiting the use of gas in this industry has failed so far on constitutional grounds when tests of its legality were carried to the highest courts.

The remedy for the situation depends on the industry making a more satisfactory showing. Ninety-five per cent loss of the carbon in the original gas certainly looks bad, without even bringing up the subject of calories escaping in hundred per cent lots. That some effort has been made to improve the technology of the industry is well known. Many patents form a record of the creation of new ideas. Unfortunately, however, most of these were ill conceived and effected nothing. A tarry lampblack or a gray coky powder are usually produced by all these would-be efficient processes.

In this issue we are publishing a full description of the channel process by ROY O. NEAL of the Bureau of Mines. In a subsequent number we shall describe the other commercial processes, and in the future we shall be looking for new developments to present to our readers. Every investigator on this subject should first acquaint himself with the processes now in use and then study the reactions and products, physically and chemically. Other sources of heat than the partial combustion of the gas may possibly be used, but not in thermally decomposing the gas into carbon and hydrogen. Pyrogenetic reactions take place with the hydrocarbon decomposition products, yielding tarlike particles which if further heated produce coke dust having no resemblance to carbon black. The reducing flame composition is undoubtedly necessary as well as its temperature, but the means of obtaining these are various and should be the basis for developments of the future.

A Note On Research

SUPPOSE, it was lately suggested, that GREGOR MENDEL, the Abbot of Bruenn, had asked the head of his monastic order for land and labor and the privilege to carry on experiments in heredity. Of course, the request might have been granted, but he might also have been advised that it would be better to leave that kind of work to others. Such things often happen in the best of organizations. It may occur in a laboratory almost more easily than anywhere else.

We know that the sloppy man is a nuisance, we are fully alive to the hopelessness of results from disorderly minds, but we maintain, nevertheless, that the system and order which issue from incompetent administration is often the devil's own work. Research in industry points to a definite goal, but the trails found on the way are not to be despised. These trails are dividends, and to miss them is to miss the fruits of research. A proper division of work is necessary; great research laboratories must have analysts to speed up the achievement of men of originality; some persons are full of invention and short of accomplishment, while others can do only what they are told to do, although in this they are amazingly effective. But a false concept of system and order must not be allowed to kill invention or to discourage it. When a man of research has an idea it is well to advise with him and see if it cannot be brought to development with the help of his own enthusiasm. About the worst thing to do is to take the idea away from him and to kill his initiative because of some rule. Research is the occupation of a gentleman, and this fact should always be borne in mind. It is a very distinguished calling.

Readers' Views and Comments

More and Better Tools Needed

To the Editor of Chemical & Metallurgical Engineering

SIR:—There have been several references in CHEMICAL & METALLURGICAL ENGINEERING recently to a subject that has seemed to me one of the most important that could be considered by our technical societies, for indirectly it leads to a consideration of the proper function of the technical school and of the best training for technical students.

In the issue of Sept. 22, in describing the meeting of the American Chemical Society in Chicago, Major Howe's speech at the dinner was summarized as "a plea for better tools, among which the most important was the publication of tables of physical and chemical constants."

In the issue of Sept. 8 J. W. Richards writes at length under the head of "More and Better Tools Wanted" of the hiatuses in our knowledge of physical and chemical constants. Not long ago the American Chemical Society undertook a drive for $100,000 to make a collection of constants for publication, a work which had been begun by the International Congress of Applied Chemistry with its three volumes of "Tables Annuelles."

I am inclined to believe that the most necessary thing at present is not so much further compilation of existing data as it is the determination of new constants. In preparing the last edition of my "Metallurgists and Chemists Handbook" I made some inquiry into the source of a number of the constants there published and was amazed to find how many of them were based on work done in the '80s and '90s.

Having had my attention called to one group of melting points, I tried to find later determinations than the early '90s and spent every evening for nearly three weeks in the Library of Congress in this attempt, without success. I am convinced that a very large proportion of our published data rests on work done between twenty and thirty years ago and that almost the entire field needs rechecking.

Who is to do it? It does not seem to be the place of the consulting engineer or of the private research or analytical laboratory. It is expensive and absorbing work, and contributes not at all toward meeting the H. C. L. On the other hand, the logical place for this work would appear to be the technical school, the college laboratory and the subsidized institution, such as the Bureau of Standards. There the professor or director has a large corps of assistants, his own living is already taken care of, and apparatus and chemicals are usually available without stint. Especially important for research work of the kind I have indicated is the first point. The professor can cover a large amount of territory in a short time, checking the results of different observers against one another, yet none of his assistants is wasting his time, for the training is valuable to each of them.

Yet apparently there is no longer thought in the technical schools of anything but "industrial fellowships." A friend of mine, head of a large chemical company, told me he recently received in one week pressing invitations from six colleges to establish industrial fellowships. His own comment was, "I refused. Either I was hiring the professor, and it would be too cheap, or I was hiring an untrained student, and it would be too dear."

Again quoting from CHEMICAL & METALLURGICAL ENGINEERING, page 565 of Sept. 22, in referring to the Chicago meeting of the American Chemical Society, it says: "'The Qualifications of Organic Chemists' was presented by L. Crossley, chief chemist of the Calco Works, in which he, like Dr. Rose (and both Drs. Crossley and Rose have had wide experience as professors of chemistry before entering into industry), felt that so-called utilitarian work was of least value, while training in general principles in those studies which are necessary for the meditations of thoughtful men was of leading importance."

Isn't it about time to get away from the industrial fellowship idea, and the publication of constants idea, and leave the former to the practicing chemical engineer and the latter to individual enterprise, and give a little attention to research work on the determination of some of the needed constants? It will probably be said that I write "as one whose ox is being gored." Who else is there to write on the subject but those who are vitally interested in it?

New York City. DONALD M. LIDDELL.

There's Trillions in It!

To the Editor of Chemical & Metallurgical Engineering

SIR:—The Exposition brings to light all sorts of unexpected things. A gentleman who owns 6,400 acres of shale land showed a report that he had received from a technical "expert." He refused to give up the expert's name, so I am restricted to the mere record of his glorious imagination, which seems too rich, too active, too venturesome to be permitted to blush unseen. If we could only transform this imaginative energy into foot-pounds, I believe we could run a blast furnace with it. Like all men of similar (but lesser) gifts, he presented two sets of figures in his estimate of the industrial value of the gentleman's property, which he calls respectively "high" and "average."

The value of the shale per ton is declared to be:

	High	Average
Oil, 75 gal., Penna. grade	$12 50	$7 50
Gold	65 00	10 00
Silver	33 15	5 00
Platinum	86 00	8.00
Potash	12 00	6.00
Ammonium sulphate	6 00	3.00
	$214 65	$39 50
Production cost...	5 00	5.00
"Net value" per to	$209.65	$34 50

The report continues: "Actual surveys show an average *surface* deposit of 1,000,000 tons of shale per acre, or an average profit of $34,500,000 per acre. The total tract is 6,400 acres and the prospective earnings therefore 6,400 times the above sum." Here's where we begin to see wealth! We are considering only the surface deposits and we can't tell how much more there may be underneath. But taking only the so-called

"average" or conservative figures we have a prospective clean-up of twenty-two billion, eight hundred million dollars. That's something like! It gives a man a chance to make John D. Rockefeller look like thirty cents. And these, remember, are the conservative figures. Using the "high" estimates, the happy investor can see value up to one trillion, three hundred and forty billion, with a little matter of 760 million dollars on the side.

The only prospectus to compare with this that I have ever seen is one that I came across a score of years ago when the trusts were forming, and that is a mere bagatelle in comparison. It reads:

AMERICAN RABBIT FARM CO., UNLIMITED,

to be organized under the laws of the Philippines

Prospectus

Rabbits commence breeding at six months and have drops of eight every three months. It is proposed that we commence with ten pairs, ten males and ten females, which exclusive of land will call for an investment of four dollars, resulting in the following product:

3 months	80	1 year, 3 months	4,160
6 months	160	2 years	279,680
9 months	880	3 years .	306,446,720

This product can be sold in the market certainly at five cents each, giving a gross income in three years of $15,322,366, to be deducted from which are the following expenses:

Rent of land, per annum	$4,000	$12,000
Superintendence, per annum	2,000	6,000
Feed (estimated), per annum	2,000	6,000
		$24,000

This leaves a net profit on a four-dollar investment of over fifteen million, two hundred and ninety-eight thousand, three hundred and thirty-six dollars ($15,-298,336) in three years.

The Company will issue Capital Stock to the amount of four dollars divided into 400 shares, par value one cent.

Subscriptions are invited to the Capital Stock of the Company at par.

The right is reserved to allot less than the amount applied for hereunder.

When I think of poor old Colonel Sellers and his eye wash I—why, say, Mr. Editor, I just pity him!

New York City. MARTIN SEYT.

Data on Operation of Continuous Type Lime-Soda Ash Water Softener

To the Editor of Chemical & Metallurgical Engineering

SIR:—I wish to present a number of corrections to be applied to the article on "Data on Operation of Continuous Type Lime-Soda Ash Water Softener," which appeared in your journal of Sept. 15, 1920, page 526.

The paragraph on "Analytical Data Determinations" has the following statement: "Since the water was acid in character, these readings were obtained on the raw water with the exception of C." This statement is wrong chemically and should be: "Since only the methyl reading could be obtained on the raw water, the carbonate hardness was due to bicarbonates alone."

In the paragraph on "Interpretation of Data," some one inserted a statement as follows: ". . . the $CaCO_3$ forming a gelatinous precipitate." This is not quite true and should be: ". . . the $CaCO_3$ forming an amorphous precipitate which slowly crystallizes."

Cincinnati, Ohio. H. C. FISHER.

The Type of Explosive in Wall Street Explosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—One of the most important points in the Wall St. explosion is to determine the type of explosive actually used and perhaps by discovery run down the investigation to a single track and finally indentify the plotters of this crime through this channel. The first question that interests the public is, "What kind of explosive did they use, and where did they get the supply?" From all the facts, materials and observations in possession of the authorities, one should by systematic and scientific examination and elimination arrive at an accurate conclusion, quite possible under similar circumstances, and thus determine whether any TNT, dynamite, picric acid, smokeless powder, black powder and other explosives were used in this criminal exploit.

The amount of property damage done by this explosion is surprisingly small. With the exception of window smashing there is no material loss of property over $150,000. Furthermore, instead of reducing the wagon carrying the explosive into splinters, which would be the case with powerful explosive like dynamite, picric acid or TNT, the explosion simply broke it into small pieces large enough to be collected and reconstructed. This evidence shows on its face either that the explosive was not powerful or the quantity used was very small, say not exceeding 50 lb., and probably nearer 25 lb.

All explosives are recognized by their physical and chemical characteristics and are easily differentiated from one another by the report or sound of explosion, flame, smoke, fumes and the residue they leave behind. For instance, a smokeless powder burns and explodes without smoke, leaves no residue and has a light yellowish flame; on the other hand, TNT and picric acid burn and explode with a deep orange yellow flame, dark fumes, but leave no residue. These last two explosives explode with sharp and deep detonation and when exploded in the open carry loose particles of TNT and picric acid in the air and color the fumes somewhat yellow. All the evidence obtainable in this case indicates that smokeless powder, TNT and picric acid were not used in the explosion, since no black fumes were observed and no deep orange yellow flames, and, most important of all, such explosives would not leave any residue. In the Wall St. explosion the explosives left a residue, after the explosion, which was scattered all over the ground and some of it was attached to the window weights which actually came in contact with explosive matter.

After eliminating TNT, picric acid and the smokeless powder there remains black powder, dynamite, nitro-starch and chlorate powders, which leave a distinct residue after the explosion. Although the black powder leaves a residue, its use is not likely in this case, because it is a weak explosive and leaves behind such a large volume of black smoke that it can be easily recognized by almost everybody.

Dynamite upon explosion leaves behind a residue consisting of sodium carbonate, sodium sulphate and other sulphur and soda compounds, if sulphur was used in the manufacturing process.

Nitro-starch explosive leaves behind the same ingredients as dynamite. The chlorate powders leave sodium and potassium carbonates, sodium and potassium sulphates and the chlorides and the sulphides of the same

salts. Either potassium or chlorine in the residue will indicate at once the presence of chlorate powders. One of the principal points testified by witnesses was that the explosion sound was not sharp and short as dynamite but rather long and rumbling. As a matter of fact, dynamite explodes with a short and sharp detonation, a short flame and with only gray-white fumes. Again, 25 lb. of dynamite would do more damage than was caused in the Wall St. explosion. Moreover, it would make a big cavity in the street just under the wagon in spite of the fact that the explosive was placed 3 ft. from the ground. Nitro-starch explosives are principally made by one manufacturer, and its sales could be easily traced by the authorities. Therefore it is unlikely that the plotters used this last explosive at all.

Chlorate of potash and soda are the only ingredients of this explosion that remain and fall under suspicion. There is no manufacturer of explosives in this country regularly making powder containing chlorates or perchlorates. Chemical examination of the residue has indicated conclusively the presence of potassium, chlorine and antimony. It is possible that the plotters of this crime bought their raw material in small quantities from chemical houses, drug stores, fireworks makers, etc., and by mixing them with charcoal, nitrobenzene, sulphur and antimony they concocted an explosive imperfectly balanced but strong enough to create this disaster. Had the explosive been a regularly manufactured product it certainly could have done more damage than was experienced in Wall St.

Another important point on which all the witnesses agreed is the length of the flame that came out from the explosion, burning window shades seven stories high. Now, there is only one explosive that has such a long flame, and that is the chlorate explosive.

Most people have never seen an open explosion of any explosive, hence they have no perfect idea as to the physical characteristics of the reaction. While their testimony is not contradictory, certainly it is not constructive. Estimates of the flame, sound or the fumes are widely apart. It would be a very useful as well as a practical procedure to take these witnesses in an open space and explode before them different charges of explosives, say 2 lb. each, from a safe distance (200 ft.), and discover whether their memory as to the character and the intensity of the sound, the flame, the smoke and fumes could be refreshed. While the chemical examination of the residue indicates the presence of the chlorate explosives, a practical demonstration such as mentioned above would strengthen by physical observations the conclusion brought about by chemical examination.

This matter deserves the attention of state and Federal authorities and it is to be hoped that they will carry out these practical suggestions in order to satisfy the demands of a careful investigation.

In conclusion I would re-emphasize the fact that the determination of the type of explosive used in the explosion can thus be made by two tests.

1. Chemical examination of the residue.
2. Physical examination, including the testing of the evidence from witnesses.

In the chemical test, the residue consists of a comparatively few number of ingredients, therefore this examination is short and comparatively easy. The physical examination includes reproducing the sound, the flame and the fumes, which can be determined from persons who actually saw the explosion, and the same can be repeated by practical test in the field.

From all the facts in my possession one can safely conclude that the explosive actually used in the Wall St. explosion was not a well-made manufactured product, but was concocted by the plotters of the crime and made up of such ingredients as they could buy. The explosive was not confined in any stout metal container or bomb, but it was put probably in a wooden box and covered by iron slugs and window weights. That is the reason why the damage was mostly caused by concussion and expansion of gases rather than by metal projectiles or fragments.

It is of course possible to compound explosives containing a number of materials such as TNT, picric acid, nitrobenzene, chlorates and nitrates. An explosive of this type would not show any decided characteristics and the examination of its ingredients would not lead to anything definite, but it is my opinion that even if such a mixture was used the basic ingredient of the explosive used in Wall St. consisted mostly of chlorate. If small quantities of other explosive materials were used they did not materially change the character or the power of explosion.

JOHN R. MARDICK.

New York City.

A Suggestion to Exhibitors

To the Editor of Chemical & Metallurgical Engineering

SIR:- The recent Chemical Exposition can scarcely have failed to impress both the technical man and the layman by its extent and by the care with which the various exhibits were prepared. As an advertising medium for the chemical industries and as a method for presenting the latest in chemicals and equipment it was excellent.

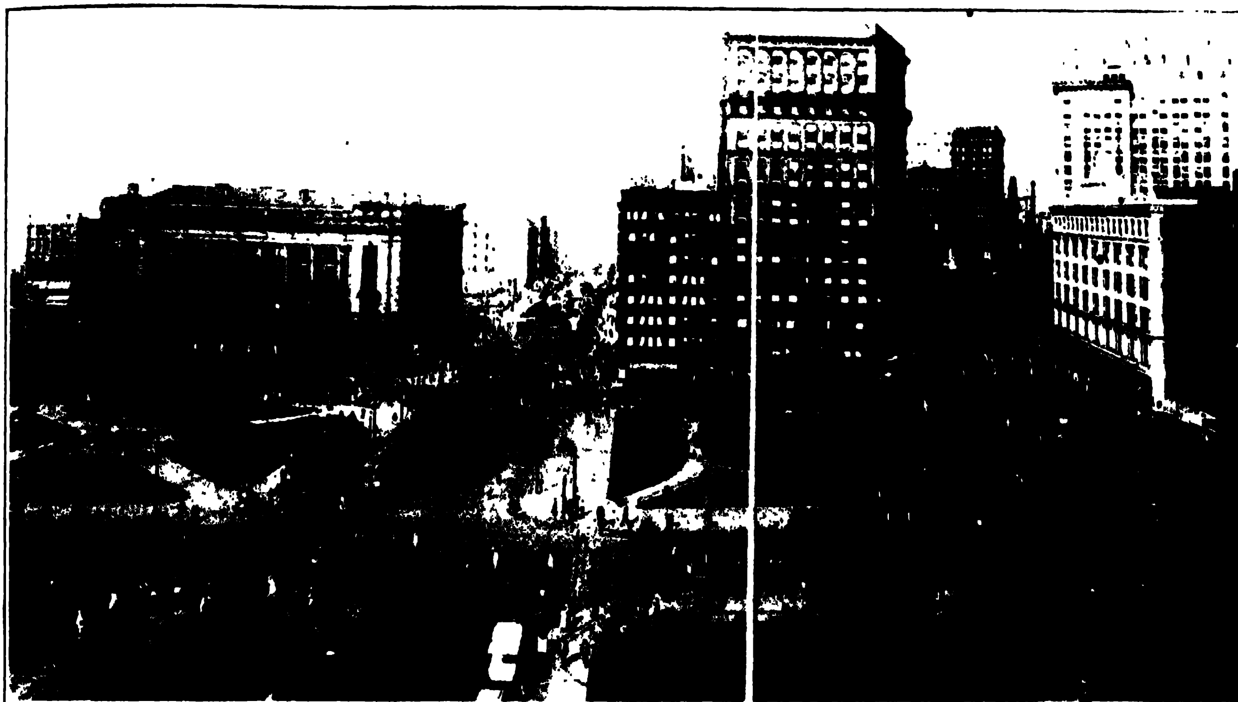
It is all the more deplorable that so many of the exhibitors placed their booths in charge of salesmen rather than under the direction of men who were thoroughly qualified to explain their respective displays. In at least half a dozen instances, to my own knowledge, well-intentioned inquiries about exhibits were answered by statements which would have been ludicrous had they not displayed such gross ignorance of facts. Surely progress in the chemical industries will be enhanced as much by the liberal use of technical men at the expositions as by the use of those men trained in salesmanship only.

ALLEN ABRAMS.

Cambridge, Mass.

Aluminum Trade of Japan

Although the aluminum industry is now well established in Japan, most of the forty-four manufacturers conduct business on only a small scale, chiefly for home consumption, states a recent article in the *World Salesman*. The variety of articles manufactured is comprehensive, including all kinds of cooking utensils, candlesticks, pipes, cigarette cases, alcohol lamps, army canteens, bottles and various kinds of castings. Japan is entirely dependent upon the United States and England for raw material in connection with this industry, though at present, in co-operation with an American aluminum company, plans are under way for the erection of a plant in Fukui Prefecture which, with the help of experienced American workmen, will later be able to supply the raw aluminum material needed. In 1918 imports of ingots from the United States were 1,466,967 kin (kin — $1\frac{1}{3}$ lb.) valued at 1,662,471 yen, and from England they reached 12,346 kin.



of the Cleveland Co

Cleveland Meeting, American Electrochemical Society

Report of Technical Sessions, With Discussion of Papers on Electrometallurgy and Electrochemistry—Visit to the Nela Research Laboratories and Industrial Plants—Banquet and Other Social Features of the Meeting

THE thirty-eighth general meeting of the American Electrochemical Society was held at Cleveland, Sept. 30, Oct. 1 and 2, with headquarters at the Hotel Statler. In spite of the fact that Cleveland is centrally located, and further, that this was the first meeting of the Society in that city, the attendance was not as large as usual. Whether this is to be ascribed to the increase in railroad fares or to some other cause is not apparent. Certainly the technical sessions which are herewith reported fully, were quite as lively and interesting as usual and the hospitality and entertainment afforded by the Cleveland members, assisted by the Cleveland Engineering Society, elicited approval and congratulations. In fact the refreshment provided was of a distinguished order.

Social Features

A complimentary smoker was tendered by the National Carbon Co., at which entertainment was provided by professional talent and members of the Society. The success of the banquet was assured by the presence of a large number of ladies and by a short but imposing list of after-dinner speakers. Dr. A. W. SMITH, professor of chemistry of the Case School of Applied Science, presided as toastmaster, and responses were made by Dr. CHARLES S. HOWE, president of the Case School of Applied Science; Dr. W. S. LANDIS, president of the American Electrochemical Society; Dr. CHARLES F. BRUSH, inventor of the arc light, and Dr. E. P. HYDE, director of the Nela Research Laboratories.

Taken as a whole, the meeting was one of unusual interest, and the Society is indebted to Dr. N. K. CHANEY, chairman of the local committee, and his efficient coworkers of the Cleveland Engineering Society. The visiting ladies will long remember the attractive program arranged for them under the direction of the Ladies Committee, headed by Mrs. E. R. GRASSELLI.

First Technical Session, Thursday

HEAT LOSSES THROUGH ELECTRODES

The first technical session was held in the large hall of the Hotel Statler on Thursday morning. M. R. WOLFE and V. DE WYSOCKI, of Lehigh University, gave an account of their measurements on the "Heat Losses Through Electrodes." A six-ton Heroult furnace was provided with three electrodes, each 38 cm. in diameter and made of ordinary amorphous carbon. In working up the calculated heat flow, Hansen's value for thermal conductivity, 0.016 cal. per second per centimeter cube per degree C., was used. Each electrode was provided with a water-cooled ring immediately above its exit electrode, the average rise in temperature of the water cooled connection at varying distances above the roof. The grams of water flowing per second was 427.8 per electrode, the average rise in temperature of the water 22.9 deg. C., and the sum total of heat in the cooling water for the furnace was 123.1 kw. Since 650 kw. was supplied to the furnace, the total electrode loss was therefore 18.7 per cent of the power used. Of this total, 18.5 kw. was absorbed by the upper cooling contact holders, and 104.6 kw. by the lower water-cooled rings.

The paper was discussed by Messrs. TURNBULL, HERING, FINK and RICHARDS. It was pointed out that Hansen's value, 0.016, was determined about fifteen years ago and that in the meantime the conductivity of the carbon electrodes had changed. A redetermination of this value seemed advisable. At all events, the resistivity of the electrodes under investigation ought to be included in Wolfe and Wysocki's report. Furthermore, it was argued that the 104.6 kw. absorbed by the lower water-cooled rings was partly derived from the roof and that therefore the value reported for the electrodes was too high.

HEAT CONTENT OF STEEL AND SLAG FROM AN ELECTRIC FURNACE

A. M. KUHLMANN and A. D. SPILLMAN, of Lehigh University, reported on a series of calorimetric determinations of the heat content of liquid steel and liquid slag from a 6-ton Heroult steel-casting furnace at the works of the William J. Wharton, Jr. Iron & Steel Co. A Fery radiation pyrometer was used for high temperatures and either a platinum-iridium thermocouple or platinum resistance thermometer for the lower temperatures. The slag analyzed 23.5 per cent SiO_2, 24 per cent Fe_2O_3 + Al_2O_3 and 42 per cent CaO. The mean specific heat of the solid slag up to 810 deg. C. was found to be $0.133 + 0.00011t$ and the heat content, Q, $0.133t + 0.00011t^2$. The value of Q for liquid slag was found to be 476 cal. at 1,190 deg. C. and 520.5 cal. at 1,250 deg. C. The heat content of the liquid steel (0.1 per cent C, 0.2 per cent Mn) was determined and at 1,900 deg. this was found to be 325 cal.

In the discussion of the paper that followed Dr. CARL HERING pointed out that in dropping the molten slag or steel into the water of the calorimeter, considerable steam was evolved which would naturally lead to errors in the thermal values. W. S. LANDIS referred to errors that would arise when using an optical pyrometer in making temperature determinations of liquid slag on account of the emissivity of the slag depending largely upon its composition. Dr. J. W. RICHARDS agreed that probably the values reported were high and that the temperature of the liquid steel was nearer 1,800 deg. than 1,900 deg. Dr. HERING suggested that the molten steel or slag be poured into lead or into a metal cup or crucible and this introduced into the calorimeter, thus largely avoiding the formation of steam.

ELECTRICAL RESISTIVITY OF REFRACTORIES

The third paper of a series on the physical properties of specialized refractories was presented by M. L. HARTMANN, A. P. SULLIVAN and D. E. ALLEN, of the Carborundum Co. research laboratory. The first two papers were read at the Boston meeting of the society.[1] This contribution dealt with the electrical resistivity of refractories at high temperatures.

In the design of electric furnaces it is important to know the electrical resistivity of the refractories used in those portions of the furnace which contain, or come in contact with, the electrodes or resistor material. Practically no data have been published on the resistivities of commercial bricks except those by Stansfield, McLeod and McMahon.[2] These investigators determined the resistivities of silica, chrome, magnesia and fireclay from 600 to 1,565 deg. C. Hering[3] has compiled from the literature the resistivities of many substances, but these do not include commercial refractories.

Using a method similar to that employed by Stansfield, McLeod and McMahon, the authors determined the electrical resistivities of nine commercially used refractories, at temperatures up to 1,500 deg. C. Measurements were taken while heating up slowly and while cooling down slowly, the thermocouple measuring temperature being outside the specimens. The amount of temperature lag thus involved was approximately determined. The results, which are summarized in the table, are necessarily only approximate, but show the relative resistivities of the different materials and the general order of magnitude of their resistivities up to 1,500 deg. C.

The paper brought forth considerable discussion in which Messrs. SAUNDERS, FINK, HERING and RICHARDS participated. It was pointed out that resistivities of refractory bricks should always be accompanied by a chemical analysis and grain size. Furthermore, whenever possible the binder used in the brick ought to be taken into account. A silica brick with 97 per cent SiO_2 and 3 per cent of a highly conducting binding material might have decidedly lower resistivity values than a 93 per cent SiO_2 brick with a low conductivity binder.

DETERIORATION OF NICKEL RESISTORS

The high cost of nichrome wire and the onerous conditions attached to a license for its use led F. A. J. FITZGERALD and GRANT C. MOYER to study the use of nickel wire as a resistor in electric furnaces. It seemed possible that for some purposes nickel wire might prove to be a suitable substitute in spite of its high thermal coefficient of electric resistance, for this disadvantage can be overcome, and its deterioration by oxidation, since this, with reasonable precautions, can be diminished so as to give a fairly extended life.

It was found, however, in some heating devices that nickel resistors broke down after very short service, for although there was no appreciable oxidation the resistor wire had become so very brittle that the slightest bend would break it. This effect was thought at first to be due to carbonization of the nickel, since the wire had been embedded in cement and a heat insulator

[1]CHEM. & MET. ENG., vol. 22, p. 729; April 21, 1920.

[2]Trans. Amer. Electrochem. Soc., 1912, vol. 22, p. 89.

[3]MET. & CHEM. ENG., 1915, vol. 13, p. 23.

ELECTRICAL RESISTIVITIES OF COMMERCIAL REFRACTORIES *

	Cold	800° C.	900° C.	1,000° C.	1,100° C.	1,200° C.	1,300° C.	1,400° C.	1,500° C.
Silica	< 125 Meg	2.38 Meg	765,000	300,000	126,000	62,000	30,900	16,500	8,420
Bonded carborundum (Carbofrax C)	< 127 Meg	835,000	477,000	197,000	75,000	29,500	15,200	10,100	8,590
Magnesia	< 137 Meg	5.00 Meg	1.24 Meg.	708,000	560,000	193,000	67,400	22,400	2,500
Zirconia (natural)	< 134 Meg	558,000	224,000	131,300	53,800	7,710	2,100	968	412
Bauxite	< 133 Meg.	109,000	32,500	17,200	9,200	6,100	5,600	2,200	1,100
Fireclay (Grade A)	< 137 Meg.	57,600	20,600	10,800	6,590	4,160	2,460	1,420	890
Bonded carborundum (Carbofrax B)	107,200	12,550	8,220	7,420	6,320	4,160	2,420	1,435	745
Chrome	48.1 Meg.	803 ohms	375	171	78	63	77	85	41
Recrystallized carborundum (Refrax)	106.9 ohms	6.45	5.25	4.11	3.11	2.45	2.05	1.74	1.62

* Data are in terms of ohms per cu.cm., except where megohms are noted.

containing carbonaceous matter. Further investigation showed that the real cause of the trouble was sulphur, which makes nickel wire brittle even at low temperatures, while the effect is very marked and rapid at temperatures above 500 deg. C.

When precautions are taken to prevent reaction with sulphur, nickel wire seems to stand up well as a resistor.

In the discussion of the paper, the question was brought up whether sulphur was the only cause of brittleness in nickel wires. To this Mr. FITZGERALD replied that they had confined themselves to the effect of sulphur and that analyses of the samples supported their conclusions. For example, in the original nickel sample only a trace of sulphur was found, but the sample subjected to sulphurous fumes for ninety-six hours contained 0.054 sulphur. C. P. MADSEN referred to the patent situation on the use of nickel as a resistor and to his elaborate experiments to determine the best refractory covering for incandescent nickel wire. Pure oxides were in general preferable to silicates. Dr. FINK referred to the bad effect of carbon on the ductility of nickel and the beneficial effects of manganese when added to the extent of about 2 per cent.

THE SÖDERBERG CONTINUOUS ELECTRODE

Dr. JOSEPH W. RICHARDS submitted a second report on the progress of the Söderberg electrode.[1] He described and commented upon the success of the three-phase installation of the Söderberg self-baking electrodes in operation at Anniston, Ala., since July 2 of this year. The furnace is rated at 1,800 kw. and is used for the manufacture of ferromanganese. An open top furnace of the usual ferro-alloy type is used. The working space is 12 x 20 ft., elliptical in shape. The three electrodes are each 32 in. in diameter and extend from the furnace up into the tamping house, which is 12 ft. above the charging floor. The total length, when a new section has just been added to the top, is 24 ft. and the weight, exclusive of the holder, about 13,200 lb. per electrode. The casing is formed of No. 18 sheet iron riveted together to the correct diameter, and provided with inwardly directed partitions, as previously described. One section 46 in. long weighs approximately 110 lb., or 2.4 lb. per in. In the baked electrode there are 18 parts of carbon per 1 part of iron shell. A new section may be required per electrode every five to fifteen days, according to the nature of the ore being reduced in the furnace and the current taken by the electrode. In the straight-line three-phase arrangement, it is almost impossible to get each electrode to take the same current, so the consumption will be somewhat different on each electrode. Holders and electrodes are suspended by wire cables controlled by hand.

The ore used was Caucasian di-oxide ore of high grade, 56 per cent manganese, with not sufficient iron for producing 78 per cent ferromanganese and not sufficient silica to give a proper slag volume in the furnace. Analysis of the ore showed 4.67 per cent moisture. The dried ore contained: Manganese 56.35 per cent, iron 0.80, silica 5.04, alumina 1.40, lime 1.90, magnesia 0.84, baryta 0.93, manganese dioxide 88.34, manganese monoxide 0.65.

Iron turnings were added, and picked return slag put back in the furnace to increase the slag volume. The average carbon consumption was 6.6 kg. per 1,000 kw.-hr. The ore was so fine in structure that it packed badly in the furnace, causing frequent cratering. It was a difficult charge to work, requiring frequent stoking. Another furnace in the same plant, working the same ore with square baked electrodes, had the same difficulties from the packing of the charge.

[1]For first report see CHEM. & MET. ENG., April 21, 1920, p. 732.

The advantages for the Söderberg electrodes are:

1. Absolute continuity of operation, as far as the electrodes are concerned. 2. Smaller consumption of electrode carbon per given power supplied to the furnace. 3. Lower cost of electrode per given power supplied to the furnace. 4. Lower power losses in the electrodes. 5. Greater regularity of running of the furnace, and therefore less wear and tear on the workmen and the management, and greater uniformity of product.

In commenting upon Dr. Richards' report ROBERT TURNBULL suggested that it is more practical to state electrode consumption in terms of pounds per ton of product rather than pounds per 1,000 kw.-hr. The consumption per 1,000 kw.-hr. might be very low and yet the consumption per ton of product very high. The question was also raised whether or not the tamping house would interfere with the free operation of a furnace of the Heroult type. In reply Dr. Richards read a cablegram just received from Norway advising of the successful operation of a steel furnace equipped with Söderberg electrodes. Tests are furthermore under way in the substitution of the Söderberg for the graphite electrodes used in the manufacture of aluminum. In the case of the steel furnace, the Söderberg electrodes are made up and added in sections, thus permitting of the tilting of the furnace. At Anniston the ferromanganese furnace operated twenty-eight days during August with but thirteen minutes shutdown on account of electrodes. The carbon consumption was 14.2 lb. per 1,000 kw.-hr. A ferrosilicon furnace in Norway equipped with Söderberg electrodes is consuming but 12.6 lb. of carbon electrode per 1,000 kw.-hr. This compares favorably with Mr. Turnbull's figure of 11.6 lb. per 1,000 kw.-hr. when using standard carbon electrodes (65 lb. per ton of 50 per cent ferrosilicon).

ELECTRIC FURNACE SMELTING OF MANGANESE ORES

A paper of the above title, originally presented by E. S. BARDWELL at the spring meeting of the society in Boston (see CHEM. & MET. ENG., vol. 22, page 681, for the full paper), was brought up for discussion.

PHENOMENA OBSERVED IN ELECTRIC FURNACE ARCS

The last paper of the Thursday morning session was by J. KELLEHER, of the University of Toronto, on "Phenomena Observed in Electric Furnace Arcs."

In the first set of experiments a bath of iron-nickel alloy covered by an acid calcium silicate slag was melted in the electric furnace. To observe the arc under these various conditions the following arrangement was employed: An opening was made in the front wall of the furnace. The opening was then covered by a piece of sheet iron in which a pinhole had been drilled. The light emerging from the opening was allowed to fall on a ground glass screen, which was moved backward and forward until a clear inverted image of the arc was obtained, thus permitting sketches and even photographs of the arc to be made. In the normal arc, that is, one where the movable electrode is the negative pole, the flame apparently flows from the electrode to the slag, depressing the slag and flaring out to all sides, or to one

side. An arc length of about 3 inches could easily be maintained. Under these circumstances the arc was silent.

As soon as the polarity of the furnace was changed, a very unstable arc appeared. This arc started below the surface of the slag, the flame moving away from the slag surface and projecting particles of slag into the air with considerable force. The length of this arc could barely be maintained at a greater length than 1 in. The noise of the arc was loud and spluttering.

It had been noticed that if with a normal arc large currents were allowed to flow, the arc became noisy and had a tendency to quench itself, even at comparatively short lengths.

The results of numerous observations might be summarized as follows: A disturbance takes place in the furnace running on normal load with an arc when the electrode is near the slag surface, tending to increase the current. The regulator immediately starts to raise the electrode. The large arc maintains its original shape until the length becomes so great that it is ruptured. Immediately all the lesser arcs move away to the outer edge of the electrode, leaving about 75 per cent of the surface of the electrode end bare. This causes a rapid and large decrease in the current flowing, and the regulator commences to lower the electrode.

These arcs do not spread across the surface of the electrode until the surface of the slag is almost reached. They then suddenly spread over the whole electrode surface, causing a sudden and large increase in current, and the whole cycle of events is repeated.

A number of sketches were shown to illustrate the various appearances of the arcs.

Dr. HERING in discussing the paper referred to the rectifying action of the arc.

Friday Morning at the Case School of Applied Science

INDUSTRIAL APPLICATIONS OF ELECTROLYTIC CONDUCTIVITY MEASUREMENTS

The use of accurate conductivity measurements on electrolytes, to determine therefrom variations in composition, such as using a salt solution of known conductivity as a solvent for sugar, and determining the amount of sugar by its effect in increasing the resistivity of the solution, was described by EARL A. KEELER. Such measurements may be useful methods of control in chemical manufacturing operations, such as boiler water concentrations, degree of evaporation, losses in tail-races, acidity of liquors, etc.

It is well known that many chemical processes or reactions can be followed and investigated by the measurement of the potential difference or changes in potential difference between two electrodes immersed in the solutions involved. These potential changes result from the changes in magnitude or nature of the ionic concentrations in the solutions undergoing the reaction or chemical changes. The determination of hydrogen ion concentration by means of the potential difference existing between a hydrogen electrode and calomel cell is the most notable example of this type of measurement.

While the technique of the hydrogen ion method has been highly developed during recent years, considerable work must be done to develop and design apparatus that will be satisfactory under the severe requirements of industrial use. Development work along this line is progressing rapidly, and it is expected that material will soon be available for a paper on the "Industrial Applications of Hydrogen Ion Determinations."

In commenting upon Mr. KEELER'S results President LANDIS briefly described a practical installation at the cyanamide plant at Muscle Shoals. Cylindrical nitric acid containers were lowered into the wells in sections and in order to detect any possible leakage of acid several pairs of electrodes were placed a short distance away from the cylinders. The electrodes were connected in series with an incandescent lamp and a current supply. The lamp would light up automatically as soon as acid leaked out near the electrodes. E. R. MORTON criticized the method of calibrating the Leeds & Northrup cells used by Keeler. They were all standardized by comparing them with another standard cell kept by the company in its factory. There ought to be some quantitative measurement independent of this comparison method.

A NEW FORM OF STANDARD CELL

A new portable standard cell which is a satisfactory laboratory standard was described by C. J. RODMAN and THOMAS SPOONER. It is of the cadmium type of special design with the usual ingredients but having a container of hard glass with tungsten leads. Instead of the common H-type a compact concentric arrangement has been devised possessing a number of advantages. This cell is made either saturated or unsaturated, and other combinations besides the standard cadmium formula may be used in the present cell blank if desired.

The cell is a marked improvement over older types and is an interesting application of the tungsten seal in pyrex glass.

FARADAY'S LAW AT THE CATHODE

Since the direct invariable relation between electrical current and chemical quantity subsists only at the anode, and the present theory of electric current postulates current passing, as negative electrons, only toward the anode, is it not logical and reasonable to assume that the direct relation between electrical current and chemical quantity is true only at the anode?

On the other hand, the relation at the cathode being variable, and therefore probably indirect, Prof. J. W. RICHARDS declared that it was logical and reasonable to assume that this relation is not electrochemical but is more properly designated as chemical only—that is, it is governed by the chemical relation between the quantity of anodic element set free at the anode and the cathodic element. In other words, when the electric current sets free electrochemically at the anode a given amount of the anodic element or constituent of the compound, an amount directly determined by the electrochemical relations and Faraday's law, there is set free at the cathode that amount of the cathodic constituent which was chemically combined with the amount of anodic constituent liberated. This relation is chemical, and determined by the chemical equivalents of the substances in question, and subject to the variable valence of the cathodic element just as in any simple chemical decomposition.

If the above reasoning is valid and logical, it would follow that Faraday's law will apply fundamentally only to the anodic constituent, which is directly related to the quantity of negative electrons traveling to the anode; it would correspondingly follow that Faraday's law does not directly apply to cathodic constituents,

but only indirectly through the chemical relation that the quantity of cathodic element liberated is simply that which was chemically combined with the quantity of anodic constituent liberated, and is only thus indirectly related to the quantity of electric current passing.

Messrs. HERING, MADSEN and LANDIS participated in the discussion and it was generally conceded that Dr. Richards' interpretation of Faraday's law was an excellent one, although perhaps not entirely new.

Saturday's Technical Session

The third technical session was held Saturday morning and was devoted to papers on electrolytic refining, electroplating and corrosion. In the electroplating art considerable attention has been paid to brass plating and remarkable results have been achieved within the last few years.

ELECTRODEPOSITION OF BRASS FROM CYANIDE SOLUTIONS

After discussing the theory of the co-deposition of two metals from solution, ALFRED L. FERGUSON and EARL G. STURDEVANT presented the results of a series of experiments upon the deposition of brass from cyanide solutions. Cast zinc and electrolytic copper anodes were used so that the single potentials of each metal could be determined. The following conclusions were noted:

Increase in the ratio of copper to zinc in the solution increases the percentage of copper in the deposit. A solution in which the ratio of copper to zinc is 4.2 gives a deposit of about 65 per cent copper (ratio 1.9). Solutions of high metal content are more satisfactory than dilute solutions. A solution containing 35 g. of metal per liter, in the above ratio, gives satisfactory deposits. Increase in temperature decreases cathode polarization and consequently increases the percentage of copper in the deposit. Increase in current density produces a gradual decrease in the percentage of copper in the deposit. At current densities greater than 0.3 amp. per sq.dm., the deposit becomes granular, nonadherent and dull in color. Increase in free cyanide does not increase anode efficiency, but does decrease cathode efficiency. Its influence on the percentage of copper in the deposit is variable.

Slightly acid substances increase the percentage of copper in the deposit. A weak acid may be used in place of any of the acid substances that have been recommended. Slightly alkaline substances decrease the percentage of copper in the deposit. The presence of slightly alkaline substances is beneficial in that it improves the appearance of the deposit. Neutral substances have no influence on the deportment of the cyanide brass plating solution.

Brasses which vary in composition from 62.3 to 85.0 per cent of copper dissolve as such anodically. The efficiency of corrosion is about the same as that of copper. Decided depolarization of zinc by copper takes place and makes possible the deposition of brass from solutions in which the potentials of the two metals are not equal. Electrodeposited brasses which vary in composition from 37.6 to 82.0 per cent copper give nearly the same potentials in a plating solution. These potentials are nearer to that of copper than to that of zinc.

Mr. HOGABOOM dwelt at length upon the importance of controlling and regulating conditions during deposition of brass. He has developed a commercial process for coating steel and iron with brass and the results are so good that it is practically impossible to distinguish the brass plated articles from those made of solid brass. Dr. BLUM of the Bureau of Standards criticized Dr. Sturdevant's thesis from the theoretical point of view. He did not concur with him in all of his conclusions.

TIN PLATING FROM ALKALINE TIN BATHS

FRANK C. MATHERS and WILLIAM H. BELL discussed the possibility of producing smooth non-crystalline deposits of tin from sodium stannite baths by the use of addition agents. Although it was found that balsam copaiba and rosin gave good deposits, the experiments were unsuccessful in that the sodium stannite baths gradually oxidized or deteriorated to such an extent that continued satisfactory deposits could not be obtained. No method of regenerating the baths was found. For this reason, the bath is not recommended for tin plating. It would be unreasonable to bother with sodium stannite when one can use the stannous sulphate bath, which gives splendid deposits without any important difficulties.

Although the authors did not pass favorably upon the alkaline bath for tin plating, Mr. HOGABOOM, in discussing the subject, related his success with the bath at one of the Government plants. He used an electrolyte containing stannic chloride and sodium hydrate and obtained excellent results. The plate was very smooth and adhered perfectly. Of course only thin deposits were required. Messrs. FINK and MADSEN referred to misleading statements in the literature as to the rating of a plating bath. It was suggested that hereafter authors include the limiting phrase such as "for heavy plates" or "for thin plates" in passing upon the quality of a plating bath. The tin chloride electrolyte gives good thin deposits but very loose crystalline heavy deposits.

ELECTROLYTIC REFINING OF TIN

EDWARD F. KERN presented the results of a series of experiments on the electrodeposition of tin. The electrolytes used were stannous-sodium chloride, stannous fluoborate, stannous naphthalene-sulphonate and stannous sulphate.

When no addition agents were used, the best cathode deposits were obtained from a stannous sulphate solution containing 6 g. tin and 7 g. H_2SO_4 per 100 c.c. The deposits formed in stannous naphthalene-sulphonate electrolyte (made from the corresponding copper solution by replacement with tin) were second best; and the deposits from stannous-sodium chloride electrolyte and from stannous fluoborate electrolyte were third best. In no case were adherent, smooth cathode deposits formed, with no addition agent present.

In order to produce satisfactory cathode deposits of tin in the electroylitic refining of tin, it seems to be necessary to add suitable addition agents to the electrolyte. It was found that the presence of peptone and of gelatine was beneficial; the presence of aloin was beneficial only with the fluoborate electrolytes when present in proportion of 1 g. per 1,000 c.c. solution. The most satisfactory cathode deposits were formed in the stannous fluoborate and in the stannous sulphate electrolytes when gelatine or peptone was present in the proportion of 1 g. per 500 to 1,000 c.c. of electrolyte. In the case of the sulphate electrolyte, the best cathode deposits were formed when the solutions contained 5

or 7 g. free H_2SO_4 per 100 c.c.; more than 2.5 g. free H_2SO_4 per 100 c.c. solution seems to be necessary. The presence of free acid over 2.5 g. per 100 c.c. keeps the solution clear, and prevents the precipitation of basic salts, which if allowed to collect on the cathode deposit cause the tip to form non-adherent, large crystals. The cathode deposits formed from the stannous sulphate electrolyte containing 5 and 7 g. free H_2SO_4 per 100 c.c. were as satisfactory as those formed from stannous fluoborate electrolyte.

Heating the electrolytes is beneficial in that the potential drop between the electrodes is reduced, and also a more adherent deposit is formed. Raising the temperature increases the effectiveness of the addition agent; a smaller amount of addition agent being required.

Dr. KERN'S paper aroused a good deal of discussion. Prof. MATHERS dwelt at length upon the importance in the selection of the addition agent and suggested that Dr. Kern include in his paper a table of costs of addition agent per ton of tin deposited. A number of addition agents suggested by the author were too high priced for a refinery. Dr. LANDIS referred briefly to the large tin-refining plant at Perth Amboy, emphasizing the fact that electrolytic tin had long since passed beyond the purely experimental stage.

LEAD PLATING FROM SODIUM HYDROXIDE LEAD BATHS

The effect of addition agents in restraining the crystalline structure of the cathode deposits in alkaline lead baths was studied by FRANK C. MATHERS. Gum sandarac, gum galbanum and oleic acid were found to be very satisfactory, while other gums, rosins and fatty acids showed marked beneficial influences.

A satisfactory concentration of bath was found to be:

	Per Cent	Oz. per gal.
Crystallized lead acetate	7.3	9.7
Sodium hydroxide	20	27
Addition agent	0.3 to 1	0.4 to 1.32

As high a temperature as possible should be used. Better deposits are obtained at 90 deg. C. (194 deg. F.) than at 80 deg. C. (176 deg. F.). The current density at the anode should not be greater than 1 amp. per sq.dc. (9.7 amp. per sq.ft.). A cathode current density of 1.5 to 2 amp. per sq.dc. (14.1 to 18.8 amp. per sq.ft.) can be used, but the lower the current the better the deposit. At these current densities, the corrosion and deposition are approximately 100 per cent. The deposits are not as perfect as those from the acid lead baths, hence they are less satisfactory as protection against sulphuric acid.

In the discussion that followed, the early experiments of ANSON G. BETTS were referred to and it was suggested that, since our knowledge of electrolytic refining of metals had advanced rapidly within recent years, it would well repay the research men to repeat Mr. Betts' experiments with a view to improve upon the fluosilicate electrolyte.

A general debate followed on the theory of addition agents. Dr. FINK briefly reviewed the protective colloid theory and the colloid-electrolyte complex theory. Dr. BLUM recited a number of experiments in support of the protective colloid theory. Dr. HERING described tests he had carried out under the microscope. There seemed little doubt in his mind that the colloid particles were attracted to (or by) the points of the cathode crystals, necessitating a new direction or location of the next crystals. In one of his experiments he introduced into the electrolyte both a positive and a negative colloid as addition agents. He expected the positive particles to collide with the negative particles, but under the microscope no such collisions could be detected. Dr. BLUM emphasized the importance of taking into account the relatively high current density at the points of the crystals. Dr. FINK suggested that further experiments be carried out with diaphragm cells, putting the addition agent in the cathode compartment and none in the anolyte; also reversing the procedure and putting the addition agents in the anolyte.

ELECTROLYTIC PRODUCTION OF HYDROGEN PEROXIDE

The literature on electrolytic hydrogen peroxide was briefly reviewed by F. W. SKERROW and E. R. STEIN before introducing their results on the experimental decomposition of sulphuric acid, sodium or potassium acid sulphate solutions. The current efficiencies with which persulphuric acid was formed were about the same in all three solutions. Of the materials experimented with as anode material, platinum was the only one offering possibilities of success, with the possible exception of manganese dioxide. Sodium persulphate solutions can apparently be produced to a much higher concentration than can persulphuric acid, without sacrifice of current efficiency. The potassium salt is, of course, obtained in solid form. Distillation of once recrystallized potassium persulphate with sulphuric acid and water gives reasonably high yields of hydrogen peroxide. Distillation of persulphuric acid or sodium persulphate solutions would need to be preceded by extremely rigorous purification to remove catalytic impurities.

INFLUENCE OF COPPER, MANGANESE AND CHROMIUM ON CORROSION OF THEIR IRON ALLOYS

Extensive data were presented by E. A. and L. T. RICHARDSON showing that there is a mutual action between manganese and copper in their effect upon the atmospheric corrosion of iron. Copper alone reduces the corrosion of pure iron and, to a still greater extent, the corrosion of steel. This is due to the effect of manganese, which enhances the effect of copper. If manganese is replaced by chromium, the effect is still more pronounced. It is shown that the red-short range in iron, due to the presence of copper, is removed by either manganese or chromium. It is believed that there is some relation between this red-short range and resistance to atmospheric corrosion. Based upon this, the film or inter-grain hypothesis is suggested to explain the corrosion resistance of these alloys.

Mr. AUPPERLE attacked the conclusions drawn and felt convinced, on the basis of his experience, that copper had no beneficial effect and did not prevent corrosion. Dr. RICHARDS took exception to the author's statement that "it has been known for years that commercially pure iron is red-short . . . and this red-shortness is due to copper." But Mr. Richardson maintained that every sample of commercially pure iron analyzed was found to contain copper. Dr. FINK pointed out that the presence of copper in the interfaces would depend to some extent upon the relative proportion and distribution of other impurities, such as sulphur or carbon in the iron samples. It is well known that the solubility of copper in iron is greatly influenced by such impurities. Accordingly, two samples of iron may con-

tain the same quantity of copper and yet the corrosion rate of the two be entirely different. Further metallographical investigations are needed.

SOLUTION OF METALS IN ACIDS

Inconsistent behavior of the metals in corrosion and acid solution phenomena on the basis of the electrochemical series were explained by W. D. RICHARDSON, who took into consideration a number of factors of which the principal were: solution tension, the hydrogen influence, the oxygen influence, the carbon dioxide influence, the cathode influence and the halogen influence.

Corrosion and solution of metals in acids may be considered as actions tending to go forward at rates proportional to solution tension and hydrogen ion concentration, but subject to the accelerating and retarding influence of many substances acting as catalyzers. Indications of the sensitiveness of various metals to the hydrogen and oxygen influences can be obtained by

The rates of solution of copper-bearing and pure open-hearth iron in nitric acid are catalyzed negatively by silver, copper and formaldehyde, but the rates of gray cast iron and semi-steel are catalyzed positively by the same three catalysts. No pronounced change of rate is shown by silver, copper or formaldehyde acting as catalysts on copper-bearing or pure open-hearth iron in sulphuric or hydrochloric acid. The same is true for silver and copper when acting on gray cast iron and semi-steel, but in contrast with this behavior, formaldehyde catalyzes these metals strongly in a negative direction in the non-oxidizing acids.

Platinum catalyzes the rates of copper-bearing and pure open-hearth iron positively in normal sulphuric and hydrochloric acids, and the action is more pronounced in the case of pure open-hearth iron than in the case of copper-bearing iron. On the contrary, the rates of these metals in normal nitric acid are catalyzed negatively by platinum. The rate for copper is not certainly catalyzed by any of the catalysts used. Nickel as a



Photo by C. J. Murphy, Cleveland, Ohio

BANQUET OF AMERICAN ELECTROCHEMICAL SOCIETY AT HOTEL STATLER, CLEVELAND, FRIDAY, OCT. 1, 1920

their behavior when treated as couples in dilute acids and neutral salts and connected through a sensitive voltmeter or galvanometer.

Studying the behavior of metallic catalyzers on the rates of solution of copper-bearing iron, pure open-hearth iron, gray cast iron and semi-steel in normal sulphuric, hydrochloric and nitric acids at 16 deg. C., with several metallic catalyzers, it was found that the rolled metals in general showed a different and opposite behavior to that of the cast metals.

Again, the behavior of any of these metals in the non-oxidizing acids, sulphuric and hydrochloric, is as a rule different from the behavior in nitric acid. A similar rule holds for these metals in corrosion and also for solution in the above acids without catalyzers. Although the mode of action of a soluble organic catalyst, such as formaldehyde, is probably different from that of the metallic catalysts, nevertheless the opposite tendency in the case of different metals in oxidizing and non-oxidizing acids is revealed in this case also.

catalyst produces no effect on any of the metals in any of the acids except aluminum in hydrochloric acid. Aluminum is not affected by any of the catalysts in nitric or sulphuric acid. In normal hydrochloric acid the rate for aluminum is catalyzed strongly by nickel and still more strongly by platinum. A similar action might be expected in sulphuric acid and the lack of action in this case is probably due to the oxygen influence of sulphuric acid on aluminum.

Under conditions of corrosion the cast metals are relatively less attacked in the presence of much oxygen than the purer rolled metals. They are also relatively less attacked by an oxidizing acid, such as nitric, than by the non-oxidizing acids, sulphuric and hydrochloric. The catalysts, silver, copper and formaldehyde, all reverse this action and cause the rates of the cast metals in nitric acid to be increased and the rates of the copper-bearing and pure open-hearth irons to be reduced. Platinum, while catalyzing the rolled metals negatively in nitric acid, catalyzes them positively in sulphuric and hydrochloric acid, and is without action

on the cast metals in any acid. The failure of platinum to catalyze the cast metals is probably due to the evolution of poisons from the impure metals by the action of the acids.

After a brief discussion the members adjourned for luncheon in the rooms of the Cleveland Engineering Society.

Visits to Industrial Plants

Under the very able guidance of the chairman, Dr. N. K. Chaney, and W. R. Mott, a number of interesting visits were made to neighboring laboratories and factories. At the plant of the National Malleable Castings Co. the points of special attraction were the large Heroult steel furnaces, the malleabilizing process, the method of casting chains, the Baily electric heat-treating furnace and the pulverized coal plant.

At the Guide Motor Lamp Mfg. Co.'s plant copper, silver and nickel plating vats were in operation. This is a new plant and a number of improvements, such as rotating cathodes, have been installed. The last plant visited Thursday afternoon was that of the U. S. Copper Products Co. Here an opportunity was offered to see a G.E. smothered arc furnace, for brass melting, in operation. Alongside of this was a Baily brass furnace casting ingots about 3 ft. long and 3 in. in diameter. These ingots were subsequently forced over mandrels and drawn into tubing.

On Friday afternoon an elaborate visit was arranged to Nela Park. A number of the laboratories were taken in and with the aid of moving picture films the many intricate steps involved in the manufacture of the tungsten lamp, from ore to finished product, were explained. Opportunity was afforded to see the red hot tungsten wire being drawn through diamond dies, also assembling of the various lamp parts into the finished "Mazda."

Dr. ERNEST FOX NICHOLS, director of pure research at Nela, addressed the Society on "The Value of Research in Pure Science and Its Relation to Industry." It will be recalled that recently there has been a reorganization of Nela Research Laboratories into two sections, one of applied and the other of pure science. It is the latter which is under the direction of Dr. Nichols, formerly president of Dartmouth College and more recently professor of physics at Yale University. The speaker showed how science first came into industry through the testing of raw materials and final products. This was followed by industrial research, and this in turn by pure science research. The aim and purpose of the latter, he explained, are the extension of the boundaries of our knowledge, providing data of a fundamental nature which industrial research applies to the improvement of the product and reduction of its cost. Research in pure science, therefore, may go far afield, and sometimes a long period will elapse before the knowledge thus gained is used. In general, however, the time lag between a fundamental scientific discovery and its industrial application is becoming shorter and shorter. The pure scientist is being pushed by the industrial researcher. It is recognized, of course, that immediate profits come from industrial research, while the longer deferred dividends come from research in pure science. In the opinion of Dr. Nichols it is not only advisable for industry to give more attention to pure research, but it is a duty which it should assume in order that its service will be more efficient.

On Saturday afternoon the members visited the Hazelett Storage Battery Co. Mr. Hazelett demonstrated his novel method of making very thin lead plates by casting the metal on a revolving drum. The plates obtained are decidedly thinner than any others heretofore produced for battery purposes and accordingly the ampere hours per unit weight of battery are far in excess of those of older types.

A trip through the factory of the Western Reserve Chemical Co. was arranged by Mr. Burwell, general manager of the plant. Phthalic acid was produced in large quantities by the oxidation of naphthalene with chromic acid. A novel electrolytic cell arranged in cascade was demonstrated; this was used for the regeneration of the spent chromic acid. The cost of making phthalic acid and benzoic acid is lower than by other processes.

E. S. MacPherson conducted the members of the society through the "gas factory" of the Ohio Chemical Co. It was one of the most attractive plants visited. Four gases were being turned out: oxygen, hydrogen, laughing gas and carbon dioxide. The electrolytic plant consists of one of the very first Levin cell installations. The oxygen analyzes 99.8 per cent pure. Neither the oxygen nor the hydrogen requires purification after leaving the cells. The carbonic acid is made from magnesite by a new process.

Canada's Paper and Pulp Exports

According to statistics issued by the Dominion Government, Canada's pulp and paper exports for July were valued at $16,014,747, as compared with $7,730,162 for the corresponding month a year ago, an increase of $8,284,585, or more than 100 per cent. The shipments were made up as follows:

Paper and Pulp	Month of July 1919	1920
Paper	$4,639,225	$6,877,014
Chemical pulp	2,654,333	6,608,740
Mechanical pulp	436,604	2,528,993
Total	$7,730,162	$16,014,747

The paper exports during July, which included 9,789 cwt. of book paper, valued at $110,596, and 1,219,439 cwt. of newsprint, valued at $5,727,193, went to: United States, $5,535,386; United Kingdom, $425,949; other countries, $915,679.

Exports of unmanufactured pulp wood show an increase in both volume and value for the month of July. They were: 1919—122,069 cords, value $1,234,527; 1920—144,721 cords, value $1,545,906.

APRIL-JULY SHIPMENTS

For the first four months of the current fiscal year Canada's pulp and paper exports reached a value of $52,494,052, as compared with $27,067,236 in April-July, 1919, a gain of $25,426,816. They were greater by $5,966.784 than the value of such exports in the complete year 1916-17—up to that time a record. Details of the four months' period follow:

Paper and Pulp	April-July 1919	1920
Paper	$17,532,409	$26,423,454
Chemical pulp	7,903,626	20,118,759
Mechanical pulp	1,631,201	5,951,839
Total	$27,067,236	$52,494,052

In April-July, 1920, the paper exports (which included 24,751 cwt. of book paper, valued at $259,886, and 4,906,188 cwt. of newsprint, valued at $21,916,549) went to: United States, $20,998,774; United Kingdom, $1,548,102; other countries, $3,876,578.

Legal Notes

By Wellington Gustin

Palmer Potash Products Co.-Nebraska Potash Works Co. Controversy

The Supreme Court of Nebraska has affirmed the judgment in the controversy involving the Palmer Potash Products Co. and the Nebraska Potash Works Co. and others, except as to the amount of recovery, $120,000. The court found no satisfactory basis for arriving at these figures and directed the lower court to have another accounting made.

Plaintiff's Clay and Irwin are members of the partnership called the Palmer Potash Products Co., each owning a one-third interest; Palmer owned the remaining interest. Palmer had purchased 1,240 acres of land in Sheridan County, Neb., on part of which were two lakes, the waters and underlying soil of which contained potash. Shortly after this purchase the partnership was formed for the purpose of producing potash from the waters and deposits of part of the larger lake, known as Ashburger Lake. It was contended that Palmer made an oral lease to the partnership for the term of twenty years to the southern part of the lake, with the right to remove and appropriate all the potash and other minerals in the lake and underneath the same. The lease further conveyed the right to use sufficient ground near the lake north of this lease for the necessary buildings, tanks and machinery, and for a right of way across the tract to the C. B. & Q. R.R. and for other necessary buildings and sidetracks. Palmer was to be paid a royalty of one-eighth of the proceeds of the potash produced. The oral lease is referred to in the partnership agreement, but this instrument does not provide for a 20-yr. limit to the lease nor for its own termination as agreed upon, and it further lacked definiteness as to the premises leased.

Land Sold and Another Lease Made

After the execution of the agreement the partners constructed buildings and improvements on the margin of the lake and began extracting potash. In a somewhat crude manner, it was found, they extracted about thirteen tons of potash before lack of capital and dissensions between them prevented operations. The partners attempted to interest others who could provide necessary capital to make the payment upon the land coming due under Palmer's contract of purchase. Palmer finally assigned his interest in the land to Dr. Copsey of Alliance, Neb. It was alleged that Copsey bought the land from Palmer with full notice and knowledge of the partnership rights, and executed a lease to the lake to the Nebraska Potash Works Co., which also had full knowledge of plaintiffs' rights.

The plaintiffs brought suit to re-form the partnership agreement so as to show that the term of the partnership and the term of the lease should each be for twenty years, and when re-formed that the contract be specifically enforced and the defendants be enjoined from interfering with the use and occupancy of premises by the partnership and that title be confirmed and quieted in said partnership.

Defendants, the Nebraska Potash Works Co., Dr. Copsey, Palmer and others, answered, claiming the written agreement between Palmer and his copartners was the only agreement made between the parties, denying the lease was for twenty years and alleged abandonment of the enterprise by the partnership. The cause was then removed by defendants from the state courts to the Federal court, but was afterward sent back from the Federal court. During this time the company sank wells in the lake and began pumping water and extracting potash.

In a supplemental petition the plaintiffs alleged in addition that Palmer was still the owner of the land; that the company had taken out from twelve to thirteen tons of potash per day, of the value of $136 per ton; that the company had sunk over 400 wells in and about the lake, and that the partnership was indebted and that Palmer refuses to contribute his share in payment. The plaintiffs then asked that the lease of the company be canceled; that it be restrained from operating upon the premises; that the title be quieted in the partnership; that an accounting be taken of the potash extracted and the amount with interest be paid over to the partnership.

The trial court found that plaintiffs were entitled to all their claims and gave a judgment for $120,000 with interest as damages sustained, caused by the trespass of defendants.

Lower Court Upheld

The Supreme Court has upheld the lower court, except as to the amount of the damages, finding there was not proper basis for determining this amount. It found that Copsey and the company had full knowledge of all the rights claimed by the partnership and therefore whatever rights they have acquired with such knowledge are subject to the rights of the partnership.

The agreement set forth in the opinion considered in connection with other evidence in the case the court held to be more than a mere license to extract potash and to confer upon the lessees the exclusive right to occupy the leased premises and remove potash.

The facts showed that the distribution of potash in waters of the lake was by no means uniform, presumably for the reason that evaporation proceeds as the waters move southward. The natural drainage is toward the south or southeast and the waters in the south end of the lake are much the richer. Defendants first confined their operations to that portion of the lake north of the dividing line, later invading the southern portion on the premises of the plaintiffs.

The court found that the evidence did not show abandonment by the lessees at the time defendants entered and removed mineral-bearing water from the leased premises.

Defendants contend that operations of the partnership were not interfered with and that there was no force used in the occupation of the south part of the lake, but the court says it seems obvious that the taking of actual possession and sinking of over 400 wells by the company in the south portion of the lake would effectively interfere with the raising of capital by the partners and the successful prosecution of their enterprise. It is true that if let alone the parties might have been forced to abandon their lease and thus lose all their rights, said the court, but as long as it was in existence no one had the right to interfere with them.

The question of its proper measure of damages gave the court much trouble. The general rule is that where

one having knowledge of the rights of another willfully trespasses upon and takes his property the owner is entitled to follow and recover it, even though its condition may have been changed and value added by the wrongdoer. On the other hand it was said if the taking had been under an honest mistake of fact and with no wrongful intention on the part of the trespasser the owner is entitled to recover only its value in its natural state.

Following the latter rule, in remanding the case to determine the proper damages, the court directs the ascertainment of the proportion of potash derived from the southern portion of the lake as near as possible; to charge Copsey and the company with the net proceeds of all potash derived from the same, less the royalty of one-eighth and the cost of extraction after the water was in the pipe line.

Buyer and Seller Held in Default Where Shipment Is Prevented by Embargo

The Appellate Division of the Supreme Court of New York has reversed judgment of the lower court in the action brought by Miller & Sons Co. against the E. M. Sergeant Co. and directed judgment for the latter.

The action arose out of a sale of twenty-four carloads of about 50,000 lb. each of Solvay brand 58 per cent light soda ash to the Miller company, for shipment in two installments each month, price f.o.b. Solvay, N. Y. There was a provision that default in any payment by the buyer gave the seller the right to cancel any undelivered portion of the contract.

The Government having possession of the railroads and having laid an embargo on freight, shipment deliveries for January, the first month of the contract, became practically impossible. The seller wrote buyer to get a special embargo permit from the Government, which the buyer failed to obtain upon application. The embargo was lifted Feb. 16, and the buyer then wrote the seller to ship immediately all soda ash due. The seller, in response to this, shipped two carloads due for February, but declined to ship the January installment upon the ground that having offered to deliver the two carloads in that month, and the buyer having failed to take the same, the shipper could not be required to deliver that installment in any other month.

Damages for failure to deliver the two cars in January were asked. The trial court adopted the contention of the buyer that the seller failed to deliver the two cars due under its order, that delivery was to be made in Philadelphia, where the buyer's plant was located, and that the words "f.o.b. Solvay, N. Y." were an element of the price and merely meant that the buyer was to pay the freight.

What the Term F.O.B. Meant

The higher court held that the words "f.o.b. Solvay, N. Y." did not have reference to the place of delivery, but held the place of delivery was not at the buyer's place of business in Philadelphia. It said the contract was silent as to the place of delivery, and where that is the case the store or factory of the seller or the place where the goods are kept is the place of delivery.

The buyer claims that it was the duty of the seller to deliver a total of twenty-four cars, and if because of contingencies beyond its control it could not make the delivery the buyer was entitled to require delivery at a later date when delivery was possible. But the court said the contract was not an entire contract for the sale of twenty-four carloads, but was for the sale of twenty-four carloads in two installments each month, for which payment was to be made on each installment. Therefore it said the contract was severable and under the common law the failure of one of the parties to tender delivery or to pay for an installment would entitle the party to rescind the entire contract. If the parties thereafter proceeded under the contract the right to rescind would be lost. This rule is now changed in New York State by the personal property statute so that it depends in each case on the terms of the contract and circumstances whether the breach "is so material as to justify the injured party in refusing to proceed further and suing for damages for breach of the entire contract, or whether the breach is severable, giving rise to a claim for compensation for any loss, but not to a right to treat the whole contract as broken."

As might have been done, neither party sought to excuse its failure because of contingencies beyond its control; in fact, each claimed the other failed to perform, there being no failure on their own part. The sole remaining question is which party did fail to perform. It being found that Solvay, N. Y., was the place of delivery, when the seller notified the buyer that the goods were ready for delivery and asked buyer to secure embargo permit for shipping, the seller performed, and the failure of the buyer to accept the delivery was a breach of the contract on its part. Therefore it has no claim for the January installment and judgment was directed against it.

Where Buyer May Not Enforce Contract for Deliveries

In a recent decision of the Supreme Judicial Court of Massachusetts in the case of Lionel Samuels against the W. H. Miner Chocolate Co. the court holds that the buyer had broken the contract by omitting to forward his check and to send orders, which justified the seller's cancellation of the contract.

The contract was for the purchase and delivery of 2,000 bbl. of cocoa at 11½c. per lb., to be shipped by the chocolate company at such times and in such amounts, not to exceed 100 bbl. per week, as the buyer should direct. The buyer was not obliged to draw each and every week or at any particular time. The whole 2,000 bbl. was to be ordered shipped during the year 1917, and payment for each shipment was to be made in advance.

There was some delay on the seller's part in shipping during July and August. But this delay was waived by the buyer. In September the buyer made excuses for not ordering, and the latter part of said month the seller notified the buyer to furnish the orders under the contract or same would be canceled, and finally in October the seller canceled the contract.

When the contract was canceled there remained but eleven weeks of the contract period, with 1,485 bbl. unordered, and the buyer was not obligated to ship more than 100 bbl. per week. Now, in addition to this failure to send orders as required by the contract there was a further neglect on the buyer's part to comply with the agreement by his failure to forward a check for each lot before shipment was made.

The court found that buyer's breach in these matters went to the essence of the contract and that it justified the seller in canceling the rest of the order. The judgment of the lower court was upheld.



The Channel Process of Making Carbon Black

Details of Plant Construction for Channel Process—Condensing Building—Gas Transmission —Channels—Hoppers, Scrapers and Conveyors—Burners—Driving Mechanism and Accessories

BY ROY O. NEAL

IN COMMERCIAL practice there are four different processes of manufacturing carbon black from natural gas—viz., the channel system, the small rotating disk, the roller or rotating cylinder, and the large plate processes. The main points of difference in these methods is in the size and shape of the surface upon which the carbon is collected and the rate at which the moving devices actuate. The channel process is probably the best method and is the most extensively used. Classified according to the quantity of carbon black produced, the order is as follows: Channel, small rotating disk, large plate, and roller processes. At the present time the production of carbon black by cracking or thermal decomposition methods is not extensive.

THE CONDENSING BUILDINGS OF THE CHANNEL PROCESS

The buildings in which the channels and burners are installed are made of 24-gage sheet iron, held by wire to a steel frame made of ¼ x 1¼ x 1¼-in. angle iron. Fig. 1 shows the structural details of a typical building (sometimes referred to as the condensing building). The ridge piece does not extend the entire length of the building, as spaces are left to allow the escape of the gases of combustion. The ridge pieces are flexibly attached so that spaces can be changed, and consequently the draught regulated. In the design of some plants chimneys are provided. Slits or slide doors are located along the bottom of the buildings for controlling the air entering the buildings, but usually are not adjusted to meet the various weather conditions. A door at each end and one or two doors on both sides furnish access to the interior of the condensing buildings. With buildings having one table—that is, buildings that have one group of channels bolted together—the dimensions are 8 or 10 ft. in width by 80 to 115 ft. in length. With two-table buildings, the dimensions vary from 18 to 20 ft. in width and from 80 to 115 ft. in length.

EDITOR'S NOTE.—The present description and others that will be published shortly are published by permission of the director of the Bureau of Mines in advance of the report of the Bureau.

The buildings are arranged in parallel rows at right angles to and on both sides of an alley. The alley-way is about 15 ft. wide and buildings are from 3 to 5 ft. apart. The number of one-table buildings per unit—that is, whose power is furnished by one engine—varies from 24 to 30. In some districts, particularly Louisiana, a larger yield has been obtained with one-table buildings on account of the atmospheric temperature. With two-table buildings, the number of buildings per unit varies from 12 to 16. The units have a capacity ranging from 60 bbl., or 3,000 lb., to 100 bbl., or 5,000 lb. of carbon black per day. The largest plant that the writer inspected was made up of six units and consequently had six packing houses, six engines for furnishing power and six main driver shafts. The entire plant consisted of 180 condensing houses.

GAS TRANSMISSION

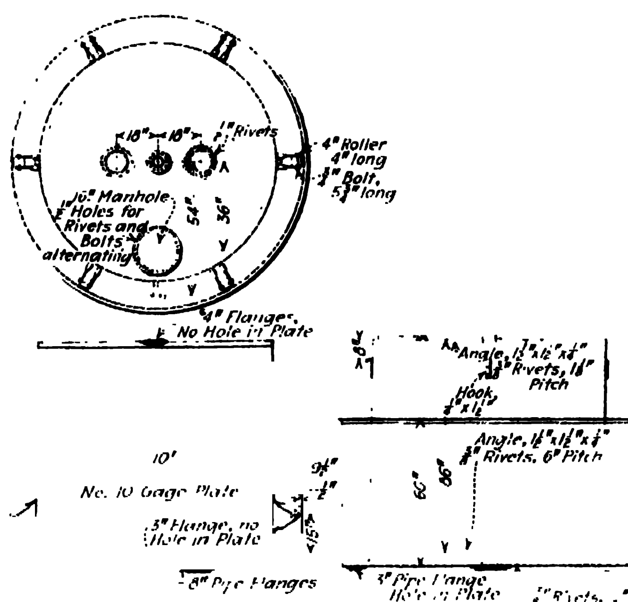
The gas coming from the wells, discharge from gasoline plant or gas transportation mains, is reduced in pressure by suitable regulators. After passing through the regulator the gas goes through a gasometer tank that is partially filled with water. Details of a typical gasometer are shown in Fig. 2. It consists of two tanks made of boiler plate, one inverted in the other. The gas is passed into the inverted tank and held by a water seal. The pressure of the gas blowing from the gasometer will be determined by the weights on top of the tank and the height to which it rises. The inverted tank is connected to a butterfly valve on the intake gas line by means of a lever arm, so that, as the pressure increases, the inverted drum of the gasometer tank rises

and the butterfly valve is closed. The flow of gas is controlled by the gasometer so that the pressure of the gas upon discharge will have a pressure of less than 1 oz. per sq.in.

In a plant having one-table condensing buildings, the gas is piped from the gasometer tank to a 24-in. distribution pipe made of riveted boiler plate, which lies in the center of the alley. Two 4-in. lines connect the distributor to each building, each of which is provided with a 4-in. gate valve. In the buildings a 1½-in. pipe is connected to a 4-in. line every 8 ft. Between the 1½-in. pipes a 1-in. rod or riser 3 in. high is welded, upon which the overhead channel work is supported. This arrangement is shown in Fig. 4.

In another design, an 8-in. gas line completely encircles the condensing buildings, to which two 4-in. inlet pipes are connected at each end of the building. Fig. 3 shows an installation of this description. The method of piping in all cases must be capable of distributing the gas evenly throughout the entire unit and the fact that the gas is held under such low pressure demands considerable attention.

The channels upon which the carbon black is deposited are made of mild steel, 7 to 8 in. wide and weighing about 12½ lb. per linear foot. The channels are supported by trucks that run on overhead rails. The channels, trucks, rails and other accessories are held up by 1½-in. standard pipe that rests either on concrete piers or upon the gas-distributing pipes. An upright pipe is provided at approximately every 4 ft. They are stabilized by 1 x ¼-in. cross-strap iron braces.



DETAILS OF GASOMETER TANK

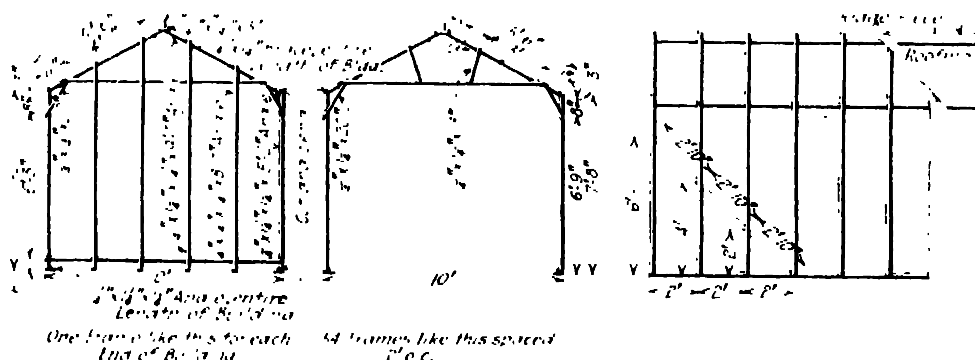


FIG. 4. DETAILS OF CARBON BLACK CONDENSING PLANT

At the top of each upright support is placed a small cast-iron rail chair which carries the rails. The rails are made of steel weighing from 16 to 20 lb. per yd. Running on the rails are 10-in. double gudgeon truck wheels. The wheel has lugs projecting out from the axis on each side which regulate its position, and it is held rigid longitudinally by two short lengths of 2 x 2-in. angle iron, although it can oscillate within a fixed distance in the line of direction of the rails.

Attached to the angle iron on both sides of the truck wheel are transverse channel beams (6½ lb. per ft.), to which the channels upon which the carbon black is deposited are bolted. Most of the plants have eight rows of channels on each trestle. These trestles are about 6 ft. wide and are called tables. An installation of this type is shown in Figs. 5 and 6, the views having been taken at a plant under construction. The channels are bolted together in lengths as great as 100 ft., while the trestle work is from 10 to 15 ft. longer to allow for the oscillations of the table.

Below the channels the carbon-collecting hoppers are located, being spaced approximately 4 ft. apart. The hopper is made up of three parts, the crown, body and base. The crown is supported upon the trestle by a ¼ x 1½ x 1½ in. angle on each side and sits loosely in the body, which is about 6 ft. in width in the upper portion and tapers down to about 10 in. The base is about 15 in. high and carries the conveyor pipe at its lower extremity. All three parts of the hopper are 6 in. wide, and the crown contains four notches which retain the scrapers. (See Fig. 8.)



FIG. 3. MAIN SHAFT AND SUPPORTS

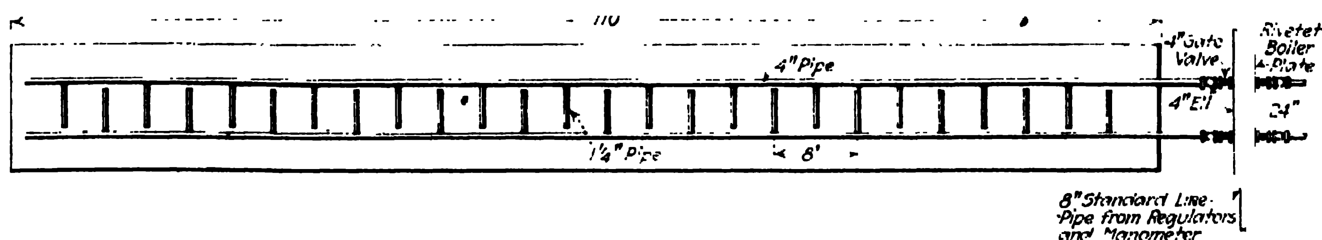


FIG. 4. PIPE ARRANGEMENT AND GAS DISTRIBUTION LINES

There are two classes of scrapers for removing the carbon from the channels—viz., those that operate continuously and those that are in direct contact with the channels while the tables are moving in one direction only. The latter is considered the best practice, since it gives a more uniform grade of black. The scrapers



CHANNEL PROCESS PLANT UNDER CONSTRUCTION

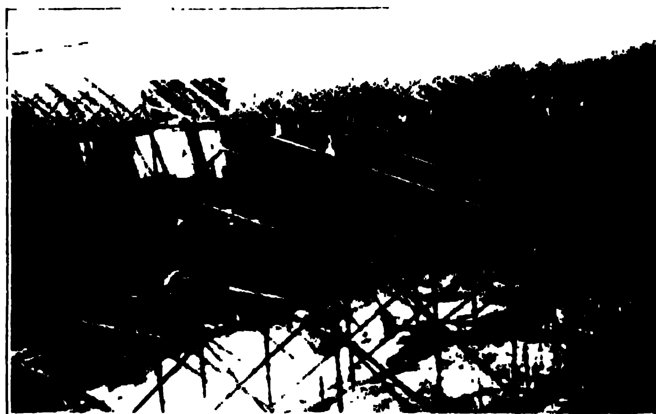


FIG. 6. UPPER VIEW OF CONSTRUCTION

are made of ⅛ x 1¼ in. steel, being 8 to 11 . in length, and have two blades that are attached to 20-in. arm which carries a loop to which is attached weight if the scrapers are to remove the deposited carbon continuously. With installations that remove arbon only while channels are moving in one direction system of levers is provided that is actuated by an automatic trip (referred to by the workmen as a "grasshopper"). Most plants are equipped with side scrapers for removing the carbon on the sides of the channel beams. A table having eight channels would have nine side scrapers over each hopper. The side scraper is made of a strip of strap iron ¼ x 32½ x 1 in., which is bent in the shape of a narrow U tube having 15-in. legs and about a 2-in. arch. The upper ends, 3 in. from the uppermost extremity, are bent at right angles with the arched part.

CONVEYORS

The conveyors that connect the bases of the hoppers and that carry the carbon from the different condensing buildings are made of galvanized sheet iron and are the spiral or screw type. The conveyor under the channels is 7 or 8 in. in diameter, the outside pipe being made of sheet iron throughout and crimped at one end of each section. The screw is usually made at the carbon plants by a simple tinner's machine which cuts disks of sheet iron slightly less than 7 in. in diameter (if a 7-in. conveyor is being used) and boring a small hole in the center about 2 in. in diameter for the shaft. The shaft is made of 1-in. standard pipe supported every 8 ft. by a spider bearing or conveyor hub that is made of cast iron. The concentric disk is cut and wrapped around

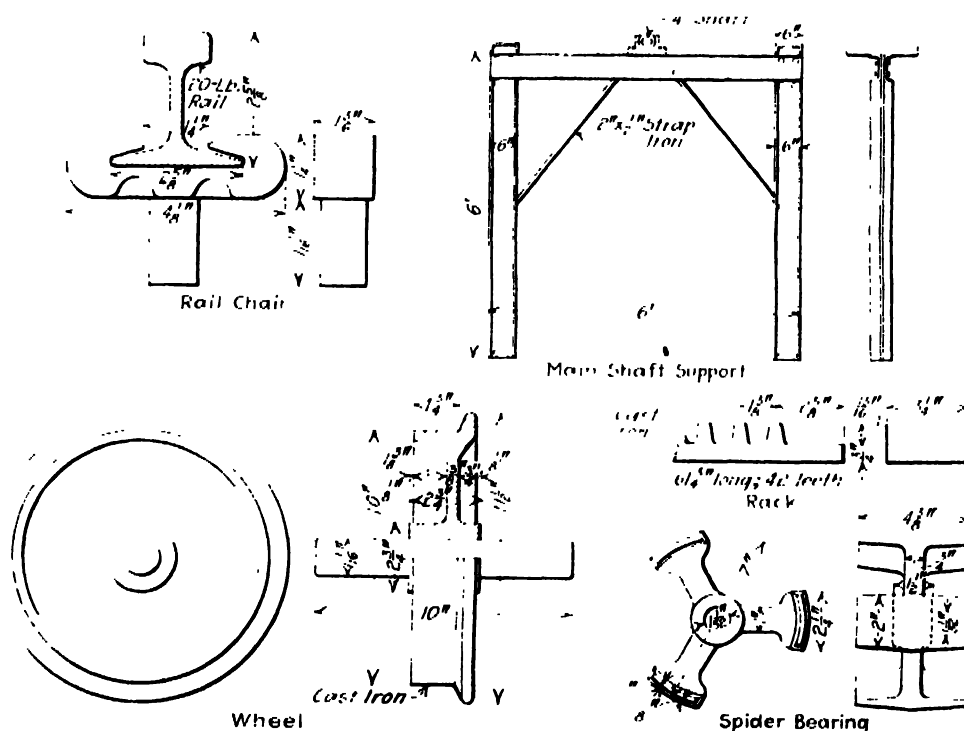


FIG. 7. DETAILS OF MACHINERY USED IN CHANNEL PROCESS

the shaft in helicoidal form and is held rigid by ¼-in. rivets. Fig. 7 shows the details of a spider bearing, truck wheel and rail chairs. Some carbon black operators prefer to purchase spiral conveyors from machine shops where helicoid is rolled from a single strip of metal before the pipe is inserted. This type of conveyor is strong, and resists to the full strength of the metal the lateral pressure due to pushing the material forward.

At the discharge end of each conveyor is an overflow tee which consists of a short pipe connected to the conveyor at a 30 deg. angle. This tee carries a sheet-iron cap. Below the tee and connected at a right angle to the conveyor is a pipe about 5 in. long and crimped at the end to allow the collected carbon to be transmitted to the main conveyors that lie on each side of the alley.

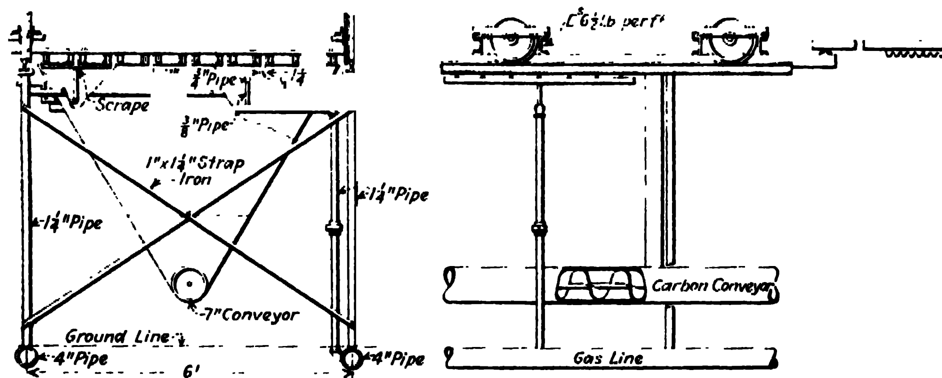


FIG. 8. ASSEMBLY DRAWING OF TABLE OF CHANNELS

Burners

The space between hoppers constitutes one section of the trestle. In this space are located the burners. The gas is delivered to the section by a 1¼-in. pipe, to which is connected a ⅜-in. pipe that carries the ¾-in. burner. The burner is parallel and about 3 to 4 in. below the channels. Each burner holds from eight to ten lava tips. A typical 60-bbl. plant would contain eight lava tips per burner, sixty-four lava tips per section, 1,600 lava tips per building, 38,400 lava tips per plant having twenty-four buildings.

The lava tips are made of a selected grade of steatite, that is easily machined in its green condition to any desired form by turning, milling and grinding. It is then heated to a temperature of about 2,000 deg. F., thus becoming hard and strong. Most of the manufacturers of lava tips are located in the vicinity of Chattanooga, Tenn.

There are a great variety of tips used, but the more common type burns 4 to 14 cu.ft. of gas per hr. The requisite for good tips is that they should produce uniformity of flame and have uniform gas consumption. A typical lava tip has a slot 0.20 in. deep and 9.934 in. wide. The lava tips are slightly tapered so that by drilling a hole slightly larger than its smallest outside diameter in the burner pipe, the tips can be securely held and made gas tight by the application of white lead. In Fig. 8 is given the general arrangement of burners, hopper, conveyors and channels.

Each unit is equipped with a separate engine which is usually about 20 hp. in capacity and is of the internal gas combustion, two-cycle type. Some factories use a simple steam engine, but instead of utilizing steam for work, allow the high pressure gas before passing through the regulators to expand and furnish power for the expansion engine.[1] This arrangement effects an appreciable saving in the cost of operation. The engine is belt-connected to a drive shaft through which power is transmitted to the conveyors, elevators, bolting machines, packing machines and the reversing gear shift that actuates the channels. These details are shown in a plan view of a complete carbon black plant in Fig. 9.

A working drawing of a reversing gear shift is shown in Fig. 10. Power for the device is transmitted by a belt from the overhead drive shaft. Pulley *d* is connected to pinion *b* by means of a sleeve; pulley *e* is an idler and *f* actuates pinion *c* through a collar. A carriage traveling along the threaded shaft *g* shifts the belt from *f* over *e* to pulley *d* periodically by means of a lever system, consequently changing the direction of rotation of bevel gear *a*. This change takes place about every fifteen minutes. The gear that is keyed to shaft located in center of alley meshes with the worm gear *h*. Another arrangement with a worm gear drive is given in Fig. 11.

The main shaft that moves the channels extends the entire length of the alley and is usually 3 or 4 in. in diameter. It is supported by trestles 6 ft. high and made of channel steel. Details of a support are given in Fig. 7. There is a support with a pillow block for each pair of buildings. Couplings are placed every 16 or 20 ft.

Over each support is a thirteen-tooth flanged pinion for engaging teeth in a rack or cog plate that is on the under side of an inverted tee steel beam connecting end trucks in opposite buildings. The rack is made of cast iron, containing forty-two teeth and is about 62 in. long. A stirrup of iron or roller is used to assure engagement of the rack and pinion. The entire table of channels and scrapers is moved by this rack and pinion, the channels having a straight line reciprocating motion of 55 to 60 in. which occupies a period of time of fifteen minutes. In a typical 60-bbl. plant there is approximately 200 tons of iron and steel in the condensing buildings, which does not include frame work or sheet iron covering that enter in the construction of the buildings.

The conveyors are drawn by a shaft belt connected to the main power shaft in the engine room. One 1-in. shaft lies on each side of the alley and transmits power to the conveyors in the condensate buildings by means of bevel gears. Another conveyor runs along each side of the alley that is chain driven by a sprocket wheel on the 1-in. shaft. These conveyors carry all of the black from the buildings to an elevator which is simply an endless chain having buckets attached. The elevator is enclosed in a 16-gage galvanized sheet iron box.

The grit, scale and hard particles in the carbon black are removed by the bolting machines that vary greatly

[1] See Technical Paper 232, p. 20, W. P. Dykema and Roy O. Neal, U. S. Bureau of Mines, 1919.

in design. The practice is also different at various factories. Some operators pass the carbon through two bolters, some through one, while others are not equipped with machines. At a few plants there is an apparatus fitted with coarse wire for removing bolts, pieces of iron and similar articles, which is called a "scalper." The bolting machine may be of the horizontal or vertical type, although the latter design is more commonly employed.

Details of a machine that is largely used are given in Fig. 12. It is made of 20-gage galvanized iron. The size of the steel screen used varies from 45 to 60 mesh, which is held up by a heavy wire as reinforcement. The screen is attached to a cylinder that can be removed through

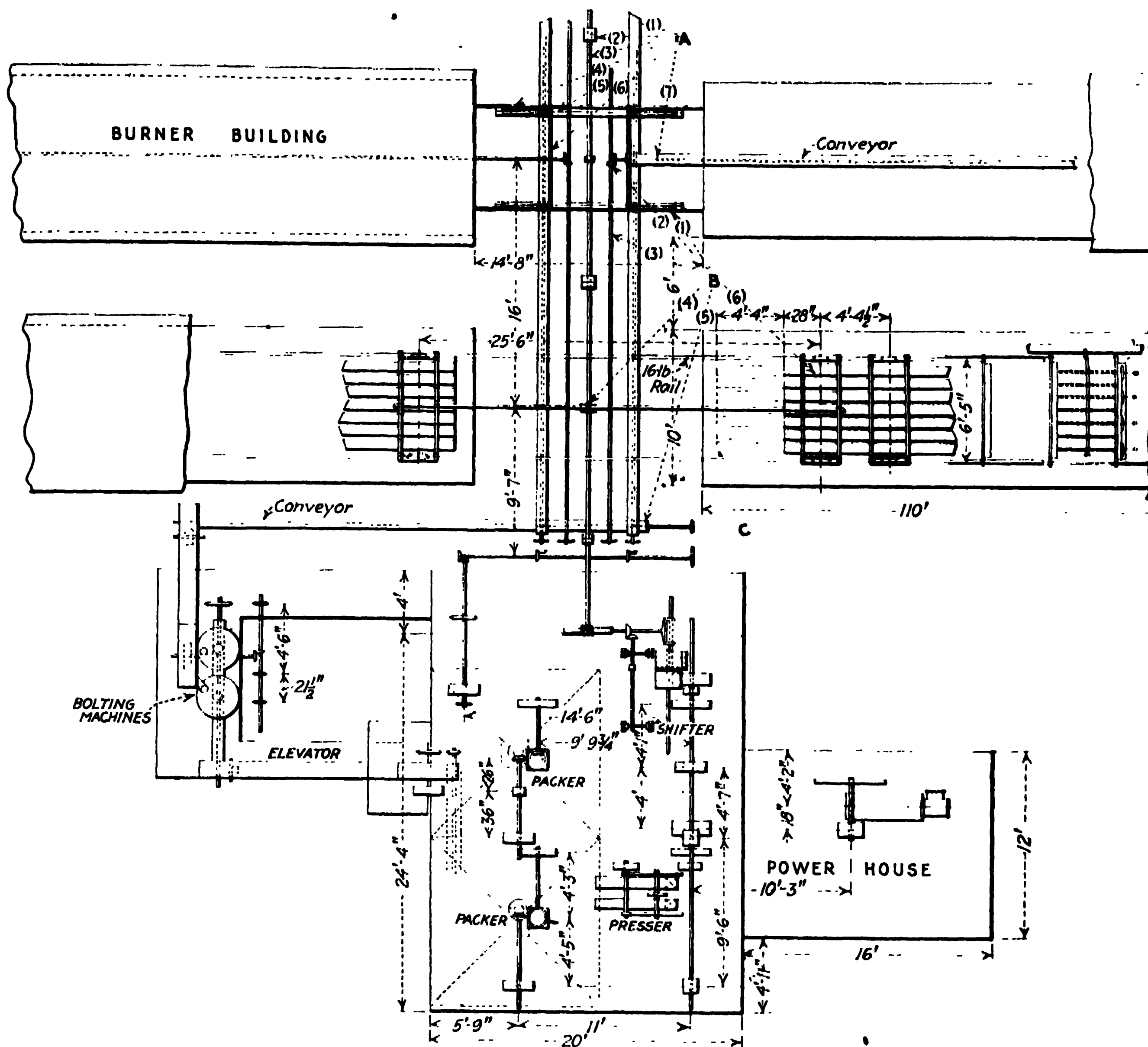


FIG. 9. PLAN OF TYPICAL PLANT

A1—8-in. spiral conveyor receives material from conveyor extending through entire length of each building.

A2—On main drive shaft couplings are placed, spaced 16 ft.

A3—3-in. main drive shaft, extending entire length of alley between buildings.

A4—16-in. rail of track on trestles in opposite buildings extends continuously across alley, connecting and bracing opposite trestles.

A5—A two bent steel trestle in alley between opposite buildings affords a brace for buildings and supports main drive shaft and conveyors.

A6—¼ x 2 x 2-in. angle iron tying trestle bents at top and supporting 16-16 rail crossing alley and connecting opposite buildings.

A7—Overflow tee placed on discharge end of each conveyor.

B1—2 pieces ¼ x 2 x 2-in. angle iron forming batter post for trestle.

B2—5½-in.-20-tooth cog on conveyor drive shaft engaging 10-in.-40-tooth cog on shaft of conveyor extending through building.

B3—Drive shaft (1-in. Stand. G. P.) for conveyors which extend entire length of each building.

B4—Flanged pinion to engage teeth in G. I. cog plate on underside of inverted T-steel connecting end trucks in opposite buildings (6 in. diameter, 3½ in. face, 13 teeth.)

B5—Conveyor from conveyors in alley to elevator.

B6—Channel iron placed with flanges turned upward and spaced 10 in. o.c. Bolted to under side of trucks. Seven pieces of ⅜ x 2½ x 18 in.

C—To each bent is fastened a sheet iron hopper held in position by being wired to angle irons between bents.

Bent posts are made of gas pipe spaced 6 ft. 6 in. wide and held in position at top by 1½ x 1½-in. angle iron.

Each hopper tapers toward its lower end and deposits its contents into a spiral conveyor. Between hoppers is arranged a system of gas pipes, which provides burning gas flames under each channel.

Bents are spaced 5 in. o.c. on top and 50½ in. on bottom and held in position on top by means of 1½ x 1½-in. angle irons.

Along center of each hopper is arranged seven scrapers, which bear on under side of channels to which trucks are bolted, pressure being obtained by means of weights on outer end of rods. Double gudgeon truck wheels, 1½ in. bearing x 10 in. diameter, made by Styles Mfg. Co.

the drop door. A shaft having a spider with six arms, each of which carry two fiber brushes, forces the carbon black through the screen. The product not passing through the screen is discarded periodically as waste material.

Storage Bins and Packers

The storage bins are made of galvanized iron and vary in size. They are tapering-shaped hoppers located over the packers. Some operators use bins of sufficient

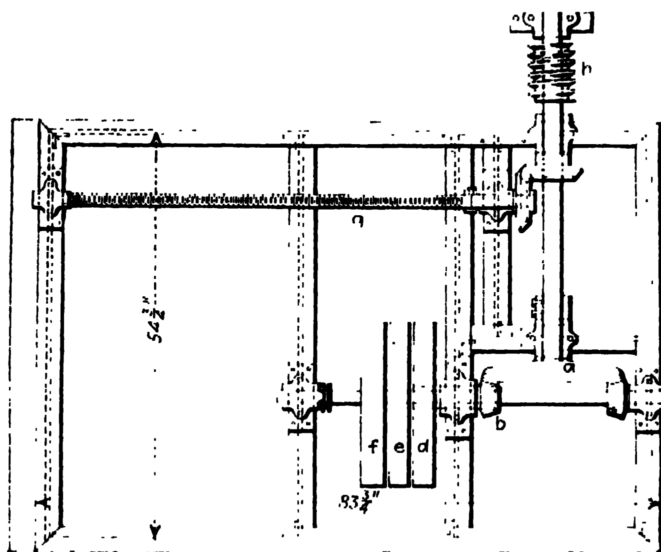


FIG. 10. REVERSING GEAR SHIFT

size to store two or three days' production, in order to eliminate any shut-down due to trouble in the packing room or to hold the carbon black made on Sunday, as in some plants the packers operate only six days per week.

The packers are very similar to those used at sugar refineries. An auger works inside of a tight sheet steel tube, pressing the carbon black into a paper sack. The auger is designed to stop the waste of the free-flowing stock running out between the blades of the auger when the packer is stopped for changing sacks. The stock, when passing through the auger, keeps the hinged gates folded parallel to and against the top auger blades. When the auger stops, the coil springs force the gates downward against the carbon lodged between the blades, not closing the passageway completely, but holding it back sufficiently to prevent leakage. The machine is gaged to pack a uniform amount in each sack, which is

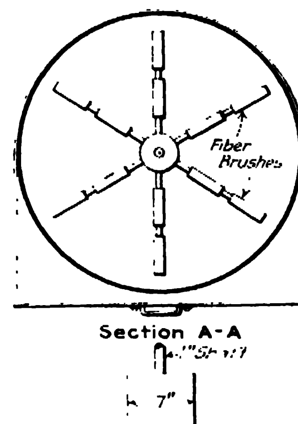


FIG. 11. DRIVING WORM GEAR CHANNEL PROCESS

usually 12½ lb., or a quarter of a barrel. In some cases, especially for export trade, the sacks contain 15 lb. The device starts by a simple movement of a lever which causes the bevel gears to mesh, and stops automatically when the sack has been filled with 12½ lb. of carbon black. The packer is connected to a storage bin by a spout.

A 60-bbl. plant usually is equipped with four packers that fill a sack in approximately fifteen minutes. The inner shaft rotates slowly in order to effect the proper separation of the carbon black from the air, in which it floats or holds mechanically. The problem of packing is to separate the black from the air as far as is commercially practicable.

The sacks are tied, and in most plants slightly compressed. The compressor consists of a steel plate box,



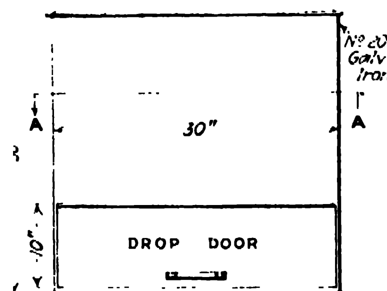


FIG. 12. DETAILS OF A BOLTING MACHINE

in which a plunger, actuated by a crank shaft or eccentric, travels. The sides of the sack are flattened to facilitate storing and transporting. After compressing, another paper sack is placed over the package.

The sacks of carbon black are removed from the packing building by trucks to the warehouse. If the black is to be sold to export trade, it is packed in wooden boxes 3 x 3 x 2 ft., holding from twelve to fifteen sacks each. The warehouses are located on the main transportation line, or on a narrow-gage railroad, that has electric or gasoline engine-driven trucks which convey the product to a transfer point. The warehouses differ greatly in size. At one plant that was visited by the writer, a stock of 35,000 sacks of black was stored, with spaces available for an equivalent quantity more. The warehouses may be open wooden frame buildings with corrugated sheet iron roofs, or completely inclosed sheet-iron buildings.

The disk, plate and cylinder processes will be described in a subsequent issue.

Foundry Methods for Light Aluminum:Copper Alloys

A Statement of Melting and Alloying Practice in Vogue in America for the Production of No. 12 Alloy, and a Discussion of the Apparent Advantages and Disadvantages in the Use of Copper or Various Copper-Rich Hardeners

BY ROBERT J. ANDERSON*

IN MANUFACTURING light aluminum : copper alloys for sand castings and for die-casting purposes several distinct problems exist which are of interest to aluminum founders. These problems are those which are connected (1) with the method of alloying copper and aluminum so as to produce alloys containing from, say, 2.0 to 14.0 per cent copper; (2) with furnace temperatures; and (3) with melting practice. Casting losses, oxidation and dross losses, and melting costs may vary considerably, depending upon the mode of manufacture of these alloys. The present article deals with the commercial manufacture of light aluminum: copper alloys in the United States, but so-called aluminum bronzes are not considered. In addition, experiments made in studying methods of preparing No. 12 alloy are described.

LIGHT ALUMINUM: COPPER ALLOYS

In aluminum founding the light aluminum : copper alloys are preferred for general casting purposes, and alloys of aluminum with other metals are not actually used to an important extent. The usual alloy employed in the United States for sand castings is one containing approximately 92.0 per cent aluminum and 8.0 per cent copper, and in fact this is virtually the present standard casting alloy. There are, however, several other distinct binary aluminum: copper alloys employed for commercial castings; these alloys contain from 2.0 to 14.0 per cent copper and remainder aluminum. An alloy containing 96.0 per cent aluminum and 4.0 per cent copper is used extensively in the United States for sand-cast cooking utensils and for some automotive castings; alloys containing 9.0 to 10.5 per cent copper and remainder aluminum are used for certain automotive castings, principally manifolds and pistons. A few alloys containing, say, 12.0 to 14.0 per cent are employed for particular purposes in England. In the United States the consensus of opinion among aluminum founders and automotive engineers is that the alloy containing about 92.0 per cent aluminum and 8.0 per cent copper (known in the trade as No. 12 alloy) is the best available for general casting purposes.

According to a recent survey by the Bureau of Mines, it is estimated that about 97 per cent of the so-called aluminum castings made today are poured from No. 12 alloy. The greater part of the remainder is cast from other aluminum : copper alloys, and the balance from other binary and complex alloys. There are a number of other aluminum alloys used for castings such as aluminum: magnesium, aluminum: zinc, aluminum: copper : zinc, aluminum : copper : tin, and aluminum : copper : manganese alloys[1]; however, the total annual output of castings made from these alloys is small with respect to the output of No. 12 alloy castings.

COMMERCIAL NO. 12 ALLOY

Strictly speaking, commercial No. 12 alloy is not a simple binary alloy in most foundries because of the usual presence of appreciable amounts of certain impurities, notably iron. Where the iron is high, and this element is frequently present in amount up to 2.0 per cent, the alloy should be properly regarded as a ternary aluminum: copper: iron alloy. This distinction may appear to be academic, but it really is not, because increasing amounts of iron markedly affect the properties of the alloy. As a matter of fact the iron content of most of the No. 12 alloy cast today ranges from 0.75 to 1.50 per cent, with an average of about 1 per cent.

No. 12 alloy is made up in foundries for casting purposes by a number of methods, and a variety of materials may be employed in the melting charges, and No. 12 casting ingot is marketed by primary and secondary ingot makers. Primary No. 12 ingot is made ordinarily by aluminum producers directly from virgin metals, while secondary No. 12 ingot is run down by smelters and refiners from aluminum-alloy borings and turnings, scrap castings, aluminum clippings, and other aluminum and aluminum-alloy scrap. In the foundry the methods employed for the manufacture of No. 12 alloy vary considerably, depending upon individual preferences, upon conditions and prices in the primary and secondary aluminum markets, and upon other factors. From the metallurgical standpoint, however, the principal consideration involved is the method of introducing the copper. This is especially important in foundry practice because the method employed for making the alloy affects dross losses, oxidation, shrinkage and casting losses, as well as costs.

PRESENT FOUNDRY METHODS

At the present time there are two well-defined methods used for alloying copper with aluminum in the commercial manufacture of light aluminum: copper alloys for casting purposes in the foundry; conflicting opinions have been expressed as to which one of these methods is the more advantageous The methods employed in commercial practice call for the use of (1) copper, and (2) a rich copper: aluminum alloy such as 33: 67 or 50: 50 alloy.

Some foundries prefer to make No. 12 alloy or other light aluminum: copper alloys by the addition of solid copper to liquid aluminum. This is quite a common practice in small foundries, but it is not used much in the large plants. Where copper as such is employed the usual practice is to melt the aluminum first, and then add the requisite amount of copper later. Thus, for a small heat of No. 12 alloy, say 100 lb., the

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[1]Anderson, R. J., "Special and Commercial Light Aluminum Alloys," U. S. Bureau of Mines, War Minerals Investigations Series, Bull. No. 14, April, 1919.

melter will first liquefy 92 lb. of aluminum in a crucible and then add 8 lb. of light sheet copper. The copper is alloyed by diffusion and partly by solution. In foundry practice copper is usually employed in the form of clean light-gage sheet, clippings and punchings, light sheet scrap, or scrap wire. Rarely, if ever, is the copper added in the form of ingot or cake copper, because large, massive pieces require too long a period of time for solution.

Use of Solid Copper

Copper as such is used because it is supposed to alloy satisfactorily, and to save the cost of preparing the rich alloys, such as 33:67 and 50:50 copper: aluminum. There are some apparent advantages in the use of copper direct, but at the same time some obvious objections. While many conflicting opinions have been expressed in considering the use of copper rather than a rich alloy, the most apparent advantage in the former would appear to lie in the saving made by obviating the cost of manufacture of a rich alloy.

The presumed difficulty of dissolving solid copper in liquid aluminum has been offered as an objection, but there is no basis in fact for this, because copper, in the form of light-gage punchings and sheet, goes into solution in aluminum quite rapidly at 700 deg. C. (considerably below normal furnace temperatures in aluminum-melting practice). More massive pieces of copper dissolve more slowly at low temperatures but go into solution fairly rapidly at 900 deg. C., as has been shown by experiment.[3] Hence, if bulky and heavy copper is used, the melting charges must be heated to rather high temperatures, and this is decidedly inadvisable for aluminum alloys—where high furnace temperatures are permitted in melting the resultant castings are likely to be porous, unsound and leaky because of gas absorption and oxidation of the alloy. In case the copper is dirty or greasy it is advisable to boil it in sodium hydroxide, as is done by some foundries, but cleaning for the mere sake of securing a bright surface simply adds to the production costs. If the copper is covered with a considerable layer of copper oxide (Cu_2O) or if the copper oxide content of the copper is high an appreciable thermit reaction will take place when the solid metal is added to liquid aluminum; badly oxidized copper should not be used, as it thus increases the dross losses.

Advantages and Disadvantages of Using Solid Copper Rather Than a Rich Copper Alloy

A few foundries prefer to use copper rather than a rich alloy on the ground that the former minimizes errors in weighing, but this seems to be a dubious advantage, if any exists. Some foundries have had difficulty with porosity and excessive shrinkage in castings made by the use of copper direct, while others have experienced non-uniformity of product, where the castings run "hard" and "soft." Both porosity and shrinkage might be readily traced to causes other than the method of making the alloy, and since molding and melting practice influence these defects it is not possible to deal with this objection without more complete data. Heterogeneity of composition (hard and soft castings) can logically follow from the use of copper either because of failure to secure complete solution of the copper or because of insufficient stirring and mixing, and much of the trouble experienced by founders in the use of copper has doubtless come from inadequate mixing. In the case of poorly mixed No. 12 alloy made by adding copper to aluminum it is not unusual to find the first pour running 3 to 5 per cent copper and the last pour 9 to 11 per cent copper. It takes a longer time to dissolve copper in aluminum than it does to dissolve the rich alloys, principally because of the difference in the melting points; viz., aluminum, 658.7 deg. C.; copper, 1,083 deg. C.; 33:67 copper: aluminum alloy, 540 deg. C.; and 50:50 copper: aluminum alloy, 575 deg. C. Metals which form solutions in the liquid state and in whole or in part in the solid state are more easily alloyed the less the difference in melting points.

As to the possible saving in cost made by using copper instead of a rich alloy, this may be offset by the greater expense incurred in dissolving the copper, and it may be further offset by comparative figures on casting losses, and also dross losses.

Use of 33:67 Cu: Al Alloy

An alloy containing 33 per cent copper and 67 per cent aluminum is employed in some foundries, but it is less widely employed than either pure copper or 50:50 copper: aluminum for the manufacture of No. 12 alloy. The alloy in question has the minimum melting point of the binary system, and shows a typical eutectic structure; it melts at about 540 deg. C. (1,004 deg. F.). The 33:67 alloy does not segregate within itself as does 50:50 copper: aluminum, and this is an advantage, pointed out by founders who use the former for introducing copper into aluminum. As is well known, when a eutectic alloy freezes the crystallization of both components takes place simultaneously, and thus forms a very intimate *mixture*. Such an alloy cannot properly be considered as homogeneous, but the intimate mixture might approach homogeneity. The low melting point of the 33:67 alloy is also of advantage, for if placed in liquid aluminum it quickly alloys, since it is melted almost immediately. If charged solid together with solid aluminum it will melt first, but there will be some diffusion of the solid aluminum into the liquid alloy before the former melts. In foundry practice 33:67 copper: aluminum alloy, aluminum ingot and foundry scrap are charged in the proper proportions so as to produce No. 12 alloy, and the relative amounts of each material used in a charge may vary considerably.

The main disadvantage in making and using the 33:67 alloy lies in the fact that so much aluminum must be melted in preparing it, and larger quantities of the alloy must be remelted in manufacturing No. 12 alloy. The objection is also offered that it is not so easy to calculate the make-up of charges when using this rich alloy. This is not a serious objection, but the former disadvantage is. However, it has been shown to be a satisfactory rich alloy, from the metallurgical standpoint, for introducing copper into aluminum.

Use of 50:50 Cu: Al Alloy

The majority of the foundries in the United States favor the use of the 50:50 copper: aluminum alloy for introducing copper into aluminum. This alloy melts at 575 deg. C., but it is liable to be badly segregated unless thoroughly stirred during its preparation and then frozen rapidly by casting into chill molds. If segregated it may cause some non-uniformity in suc-

[3] R. J. Anderson, "Diffusion of Solid Copper in Liquid Aluminum," Chem. & Met. Eng., vol. 23, No. 12, p. 575 (Sept. 22, 1920).

cessive heats of No. 12 alloy, but ordinarily no trouble should occur from this source. Due to the fact that the 50:50 alloy melts at a lower temperature than aluminum, it will readily alloy. The objections offered to both the rich alloys include the cost of making the alloys and the liability that weighing mistakes may be made in the melting room. In using 50:50 copper: aluminum the requisite amounts of the alloy and aluminum ingot plus No. 12 scrap are charged together.

It has been pointed out when discussing the use of copper directly in making up No. 12 alloy that the heats may run "hard" and "soft" because of failure to stir thoroughly. Even with the use of the rich alloys vigorous stirring is essential if castings of uniform composition are to be produced.

Comparison of the Methods

In comparing the above methods from the practical standpoint the foundryman is interested in knowing (1) which method is the more economical, (2) which method is the more easily carried out in the foundry, and (3) which method gives the better castings. The tentative answers to these questions, as they appear to the writer, will be given after comparing the different methods in detail.

With regard to the use of copper, the main advantages claimed by foundries which employ that method are that there is less liability for error in weighing charges than when a rich alloy is used, and that the cost of preparing rich alloys is saved. The presumed former advantage appears to be untenable because, once the charges are calculated, weighing out definite amounts of metal is simple and can be done by very low-grade labor. The more apparent advantage, if it is one, should arise in reduced production cost brought about by the saving in cost of making a rich alloy. That advantage may be partially offset in some foundries because, in alloying copper with aluminum directly, the cycle will generally require a longer melting period. However, unless the proper relation between molding and melting is worked out the melting may be in advance of the molding, so that the charges might thereby be heated longer than actually necessary. The best practice would insure that the condition be reversed, and that the molding should always be in advance of the melting; in this way the heats would be poured as soon as ready.

There appears to be some difficulty at times in obtaining a supply of sheet copper suitable for the purpose in question, and less desirable forms of copper might have to be used with attendant disadvantages. The situation in regard to that matter may be largely dependent upon local conditions and periodic conditions in the copper scrap market. Scrap copper is available in the following forms: Heavy copper, consisting of copper not less than $\frac{1}{16}$ in. thick (including heavy wire, clippings and punchings, and segments), No. 1 and No. 2 copper wire, and light copper (including fabricated copper and sheet). If foundries have difficulty in alloying solid copper with liquid aluminum the trouble lies in the use of too large pieces of copper, too little stirring, or too low temperatures. Of course, it is conceded that in ordinary melting practice the temperature should be kept low, say about 750 deg. C. or so; where the castings must be poured at higher temperatures, because of difficulty in running them, the furnace charges must be heated to 800 or 850 deg. C. However, at both low and high temperatures solid copper alloys readily with aluminum if the pieces of copper are small and light.

One metallurgist in the light alloy industry has written to the author on the subject as follows: "Under usual working conditions—i.e., with the class of labor available, etc.—I do not believe it is possible to use pure copper. In the first place, I do not believe that a uniform product can be produced. Only the other day a case came to my attention where, a few years ago, a foundry went through a period of considerable trouble with its castings. For some reason it took this foundry a long time to discover why the castings were running hard and soft. The company making them was trying to alloy copper directly."

There is this to be said with regard to the use of copper: The tendency on the part of melters is to raise the heats to unduly high temperatures to hasten alloying, and further there is danger in not thoroughly stirring the melts. The writer's experience has been that copper may be used to advantage under certain definite conditions, and in fact it will be just as satisfactory in some cases as a rich alloy if proper attention is given to details. Metallurgically, it is generally recognized as poor practice to attempt to alloy metals of greatly different melting points directly in commercial work. In the case of aluminum: copper alloys the difference in melting points between copper and aluminum is 425 deg. C. In alloying the two metals by the addition of solid copper to liquid aluminum advantage is taken of solution and diffusion in the solid state, but normally the temperature may have to be raised somewhat above that necessary when using either of the rich alloys.

The use of a rich alloy, usually 50:50 copper: aluminum, is an old practice. In manufacturing light alloys in the foundry there are definite advantages in its use. There is no evidence to show that No. 12 alloy made by the use of a rich alloy is any better than when made with copper, but the device of employing a rich alloy is certainly a convenience. This alloy is very brittle, due to the presence of much $CuAl_2$, and this property enables the alloy to be broken readily and thus weighed with great accuracy when necessary. Furthermore, it is possible to hold the melting temperatures relatively low, and that is an important point. The 50:50 alloy is much more brittle than the 33:67 alloy, so from the standpoint of brittleness the former is to be preferred. The main objection offered in connection with the use of the 33:67 alloy is that more of it must be used than the other alloy in making No. 12; furthermore, it is not extremely brittle, and it is not so easily calculated.

Conclusion

It appears, taking everything into consideration, that light aluminum: copper casting alloys for casting purposes may be most conveniently made by using the 50:50 alloy. Under the conditions of fast practice which obtain in large foundries this alloy appears to be safer. There is less calculating to be done than in the case of 33:67 alloy; it melts at a lower temperature than aluminum; it is brittle and therefore can be weighed out with great accuracy; and, considering all factors, it is more fool-proof. The use of copper may be more economical in some cases. So far as quality of castings is concerned the various methods are doubtless equally good, provided thorough alloying is obtained.

Proceedings of Rubber Division, A.C.S., Chicago Meeting, 1920

Committee Reports — Aging of Some Rubber Compounds — Microscopic Study of Vulcanized Rubber Containing Fillers — Organic Accelerators — Polysulphide Theory of Accelerator Action — Effect of Heat and Light on Vulcanized Rubber—Symposium on Rubber Analysis

THE convocations of the Rubber Division at the sixtieth meeting of the American Chemical Society in Chicago, Sept. 8 and 9, 1920, were held in Kent Hall, University of Chicago. About one hundred and fifty rubber men attended. In the absence of Dr. LEWIS the vice-chairman, G. D. KRATZ, presided.

REPORTS

Physical Testing: Mr. SIMMONS reported considerable difficulty in obtaining the necessary co-operation from other bodies interested in rubber testing to permit the drawing up of standard methods. The Rubber Division of the American Society for Testing Materials was characterized by several as being quite dormant.

Accelerators: At the previous meeting a resolution aimed to prevent the sale of unknown and harmful accelerators under trade names was passed. The executive committee thought it better to not publish the information but to file it with the secretary, where it would be available for all members of the division. The report was accepted and Messrs. Bedford, Tuttle, Zimmerly and the secretary (Mr. Smith) were appointed a committee to put the plan into effect. All advertised accelerators will be listed and their exact composition determined. Information regarding them may be obtained from the secretary.

Literature: For the improvement of the analytical symposium, W. W. EVANS, of the B. F. Goodrich Co., distributed to the members of the division a volume of abstracts from the literature covering all phases of rubber analysis. He went as far back in the files as he could find anything of value attached to the work. The volume is an excellent addition to any rubber man's library. From this came the idea that it would be desirable to issue a volume of abstracts each year, so as to keep the members fully informed on all that has been done. It was pointed out that *Chemical Abstracts* has not the space necessary for longer abstracts. Frequently an important article in a foreign language must be so boiled down that it is practically denatured. Any chemist who might wish to use it will be forced to consult the original. This is not always easy to do. The members present were of the opinion that longer and more comprehensive abstracts could be prepared by themselves and given to one of the American rubber journals for publication. A committee consisting of Messrs. Evans, Hall and Bedford was appointed to handle the work during the coming year. Mr. Evans announced that since the vote was unanimous he understood that no one would decline any abstracting he might be asked to do. He also mentioned that at the next meeting a list of delinquent abstractors would be given out.

THE AGING OF SOME RUBBER COMPOUNDS

This paper, by Mr. DEPEW, of the New Jersey Zinc Co. research laboratories, described accelerated age tests carried on in an oven at 70 deg. C. for periods up to 16 days. Three compounds were chosen:

	A	*B*	*C*
First latex crepe	92 0	92.0	92 0
Sulphur	5 5	5 5	5.5
Hexamethylene-tetramine	1 5	1.4	1 4
Zinc oxide	84 0	98 0	22.0
Gas black			25 0
Lithopone		20 0	

Basing aging on decline in tensile strength with time, compound *A* was shown to be somewhat better than *B* and much better than *C*. *B* and *C* were worked out to have the same volume relations of filler to rubber. This would apparently indicate that from an aging standpoint it would be better to replace gas black, which is extensively employed with zinc oxide in pneumatic tire treads, by lithopone.

However, in the discussion following this paper it was pointed out by several that doubtless through inexperience the New Jersey Zinc Co. men had used approximately one part too much hexamethylene-tetramine and that the poor results obtained were probably due not to any fault of the black but to a formula not properly balanced with respect to sulphur and accelerator. Also in view of the fact that few rubber men are satisfied with the accelerated age tests as they now stand, it would appear that the conclusion above mentioned must be proved more conclusively.

SOME MICROSECTIONS CUT FROM VULCANIZED RUBBER ARTICLES

The work described in this paper, also by Mr. DEPEW, was largely that of Henry Green and Roger Graver. The New Jersey Zinc Co. laboratories are perhaps further advanced in the application of metallographic methods to rubber than any others in America. In cutting sections of rubber an ordinary Spencer microtome is employed. The sample is frozen first by CO_2 and then by liquid air in a matrix of 90-10 water and glycerine. Liquid air is obtained from the manufacturer in Icy-Hot thermos bottles.

Slides showing the fineness of zinc oxide, aluminum flake, whiting and litharge were exhibited. The following sections were shown:

(*a*) White tread containing zinc oxide and magnesia as an accelerator. The zinc particles were all dispersed, but a large particle of magnesia was in evidence. The contrast was so great that Mr. Depew referred to it as a "rock."

(*b*) Red rubber sole. The particles of iron oxide and the fibers introduced for their stiffening action were visible. It was noticed that the particles were arranged in parallel lines following the direction of the grain of the stock.

(*c*) Gray tread. A white stock containing sufficient lamp black to "gray" it was exhibited. The lamp black was not well dispersed and agglomerates were in evidence. As before, the zinc oxide was well dispersed.

(*d*) A carbon (gas) black-zinc oxide stock. The

carbon black was found in agglomerates. The zinc oxide was well dispersed.

(*e*) Another section same as "*d*." Here both the zinc oxide and the carbon black were well dispersed.

(*f*) Side wall. Zinc oxide crystals and whiting were seen.

(*g*) Cushion. This stock contained 1 per cent of zinc oxide and a small amount of reclaim, which was evidenced by dark brown spots.

It was pointed out that by analysis one cannot differentiate blanc fixe from ground barytes. With the microscope this is very readily done. They are planning the use of polarized light for various fillers and staining methods for glue, etc.

In the discussion which followed it was pointed out by Mr. TUTTLE that the heating effect which leads to the disintegration and blowing out of solid tires is enormously increased by poor dispersion--i.e., by the presence of agglomerates.

THE ACTION OF CERTAIN ORGANIC ACCELERATORS IN VULCANIZATION OF RUBBER

The relative activities of molecularly equivalent amounts of aniline and diphenyl-thio-urea in the acceleration of vulcanization were compared in rubber-sulphur mixtures and in mixtures which contained zinc oxide in a paper by G. D. KRATZ, A. H. FLOWER and B. J. SHAPIRO.

In a rubber-sulphur mix the activity of aniline was found to be much greater than that of diphenyl-thiourea. In mixtures which contained zinc oxide the reverse was true.

With aniline as the accelerator either in the presence or absence of zinc oxide the same maximum tensile strength was obtained, accompanied by a higher sulphur coefficient in the absence of zinc oxide than when this substance was present.

The mixtures which contained zinc oxide attained the same maximum tensile strengths at approximately the same sulphur coefficients, irrespective of whether aniline or diphenyl-thio-urea was employed as the accelerator.

Kratz concludes that from his evidence there is approximately no general relation between the physical properties and sulphur coefficients of accelerated mixtures.

The activities of aniline, methylaniline, dimethylaniline, para- and meta-phenylenediamine, para-toluidine, para-benzidine, phenylhydrazine, and hydrazobenzene were compared in pure gum (8.1 per cent sulphur on the rubber). The accelerators were compounded in hundredth mole quantities. All samples were vulcanized ninety minutes at 148 deg. C. Para-toluidine in the above combination gave the best results (tensile 2,476 lb. per sq.in., 920 per cent elongation).

No definite relation was found to exist between the dissociation constants and the relative activity as accelerators except in the case of closely related series. This may be due to the fact that the substance itself is not the true accelerator, which is some product of its sulphur or other reaction. Thus hexamethylenetetramine reacts with sulphur, giving ammonia, hydrogen sulphide and other reaction products. In such cases dissociation constants are obviously poor indications of relative acceleration. KRATZ regards the NH_2 grouping as of most importance in an accelerator, and finds it advantageous to think of it as a substituted ammonia. Adding a second NH_2 group to the ring does not double the acceleration.

Substances such as aniline hydrochloride, etc., which decompose or react with other components of the mixture to form substances of acid character, do not accelerate unless a neutralizing base (such as zinc oxide) or salt is present.

In common with Van Horn, Kratz regards a preponderance of basicity as essential to acceleration. Thus Girard found that rubber could be vulcanized by heating it in a solution of potassium pentasulphide. The equation probably is:



$$K_2S_5 + H_2O \rightarrow 2KOH + H_2S + S \text{ (active)}$$

Kratz has found that ammonium polysulphide and even the hydrosulphide will also vulcanize. With ammonium polysulphide the reaction probably is:

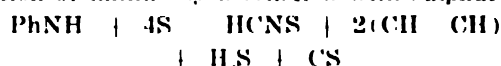


$$(NH_4)_2S_x \rightarrow 2NH_3 + H_2S + S_x$$

With ammonium hydrosulphide (under pressure) Kratz obtained a coefficient of vulcanization of 4.4; with the polysulphide the value was 1.9.

A THEORY OF ACCELERATION BASED ON THE FORMATION OF POLYSULPHIDES DURING VULCANIZATION

Very few theories of the action of accelerators during vulcanization are to be found in the literature, declared C. W. BEDFORD and WINFIELD SCOTT. Ostromuislensky considers the activation of sulphur to the formation of thio-ozonides of the type RNH-S-S-S-HNR, which pass sulphur to the rubber, then take up more sulphur, thus repeating the cycle. Dubose considers it due to the formation of active sulphur by the reaction of sulphur dioxide and hydrogen sulphide. Dubose seeks to explain the action of aniline by a reaction with sulphur



$$PhNH_2 + 4S = HCNS + 2(CH \equiv CH) + H_2S + CS_2$$

The authors obtained thio-aniline and hydrogen sulphide, but no acetylene, CS_2 or thiocyanic acid.

Kratz, Flower and Coolidge stated that the activity of aniline was due to a sulphur addition product of aniline such as $PhNH_2S$, a product which admittedly is probably very unstable.

Taking ammonia as the simplest nitrogen-containing base, it reacts readily with H_2S, forming ammonium sulphide, which in the presence of sulphur is readily converted to the polysulphide $(NH_4)_2S_n$ where *n* may have any value up to 9. Sulphur contained in the polysulphides is more reactive than rhombic or alpha sulphur. Polysulphides as sulphur carriers are quite common in the dye industry and are extensively employed in the manufacture of sulphur colors.

Thus they explain the acceleration of aniline as follows:





True Accelerator

The curing value of para-phenylenediamine they attribute partly to its basicity, but mostly to the fact that at vulcanizing temperature it reacts with sulphur to produce ammonium sulphide along with other basic products.

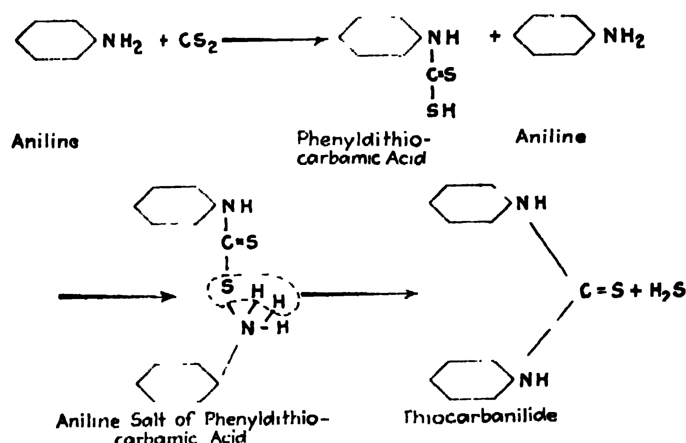
Aldehyde ammonia liberates large quantities of ammonia during the cure, and at the same time by the action of heat forms strongly basic alkyl pyridine derivatives. Para-nitrosodimethylaniline, which Peachey classes as acidic, reacts with H_2S to give the strongly basic *p*-aminodimethylaniline.

Scott and Bedford class as polysulphide accelerators the phenylene diamines, anhydroformaldehyde-aniline, methylenediphenyldiamine, hexamethylenetetramine, and all others which liberate H_2S or produce it by a reaction with sulphur at ordinary temperatures.

This class of accelerators may be represented as functioning because of the $\underset{\text{H}}{\overset{}{\text{N}}}\text{—S—S}_x$ grouping.

The remaining organic accelerators form polysulphides, then the carbo-sulph-hydro group N—C—SH thus N—C—SH S_x. This group contains the thicarbanilides, dithiocarbamates, etc.

The authors in a previous paper explained the formation of thiocarbanilide as follows:



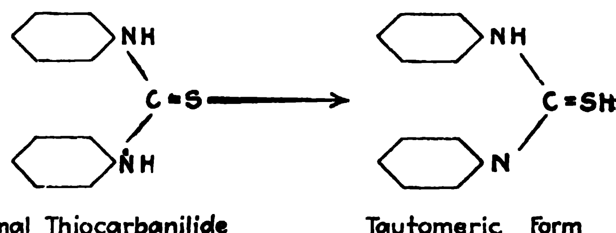
When H_2S, produced by the reaction of rubber resins and sulphur, acts on thiocarbanilide the reaction is reversed, giving the aniline salt of phenyldithiocarbamic acid which, while unstable, is an extremely powerful accelerator.

The dithiocarbamates are the strongest accelerators known and will affect vulcanization at room temperature. Such, for example, is piperidine-piperidyl-dithiocarbamate. If piperidyl (ammonium) polysulphide is added to a rubber cement containing some free sulphur no vulcanization occurs even after a period of two months. In contrast to this a small amount of piperidine was added to a rubber cement containing zinc oxide and sulphur. To this was added a small amount of carbon bisulphide which reacted to form a piperidine-piperidyl-dithiocarbamate. The cement set to a stiff jelly in twenty-four hours.

Inorganic Accelerators: Although H_2S seems to be necessary in a large class of organic accelerators there are cases in inorganic accelerators where it is not required. The sulphides of the alkali and alkaline earth metals readily take up sulphur to form polysulphides.

Zinc oxide and litharge do not form polysulphides. If litharge be added to a solution of yellow ammonium sulphide, lead sulphide is immediately precipitated and colloidal sulphur is liberated from the ammonium polysulphide. In a stock during vulcanization the resins and proteins react with sulphur, liberating ammonia and other basic substances which immediately form polysulphides. The litharge removes H_2S, leaving activated sulphur. Bedford has shown that litharge has very little accelerating effect on deresinated rubber which contains hardly any protein.

The effect of zinc oxide and other bases in increasing the accelerating effect of thiocarbanilide is thought to be due to locking the hydrogen in the tautomeric position attached to the sulphur, thus:



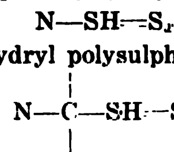
Normal Thiocarbanilide Tautomeric Form

Summary. All accelerators are thought to fall into two classes:

1. Hydrogen sulphide polysulphide accelerators.

N—SH=S_x

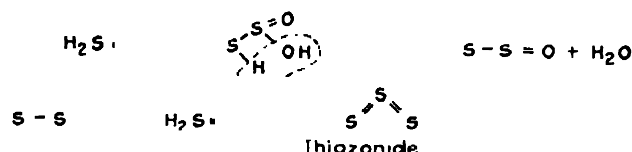
2. Carbo-sulphhydryl polysulphide accelerators.



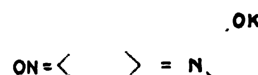
Discussion. The two papers, that by Kratz, Flower and Shapiro and that of Bedford and Scott, were discussed at the same time.

The remarkable thing is that Kratz, Flower and Shapiro and Bedford and Scott reached the same conclusions but by different routes. These papers are most interesting and instructive.

Bedford pointed out that vulcanization by SO_2 and H_2S as predicted by Dubosc's theory and recently patented by Peabody fits into the polysulphide theory. Thus:



Bedford also mentioned that vulcanization with nitro- or dinitro-benzol in the presence of litharge or caustic is preceded by the formation of a quinoid grouping, thus:



The reaction product of dimethylamine and carbon bisulphide (dimethylamino-dimethyl-dithiocarbamate), which is an extremely powerful accelerator, was reported as unable to effect vulcanization without added sulphur. Zinc oxide is necessary to activate it. The zinc salt of the acid will vulcanize without added zinc oxide.

RUBBER ENERGY

"Rubber Energy" was the title of a paper by W. B. WIEGAND. The energy storage capacity (ft.-lb. per cu.in. when stressed up to the elastic limit) of various materials was compared to that of rubber. Rubber has the enormous value of 14,600 ft.-lb. per cu.in. (as shown by planimeter measurement under the stress strain curve up to the elastic limit). Hickory wood has but 1 per cent of this capacity and spring steel less than 1 per cent. The high energy storage capacity of rubber was recognized early in designing bumpers for railways.

Hysteresis. It is well known that the retraction curve differs markedly from the extension curve. The area under the latter is a measure of the work done in

stretching the test piece—i.e., it represents "input." The area under the former (the retraction curve) represents "output"—i.e., the work given up by the stock. The difference between the areas ("input" minus "output") represents "hysteresis loss." The hysteresis loss of rubber is very high.

Bouasse and Carriere in 1903 found that hysteresis diminished as the number of cycles increased, and finally reached an approximately fixed value. The difference between the first two cycles was found to be greater than that between any other two. Schwartz found in 1910 that the area of the loop became fixed much sooner in a high grade than in a low grade of rubber. He also found that when cycles were generated to a constant final load the increasing extension at the end of each cycle was proportional to the log of the number of the cycle in question. Also these workers found the shorter the extension the narrower was the hysteresis loop.

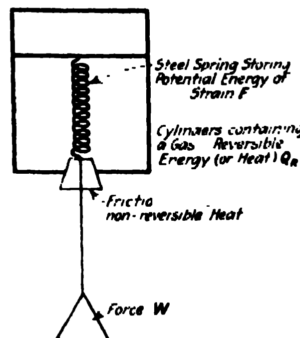
Another general rule laid down by Bouasse and confirmed by Schwartz is that the greater the speed of generation of the cycle the greater will be its area. You will at once appreciate the significance of this in regard to the internal heating of solid tires. Not only do excessive driving speeds multiply the number of loops per second and therefore the heat limited but they also actually increase the calories of heat generated per revolution of the wheel.

However, the area of the loop diminishes with increased temperature. It is quite fortunate that the reverse is not the case, since our solid tires and breaker strips in our pneumatic casings would go to pieces rapidly but for this compensating law. Incidentally, this temperature relation strongly suggests the resemblance in many respects of rubber to a viscous liquid. In fact, Shedd and Ingersoll use the term "viscosity loop" rather than hysteresis loop for this reason.

Thermal Phenomena. In 1805 Gough recorded that rubber increases in temperature on stretching. This was confirmed by Paige in 1847. Finally Joule also recorded the fact that while metals and other materials cooled on stretching, rubber became warmer. Lord Kelvin applied Le Chatelier's principle of equilibrium and predicted that stretched rubber must contract on heating. Joule confirmed this by experiment and this is now known as the Joule effect. The first stages of extension are accompanied by a slight cooling effect. The corresponding cooling which accompanies retraction of the stretched rubber is definitely less than the heating effect on the extension. This difference, representing the net increase in thermal content of the sample, is the exact equivalent of the hysteresis loop above referred to. This heat must be attributed to internal friction in the rubber.

Comparing the thermodynamical behavior of rubber with better understood systems will be of value. Gases when expanded or compressed isothermally develop pronounced thermal effects. In fact, the energy expended during compression is all turned into heat. Steel springs, on the other hand, are examples of systems which develop practically no thermal effects when deformed. All of the work done on the system appears as potential energy of strain.

Vulcanized rubber is intermediate between a gas and a steel spring. The accompanying figure contains the mechanical conception of rubber. A piston is moved downward by a force W. The rod passes through a friction member which furnishes lost or non-reversible heat Q_F. The steel spring takes up the potential energy of strain E. The cylinder contains a gas which when compressed gives Q_R, the reversible heat. Rubber is the reverse of this picture. Thus when a piece is stretched we have energy stored up as potential energy of strain.



Heat is given off, part of which is reversible and part irreversible or lost. The search for compounds and cures having Q_F (frictional or lost heat) a minimum is of extreme importance. Returning now to hysteresis. Mr. Wiegand's machine he describes as simple, being actuated by a helical spring which allows him to work at a speed of 20 in. per minute. He uses a wide test piece and special non-slipping grips. He has found that the area under the third up-curve differs but little from those following. Therefore his test pieces are given two preliminary stretches and are then remeasured and placed in the machine.

The question as to whether he should run to constant load or constant elongation he has not entirely settled yet. Experiments have been made running the loops to from 100 to 500 per cent elongation. He found hysteresis loss (ft.-lb. per cu.in.) when plotted against cyclic elongation enormously increased when past 300 per cent elongation. Therefore he chose 200 per cent elongation and runs all his cycles to this point.

He found that the state of cure has an influence on the hysteresis loss. Cures varying from 50 per cent of the optimum to 275 per cent were made. In general, an undercure showed increased hysteresis, and the minimum loss was obtained with overcured samples. However, taking other considerations such as aging, etc., into account, a cure slightly less than the optimum is desirable.

However, the actual magnitude of hysteresis loss as it varies with state of cure is very low, and consequently ply separation cannot be attributed to it. On the other hand, hysteresis shows a marked linear increase with increase in volume ratio of the active fillers—i.e., those able to store up energy such as gas black and zinc oxide.

It should be pointed out that while carbon black and zinc oxide both give high hysteresis loss the heat conductivity of the former is much less than the latter.

Tests on Tire Sections. To obtain a measure of relative hysteresis losses in tires Wiegand cut 1-in. sections of various tires, clamped one end to a rafter and suspended from the other a long pendulum. By measuring the time necessary for the pendulum to come to a stop he had a measure of the damping effect or the hysteresis loss in the section.

Thus a 3½-in. plain tread stopped in 6 minutes.

Minus the first ply of fabric it stopped in 7½ minutes.

Minus the second ply of fabric it stopped in 8 minutes.

The tread and breaker alone stopped in 21 minutes.

It was found that the hysteresis loss of all the rubber in the section amounted to only that of one ply of fabric. The time of swing of the pendulum was found to fit the equation $T_P = K_1 \times K_2^n$ where $n =$ the number of plies and K_1 and K_2 are constants. The state of cure of the tire was found to be without effect. Mr. Wiegand mentioned that a 5-in. cord tire swings three times as long as the same size in fabric.

The remainder of the paper was practically the same

as that recently published in the *Canadian Chemical Journal* and the *Rubber Age*, except that he showed photomicrographs of the various fillers along with the stress strain curves at different volume relations.

Gas or carbon black he characterizes as the "aristocrat" of fillers, being much superior to zinc oxide and all others. He placed 20 volumes of filler to 100 of rubber as the point beyond which overloading takes place for both zinc oxide and gas black.

Discussion. It was admitted by all that this was a most remarkable contribution and illustrates the aid a physicist can be to the science of rubber technology.

C. O. NORTH illustrated a new type of stress strain curing curve where the loads at various percentages elongation were plotted against time of cure. This method is of particular value in studying accelerated stocks. He also illustrated a corrected stress strain curve where the loads for the various elongations were corrected to the actual cross-section area. It was pointed out that for all stocks examined to date up to 50 per cent elongation and in some cases up to 200 per cent elongation the cure is a straight line—i.e., Hook's law holds. By taking a tangent to the corrected curve at zero the cotangent of the angle of inclination is a measure of the direction or slope of the curve and may be called the true modulus. It is possible that this value may replace the other physical tests in describing the physical properties of a stock.

CONTRIBUTION FROM THE U. S. RUBBER CO. LABORATORIES

The paper by J. F. SCHUFTER on methods for determining free sulphur and antimony tri- and penta-sulphides in golden antimony was withdrawn, and informally substituted by "The Organization of an Information Service in Connection With Industrial Research Organizations" by R. P. ROSE and J. H. REEL.

They stated that in a large corporation 2 per cent of the total turnover may profitably be spent for development, and of this about 2 per cent for information service. A description of the excellent library system of the U. S. company was given.

THE ACTION OF HEAT AND LIGHT ON VULCANIZED RUBBER

JOHN B. TUTTLE presented a paper on "The Action of Heat and Light on Vulcanized Rubber." The action of heat and light on vulcanized rubber is frequently spoken of as being identical, and oxidation is said to be the cause of the deterioration. From published and unpublished tests it is shown that the action of heat is one of change in the rate of the chemical reaction between rubber and sulphur and goes on throughout the entire mass, whereas the action of light is one of oxidation, taking place on the surface. Heat produces no change in the solubility of the rubber substance in solvents such as acetone and alcohol, whereas light breaks up the rubber molecule, forming decomposition products which are readily soluble in acetone.

Peachey Process of Vulcanization. Samples prepared by Mr. Dales of the B. F. Goodrich Co. and by Mr. Kratz of the Falls Rubber Co. were exhibited. Very nice thin sheets were secured by passing H_2S and SO_2 into dilute xylol solutions of rubber, combining them quickly and pouring on a glass plate. All attempts to vulcanize sheets of rubber by hanging first in one gas and then in the other resulted in surface cure only.

Contrary to Peachey's claim, sheets prepared by pouring treated cement on a plate do contain free sulphur which is about as much as is combined.

It was the consensus that the Peachey process is at present of theoretical interest only. Those who have investigated it closely are not nearly as enthused with the idea as some foreign papers would have us believe the English are.

SYMPOSIUM, THE ANALYSIS OF RUBBER

This symposium was led by W. W. EVANS.

The Tetrabromide Method: H. L. FISHER. The various methods were discussed. It was pointed out that in the Lewis method about five times as much potassium iodide should be used as called for. Mr. Fisher was unable to obtain checks with any tetrabromide method and was particularly unfortunate with the Lewis method.

Nitrosite Method: A. H. SMITH. To summarize Mr. Smith's remarks, he finds the nitrosite method more accurate than the tetrabromide, but it is not sufficiently satisfactory for routine.

Alcohol Soda Extract: H. E. SIMMONS. The fineness of the sample is of great importance. The results obtained are of qualitative interest only. This statement also applies to the chloroform extract.

Free and Total Sulphur: J. B. TUTTLE. The sulphur in stocks may be classified as

Sulphur added—free or combined.

Sulphur in reclaim.

Sulphur in organic fillers—oil substitutes, M R.

Sulphur in inorganic fillers—sulphides, PbS, ZnS, Sb_2S, Sb_2S_5, etc.; sulphates, $BaSO_4$, $CaSO$, $PbSO$; sulphites (in lead sulphate).

Sulphur in accelerators (thiocarbanilide, etc.).

Influencing the determination—PbCO, BaCO.

Decomposition of the rubber (*a*) Solution (Carius); (*b*) fusion.

The objection to nitric acid is that the fumes carry off some of the free sulphur, thus giving low results when the sulphur is high, as in a cushion stock. Tuttle recommends a combination of fusion and solution methods. Fusion with an alkali is necessary to decompose such materials as $BaSO_4$.

Do not evaporate down the solution from fusion. Keep it at 400 c.c. and the SiO_2 will not come out. Also do not blast the $BaSO_4$ precipitate. A Meker burner is satisfactory.

In determining free sulphur, bromine water as per Bureau of Standards method is giving good results.

The Parr calorimeter using Na_2O and the oxygen bomb for total sulphur were discussed. Satisfactory results in some instances were recorded.

Determination of Fillers: H. B. UNDERWOOD. Mr. Underwood found no solution method satisfactory. He prefers to use the ash method with suitable corrections.

During the discussion it was mentioned that the xylol-naphthalene method was perhaps the most satisfactory.

ELECTION OF OFFICERS

The following men were elected for the coming year: Chairman, W. W. Evans, B. F. Goodrich Co.; vice-chairman, C. W. Sanderson, Fisk Rubber Co.; secretary, A. H. Smith, Goodyear Tire & Rubber Co.; executive committee, G. D. Kratz, Falls Rubber Co.; J. B. Tuttle, consulting engineer, New York; C. W. Bedford, Goodyear Tire & Rubber Co.; H. E. Simmons, Akron University; J. R. MacGregor, Eagle Picher Lead Co.

Chemical Industries Likely to Lose Natural Gas Supply

By R. S. McBride*

THERE is a great prospect that chemical industries, among others, will have their natural gas supply cut off in certain important districts during the coming winter and it appears unlikely that these supplies will ever again be restored for these industrial uses. The indications of such drastic action on the part of the several state public service commissions having jurisdiction point to these conclusions definitely.

In the tri-state district of West Virginia, Pennsylvania and Ohio, where 70 per cent of the natural gas of the United States is produced and used, the state commissions have been co-operating, together with the commissions of Maryland and New York State, in the consideration of regulations regarding the conservation of gas. It is expected that these commissions will concur in and adopt the several resolutions which were proposed by the national committee on natural gas conservation which worked under the auspices of the Department of the Interior. A report of this committee dated June 11 recommends careful attention to the question of how industrial gas supplies may be curtailed in order to give adequate supply for the domestic users. The importance of this movement to chemical industries is obvious, for among those activities which will receive first attention are the ceramic manufactories, brick kilns, glass factories, carbon-black plants and others which are using natural gas in large quantities.

These five public service commissions have met several times already in conference. They met again on Sept. 10 to decide important policies, and the action above indicated is likely to result from their deliberations. Certainly the Pennsylvania commission gives clear intimation that this will be its findings unless new facts are developed.

*Engineering Representative ...aw-Hill C... D.

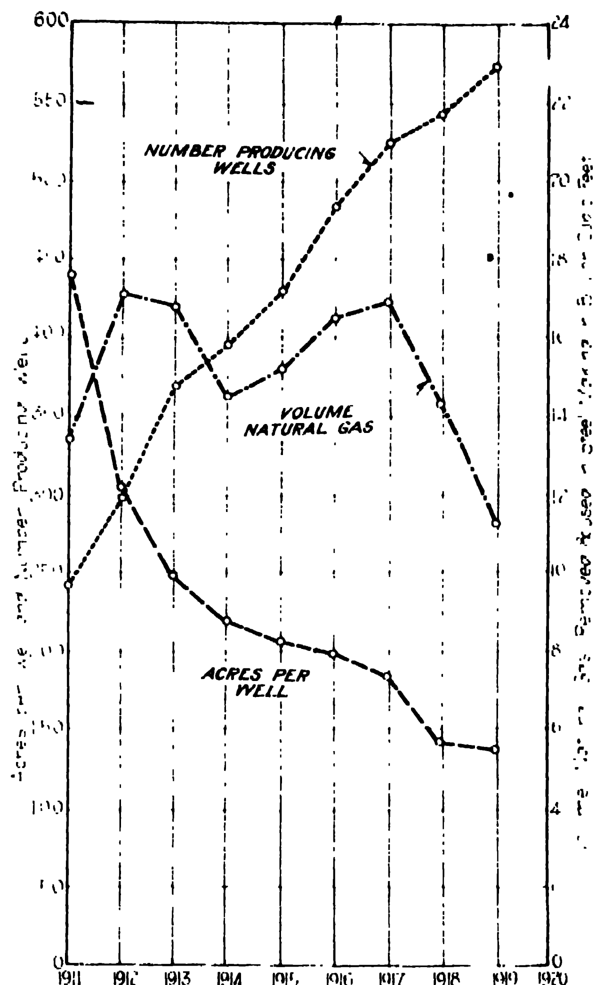


FIG. 2. DECLINE IN WEST VIRGINIA NATURAL GAS USED IN STEEL MAKING BY THE U. S. STEEL CORP.

Based on statistics filed with the West Virginia State Board of Public Works. The number of acres per well has declined from 138 in 1911 to 135 in 1919. The volume of gas removed has declined from 13.3 billion cu.ft. in 1911 to 11.2 billion cu.ft. in 1919. During the same time the number of producing wells has increased from 239 to 571.

The proportion of gas used for industrial and domestic consumers is shown in Fig. 1. (Prepared by E. G. Sievers, U. S. Geological Survey.) It should be noted that the total quantity of gas available for sale is now decreasing; and this decrease must be borne almost altogether by the industries, since as a matter of general policy it seems widely recognized that the domestic use is of superior importance in a community as a whole, and must be given priority. One of the indications that this effect is already noted is shown in Fig. 2, which was presented by Samuel S. Wyer in his report dated July 7 on the gas situation of the Philadelphia Co. of Pittsburgh. This chart shows the very striking decline in the quantity of natural gas used by the United States Steel Corporation for steel making.

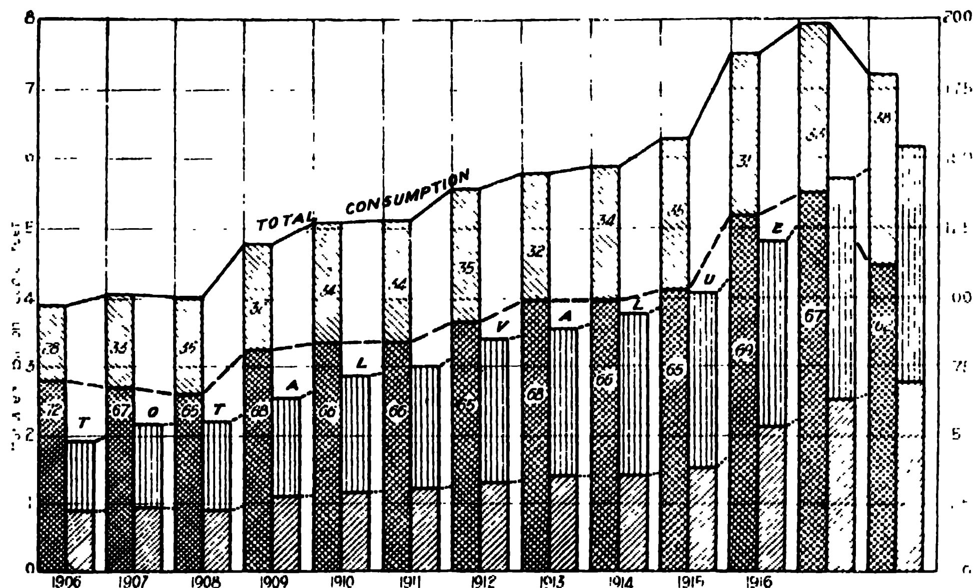


FIG. 1.

Diagram showing the quantity and value of natural gas consumed in the U. ... 1906 to 1918. The first bar shows at the bottom the per cent of industrial gas and at the top ... per cent of domestic fuel consumed. The second bar shows in the same order the value

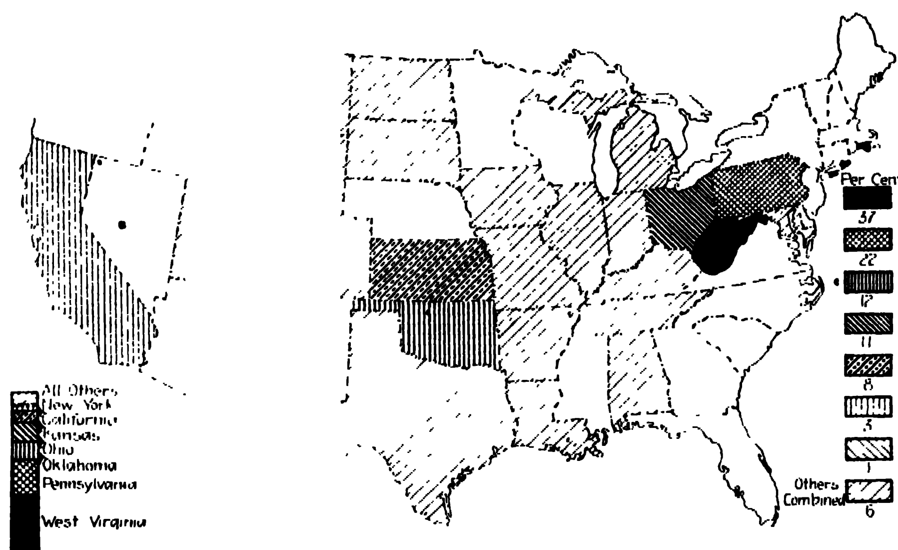


FIG. 3.
Map of United States, showing by states the percentage of natural gas produced from 1906 to 1918.

Fig. 3 (prepared by E. G. Sievers, of the U. S. Geological Survey) shows the dominating importance of the district in question, for, as indicated above, the three states, Pennsylvania, Ohio and West Virginia, jointly represent 70 per cent of the natural gas production of the United States. Moreover, it is to be expected that any conclusions reached with respect to this particular territory will also be adopted by the southwestern gas districts of Oklahoma, Kansas and Missouri, where the next largest proportion of gas production, 20 per cent of the total in the United States, is found.

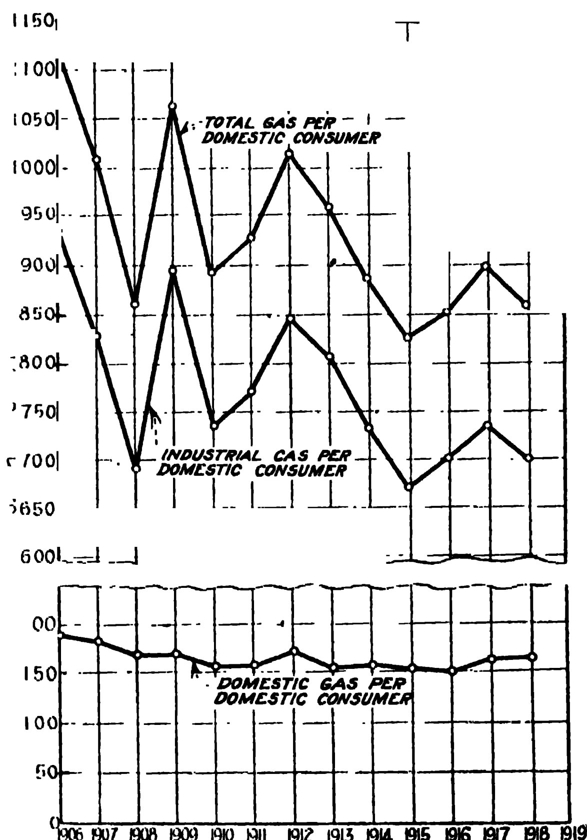


FIG. 4. DECLINE IN NATURAL GAS CONSUMED IN WEST VIRGINIA

Based on statistics compiled by the United States Geological Survey. The domestic gas per domestic consumer has declined from 188 "M" per annum in 1906 to 165 "M" in 1918, or a decline of 12 per cent. During the same period the industrial gas per domestic consumer has declined from 932 "M" per annum to 689 "M" per annum, or a decline of 26 per cent, and the total gas per domestic consumer has declined from 1,120 "M" in 1906 to 854 "M" in 1918, or a decline of 23 per cent.

That some curtailment of the industrial supply is to be expected seems certain. Naturally, use of gas under steam boilers will be one of the first uses attacked. This, however, will not be sufficient to accomplish the necessary improvement in domestic supply, and, as above indicated, the ceramic, glass making, carbon-black and related industries will doubtless be next in order for attention.

However, these industries are in a number of cases confronted with the necessity for use of a gaseous sulphur-free fuel, and where these particular uses can be demonstrated conclusively it is likely that the supplies will not be cut off until much more serious shortage is met. For example, certain of the glass-making processes, particularly flattening and annealing of plate glass, are accomplished with great difficulty when using any other fuel. A fuel containing sulphur is particularly objectionable because of the spotting effect on the plate glass. It seems important, therefore, that industries concerned in this problem should carefully analyze their needs and be prepared to present to the state commissions in due time their claims for special attention where these particular demands justify continuance of supply when other parts of the industries cannot be so favored.

France's Foreign Trade for First Seven Months of Year

French foreign trade continues to disclose the desired recuperation in the volume of exports, as compared with the imports, though the adverse balance remains formidable--more than 9 billion francs for the first seven months of the year. During this period, compared with the same period of 1919, there was an improvement of more than 7 billions in the exportations, the importations increasing nearly 3 billions at the same time. The gradual and sure increase in the amount of manufactured goods exported is an encouraging feature. This item shows an improvement of 4,603,984,000 francs over 1919.

The official figures in francs of imports and exports for the first seven months of 1920 and 1919 are as follows:

	Seven Months 1920	Seven Months 1919
Imports:		
Articles of food	5,395,180,000	5,706,445,000
Raw materials	10,153,394,000	7,369,082,000
Manufactured articles	6,212,168,000	5,946,713,000
Totals	21,760,742,000	19,022,240,000
Exports:		
Articles of food	1,088,721,000	528,315,000
Raw materials	2,775,208,000	763,235,000
Manufactured articles	7,594,169,000	2,990,185,000
Postal parcels	548,532,000	492,667,000
Totals	12,006,630,000	4,776,402,000

Segregation in Bars for Steel Tubing

BY HAROLD D. NEWELL

FROM a large number of analyses collected and tabulated it is shown to be by no means unusual, in bad cases of segregation, to find a difference of 50 per cent or more in the percentage of the impurities (sulphur, phosphorus, silicon, manganese, etc.) in the same steel ingot or bar designed for boiler tubing. Such examples of segregation are ordinarily associated with high analysis of original impurities and high temperature of the casting. An example of such an analysis is:

	Sulphur	Phosphorus	Manganese	Carbon
Top of ingot....	0.085	0.033	0.51	0.24
Bottom of ingot	0.032	0.019	0.47	0.15

This undue segregation has been prevented somewhat by allowing the metal to cool to the desired

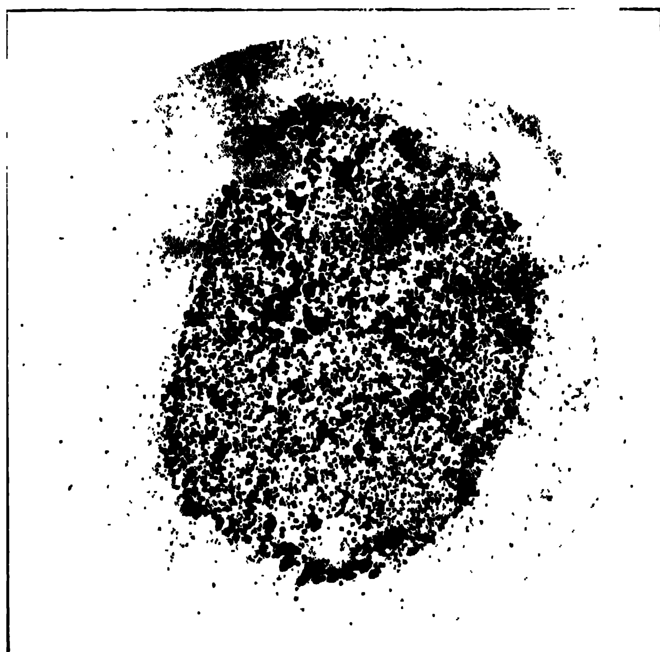


FIG. 1. SULPHUR PRINT SHOWING EXCESSIVE SEGREGATION OF FeS AND MnS

pouring temperature in the ladle, forming a skull of bad steel and slag on top of the heat, and pouring from under this skull. Steel makers, however, object to this practice, as it is expensive, the skull having to be put aside, broken up and remelted as scrap.

Provided care be taken in manufacture and the pouring be kept well under control, although there will always be some segregation, it should not be a serious matter in a good quality steel. It always occurs in rail steels to a greater extent than is desirable. It is advisable to keep the percentage of impurities in the ladle analysis as low as possible, because the proportion in which the segregating body is present will largely affect the result.

Casting of steel in large quantities undoubtedly favors unequal segregation or distribution; therefore, there will ordinarily be less segregation in a small ingot, especially if it sets and cools much faster than a large one. The rapid cooling on the outside of the ingot prevents segregation there, but the center, remaining fluid for a considerable time, allows the less soluble impurities to travel toward the center. Insoluble impurities, being specifically lighter than the steel, tend at

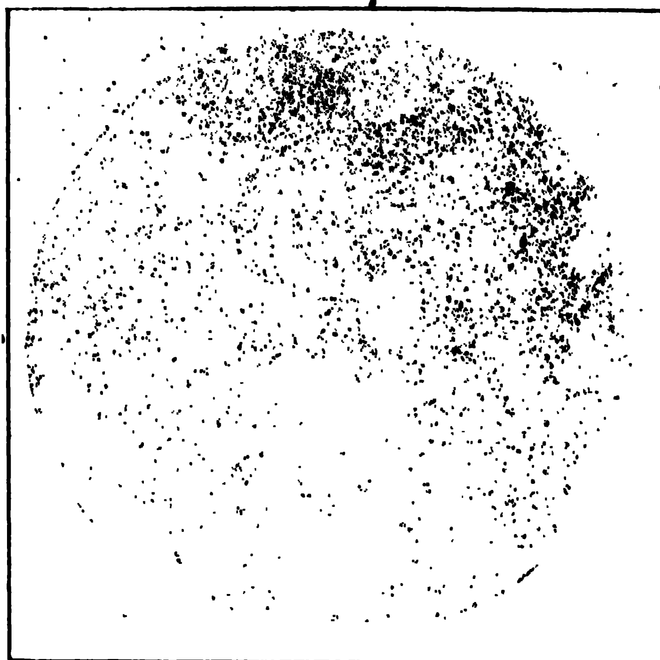


FIG. 2. SHEARED BAR SHOWING NO SEGREGATION

the same time to rise to the top of the ingot so that in the bottom center there will be less segregation than in the top center. Heavy cropping evidently is necessary to produce quality steel.

The author has been conducting a number of examinations for segregation in acid and basic steel ingots for boiler-tube steel with and without the additions of aluminum in the ladle. It has been concluded as a result that, in ingots to which no aluminum has been added, excessive segregation usually occurs down the central port of the ingot anywhere from 6 in. from the top to half-way down the entire ingot, sulphur tending to segregate the most, then phosphorus, carbon, and finally manganese. The effect of the addition of aluminum in the ladles as an oxidizing agent is to tend to reduce immediately the amount and depth of segregation.

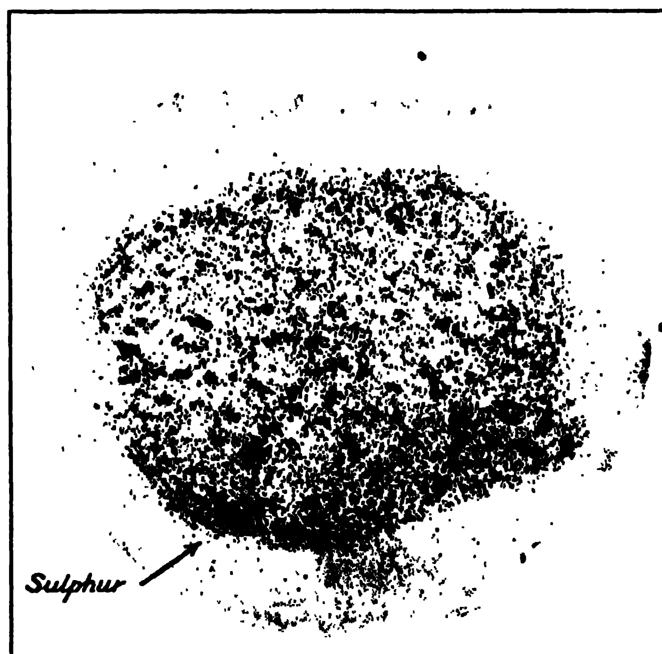


FIG. 3. SULPHUR SEGREGATION IN 3-IN. BAR FROM A BOTTOM-POURED BASIC OPEN-HEARTH INGOT

As is well known, steel tapped from the open hearth is usually more or less oxidized and contains a greater or less amount of iron oxide, which diminishes both its fluidity and strength. As this oxidized metal cools the oxide is partly reduced by carbon with the evolution of carbon monoxide gas, causing more or less violent ebullition and producing steel containing the well-known blowholes. Addition of small amounts of aluminum to such metal greatly facilitates the flow of metal from the ladle and also stops the violent evolution of gases, allowing the production of sound ingots without excessive blowholes. Two to five ounces of metallic aluminum per ton of metal is usually sufficient.

By suitable additions of aluminum blowholes, though always present, may be so reduced that finished material may be relied upon for our purposes. In most cases the blowholes weld up or are reduced

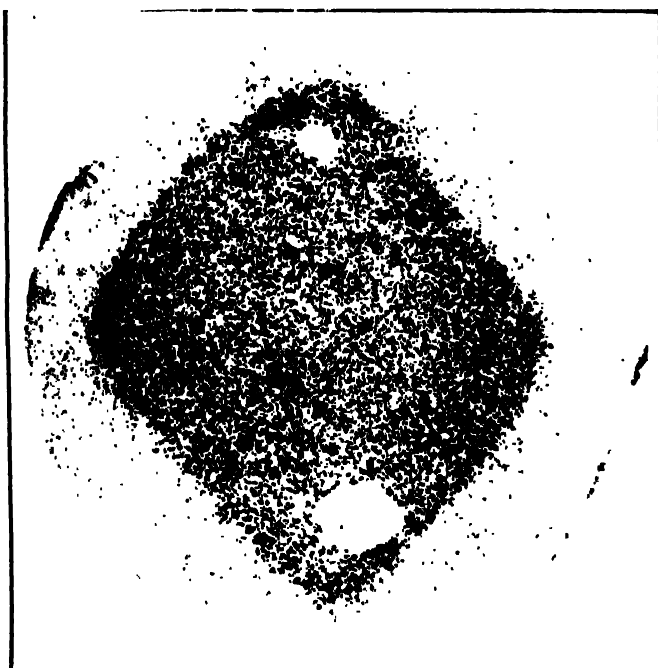


FIG. 1. SEGREGATION IN 3-IN. ROUND; ROLLED FROM A TOP-POURED SQUARE INGOT

to a minute size in the process of rolling. If this were not the case in carefully made steel, the production of sound tubes of thin gage would be impossible.

Sulphur Segregation in Steel for Boiler Tubing

Segregation of sulphur is the cause of considerable trouble in the manufacture of seamless boiler tubing. The usual chemical specifications are:

	Per Cent		Per Cent
C	0 10 to 0 15	S	under 0 035
Mn	0 35 to 0 55	P	under 0 030

A heat containing over 0.035 per cent sulphur usually causes trouble at the piercing mill because of the tendency toward red-shortness in hot-working.

The segregated ferrous and manganese sulphides are thought to become semi-fluid at the working temperature of the furnace, thus lessening the cohesion between the grains of the metal. Because of the unequal strain set up in the solid nearly sulphur-free shell (Fig. 1) and the semi-fluid mass comprising the hot axis of the bar under the piercing operation, inside seams and cracks develop which may even extend through the wall of the pierced billet.

Slag inclusions and dirty steel are also the cause of many rejections, as they produce tears and seams. Low-sulphur, bottom-poured basic open-hearth is always preferable for the manufacture of seamless boiler tubing. An example of what may be had is given in Fig. 2, which may be compared with Fig. 1.

Sulphur printing, using ordinary photographic paper, is a good way to keep tab on the sulphur segregation. Such prints showing excessive segregation of manganese and ferrous sulphide taken from rolled 3-in. rounds are given in Figs. 3 and 4. Ladle analyses for both cases conform with the above chemical specifications.

Pittsburgh Seamless Tube Co.,
Beaver Falls, Pa.

Condition of the Belgian Soap Industry

Soft soap is manufactured in practically every important Belgian center and while the factories are usually small there are several larger establishments which have entered foreign markets. Hard household soaps are produced mainly at Brussels, Verviers, Antwerp and Mons and are supplied in cakes, in blocks of all weights, in double bricks, and in yellow, brown, or marble color. Most of this production is used by home demand. Particularly at Verviers some soap manufacturers specialize in pure neutral soap which is used in the linen industry for glossing yarns and fulling fabrics. Toilet soaps are manufactured chiefly at Brussels, Liége, Verviers, Waterloo, Mons, Wavre and Tirlemont. Although importations are still large, the native article shows a tendency to replace the imported toilet soap. Soap powder, for household and industrial use, is a fairly recent innovation in Belgian factories and is almost exclusively made at Brussels, Verviers, Mons and Peruwelz. Medicinal soaps and specialties, such as transparent glycerine, tar, borax, floating bath, sand, pumice and beef-gall soaps, are also manufactured in Belgium.

Production of Soap

The following statistics give the comparative soap production in Belgium before and since the war:

Kind	1913	1919	Jan.-Mar. 1920
	Kilos.	Kilos.	Kilos.
Soft soap	17,000,000	3,903,000	2,092,000
Hard soap	6,700,000	5,561,000	2,680,000
Toilet soap	1,750,000	667,500	300,500
Soap powder	2,700,000	2,063,000	1,174,050

Many damaged soap factories were unable to begin work before March, 1919, and, aside from the shortage of raw materials, they met with active competition from American, French and British importers. During 1920 the demand has been most active for hard and powdered soaps, the producers of which were in a fair way to double their 1913 output until general market conditions cut off the demand.

Steps to Raise the Price of Rubber

A recent report from London states that, to raise the price of raw rubber, drastic steps are contemplated by the Rubber Growers' Association, which represents about one-third of the owners of 3,000,000 acres of rubber plantations. The association suggests to members that they so reduce tappings of rubber trees as to effect a reduction of 25 per cent in the output.

Metallurgical Industry in Belgium

THE Belgian metallurgical industry before, during and after the war is outlined by Emile Trasenster in the May 15, 1920, issue of *Revue Universelle des Mines*, pp. 271-320. The following is a succinct abstract:

The iron and coke industry during 1913 employed 39,500 workmen, and the coal industry 145,600 miners. There were forty-one coke plants with 2,898 coke ovens, producing 3,523,000 tons of coke, requiring 4,601,750 tons of coal, of which 39 per cent was imported. The consumption of fuel has increased in ten years from 20,228,000 tons in 1904 to 26,046,000 tons in 1913, whereas the production has remained practically stationary (22,761,000 tons in 1904 and 22,842,000 tons in 1913). During 1913, 8,856,153 tons of coal and 1,128,000 tons of coke were imported, as against 4,981,480 tons of coal and 1,002,000 tons of coke exported.





AT LEFT A BLAST FURNACE IN 1917, AT RIGHT THE SAME BLAST FURNACE NOV. 20, 1918

The fifty-four blast furnaces in operation produced 2,484,690 tons of pig iron, requiring 2,662,680 tons of coke, of which 24 per cent was imported, and 6,860,130 tons of iron ore, of which 84,900 tons—i.e., less than half of 1 per cent—was mined in Belgium, the remainder being imported mainly from France and Germany.

The 110 steel furnaces produced 2,466,630 tons of steel, of which 1,409,460 tons was finished steel; 110 puddling furnaces and 317 reheating furnaces produced 304,350 tons of finished iron and 448,400 tons of finished steel. There were in operation eighty hammers and 216 rolling mills for the production of the total of 2,162,210 tons of finished products, of which 1,161,425 tons was exported.

The total Belgian export of iron and steel during 1913 amounted to 1,762,170 tons, of which 213,203 tons was manufactured products. This represents an export of 81 per cent of the total produced. No other country in the world reached such a high percentage of export; the United States, France, Germany and Great Britain exporting for the same year respectively 5, 13, 30 and 44 per cent.

The iron and steel industry, relying as it did on exporting more than four-fifths of the entire production, had to put up a hard struggle against competition, especially when it is considered that the competitors (Germany, France, United States) had their own iron ores, whereas Belgium had to import, as stated above, more than 99.5 per cent of the ore it needed. This was made possible by the efficient methods used at the plants and by the special quality of the products manufactured.

Pre-War Production of Zinc and Other Metals

The Belgian zinc industry dates from the time Dony discovered the commercial production of zinc. His small shop in Liége, installed in 1808, was the cradle of the great zinc industry. In 1809 the zinc sold for 3.60 fr. per kg. (about 35c. per lb.). In 1810 Dony enlarged his shop and installed a plant of eight reverberatory furnaces with forty retorts, producing 200 kg. zinc per twenty-four hours. The price was then 2.60 fr. per kg. (about 25c. per lb.). The industry grew gradually until in 1913 there were 510 furnaces with 43,444 retorts and thirty-seven mills requiring 480,645 tons of ore, of which only 355 tons was mined in Belgium. The total production of zinc reached 204,225 tons, of which 87 per cent was exported.

In the zinc industry, as in the iron and steel industry, Belgium had to work hard to maintain its rank of a zinc-producing country (204,225 tons out of the total world production of 982,000 tons) with only 355 tons of zinc ores mined in the country and the other needed 480,290 tons imported from practically all the zinc-producing countries in the world.

Lead and silver are practically the only other metals produced in Belgium. In 1913 28,865 tons of lead ore, practically all imported, was treated for the production of 13,590 tons of lead; 132,220 tons of lead or silver byproducts and 48,890 tons of lead scrap were imported, from which 254,000 kg. of silver was recovered.

Situation of the Belgian Industry During the War

The Belgian metallurgical industry during the war suffered from the systematic devastation of the plants by the Germans, from lack of raw materials and from the cutting off of the foreign markets on which practically all the Belgian industry has to rely. A series of sixteen photos shows clearly the extent of the devastation.

The two views on page 747 show as a typical example what took place as late as 1918. Thus on the left is shown a blast-furnace installation as it was in 1917 and on the right the same furnace installation as it was Nov. 20, 1918, after all the useful parts, including the Cowpers stoves and cranes, were shipped to Germany.

Some idea of the depressing status of the Belgian metallurgical industries during the war might be obtained by analyzing the following table, which summarizes the metallurgical production of Belgium from 1913 to 1918:

PRODUCTION IN TONS

Year	Pig Iron	Steel	Zinc	Lead
1913	2,484,690	2,466,630	204,220	103,480
1914	1,454,490	1,396,300	145,925	70,980
1915	68,150	98,890	51,660	16,770
1916	127,825	99,371	22,930	15,560
1917	7,990	9,530	10,290	22,745
1918		10,540	9,245	20,630

The last Belgian blast furnace in operation was shut down in April, 1917. The production of steel in 1917 and 1918 was possibly due to the use of scrap iron as raw material and to two plants of the Province of Hainaut which for some reason enjoyed the particular good will of the Germans.

Reconstruction of the Belgian Metallurgical Industry

What this work implies may be surmised from the following table relating to the principal plants:

	Status Before the War, 1914	Status After the War In Working Condition
Coke ovens	2,554	993
Blast furnaces	59	4
Converters	49	8
Martin furnaces	26	19
Rolling mills	108	23

The smaller plants have undergone a similar fate.

The reconstruction work is making headway. Thus an official report stated that at the end of 1919 the iron and steel industries employed 60 per cent of the pre-war-time force, of which a great part was devoted to reconstruction work, and produced 34 per cent of the normal tonnage of iron products. During the same period the coke-oven plants employed 53 per cent of their pre-war force and produced 37 per cent of the normal coke tonnage.

The Belgians encounter many hardships in the struggle to revive their metallurgical industries. Among these hardships may be cited the depreciation of the money, labor conditions, lack of raw materials and what may be called *reverse dumping*. This consists in selling products at low prices in the country where produced and charging exorbitant export prices. Although these conditions handicap rapid recovery, the Belgians are working hard for the aim in view.

Synopsis of Recent Chemical & Metallurgical Literature

Composition of Coal Gas Obtained at Different Temperatures.—In studying the composition of coal gas obtained by the distillation of different coals at temperatures varying between 400 and 1,200 deg. C. and maintaining the temperatures at 600, 800, 1,000 and 1,200 deg. C. for some time and until only very small quantities of gas continue to distill at the considered temperature, LEO VIGNON (*Annales de Chimie*, May-June, 1920, pp. 288-292) has arrived at the following conclusions:

1. The unsaturated hydrocarbons C_2H_2, C_2H_4, C_6H_6 distill at below 600 deg. C.; at higher temperatures these hydrocarbons are broken up.

2. Methane and saturated hydrocarbons distill up to 800 deg. C. in very great quantities—namely, 60 to 84 per cent—but this percentage diminishes rapidly at a higher temperature.

3. The percentage of hydrogen in the distilled gas is from 2 to 25 up to 600 deg., is more abundant in the gas distilling between 800 and 1,000 deg., but decreases with gas obtained between 1,000 and 1,200 deg.

4. The percentage of carbon monoxide in the distilled gas varies between 3 and 11 (with an average of 6.5) according to the coal used, up to 850 deg. C. At temperatures above 1,000 deg. C. this percentage may reach 30 and even more.

5. By increasing the temperature of distillation the total volume of gas distilled increases, but the gas obtained at over 1,000 deg. C. has a low calorific value and contains in general great quantities of carbon monoxide.

Annealing Electrolytic Iron. — It is known that electrolytic iron contains quantities of hydrogen when leaving the electrolytic bath and that this gas forms hydrides, which are easily detected with the microscope, resulting in an increase of hardness. JEAN COURNOT

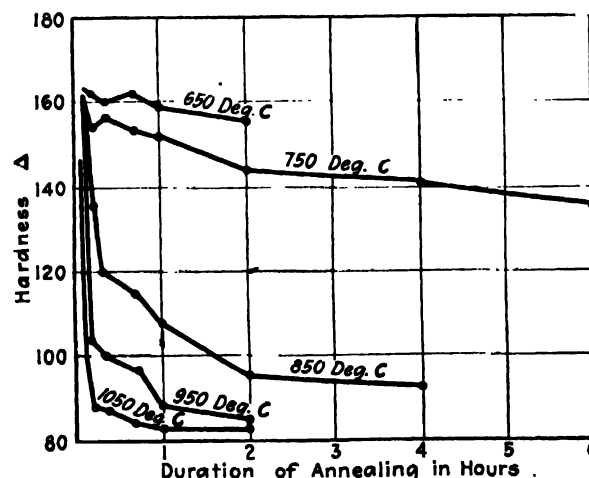
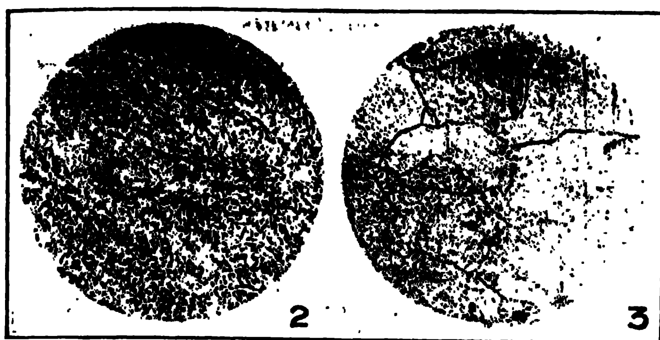


FIG. 1.

has worked out the necessary heat treatment for eliminating this hydrogen. He experimented upon test pieces, 6 cm. x 4 cm. in area, from a cathode sheet



FIGS. 2 AND 3. × 350

6 mm. thick, varying the time and temperature of annealing.

Brinell hardness as a function of time and temperature of annealing is shown in Fig. 1, from which it can be seen that during the first ten minutes of annealing there is a rapid fall in hardness, this the more rapid the higher the temperature. The limiting hardness is about 83, which is reached only after many days at temperatures below 850 deg. C., two hours at 950 deg. C. or one hour at 1,050 deg. C.

Micrographic results are as follows: After one hour heating, the sample polished and etched for twenty seconds by a 4 per cent solution of nitric acid in alcohol shows generally a polyhedric structure. Fig. 2 shows the sample before annealing, and Fig. 3 the sample after one hour. (*Génie Civil*, Aug. 7, 1920, pp. 118-119.)

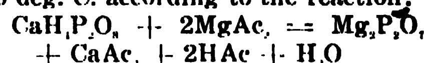
Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Ductile Nickel-Cobalt Alloy. — COLIN G. FINK has found that the non-ductility at ordinary temperatures of the alloys of nickel and cobalt is due to the presence of carbon in the alloy, and that such an alloy free from carbon, sulphur, phosphorus and basic impurities is ductile. An alloy containing twenty to thirty parts by weight cobalt and eighty to ninety parts nickel is produced in an electric furnace of the Coolidge type in an alundum crucible, special precautions being taken to prevent contamination with carbon, sulphur, etc., and when melted about two parts of manganese is added. The alloy may be rolled from 0.5 in. to 0.02 in. without intermediate annealing and is particularly suitable as a supporting and current lead wire for electric incandescent lamps, as it has but slight tendency to volatilize and spatter electrically. It has a low heat conductivity and therefore increases the efficiency of electric lamps, particularly in the case of miniature low voltage lamps. (1,342,993; assigned to General Electric Co., June 8, 1920.)

Cyanides From Ferrocyanides. — Ferrocyanide material—such as Bueb sludge obtained by treating coke-oven gas with ferrous sulphate—is added slowly to a boiling acid solution containing a small amount of finely divided copper. The acid used may be either H_2SO_4 or HCl. If the former is used, a small amount of NH_4Cl or other chloride is added to accelerate the reaction. While the ferrocyanide is being introduced, an equivalent quantity of acid is added until the solution becomes concentrated with iron sulphate or chloride. The feed of ferrocyanide is continued as long as it is completely decomposed, thus practically neutralizing the free acid. At this stage copper cyanide is precipitated and this together with the residue of metallic copper is filtered off and returned to the still for the treatment of the next batch. The vapors from the still pass through condensers and fractionating columns which separate the water and discharge it outside of the apparatus so that the capacity of the still is increased and a more concentrated solution of ferrous sulphate and ammonium sulphate obtained. The HCN which passes on through the column is absorbed in alkali to form cyanides. (1,347,518; MAX E. MUELLER, of Youngstown, Ohio; July 27, 1920.)

Pyrophosphates.—HYLEMAN A. WEBSTER, of Columbia, Tenn., has been granted a patent on a process of producing pyrophosphates without fire. He precipitates magnesium pyrophosphate from an acid solution of mono-calcium phosphate (20 deg. Bé.) and magnesium acetate at 60 deg. C. according to the reaction:



$$CaH_4P_2O_8 + 2MgAc_2 = Mg_2P_2O_7 + CaAc_2 + 2HAc + H_2O$$

The process used in the arts is according to the following reaction:

$$NaH_2PO_4 + MgCl_2 + NH_3 = NH_4MgPO_4 + 2NaCl$$

which upon heating to fusion temperatures $= Mg_2P_2O_7 + 2NH_3 + H_2O + 2NaCl$. As the acetic acid is worked in a cycle and would only suffer a percentage loss, it is apparent that the new process is the more economical. (1,346,148; July 13, 1920.)

Refractory Compound of Carbon and a Silicate Mixture.—A. J. HINCKLEY, of Niagara Falls, N. Y., produces a highly refractory article by combining fully shrunken and carefully graded carbon with high-grade fireclay. Hard coal is preferably used and should be as free as possible from laminations; this is calcined in an electric furnace to produce a fully shrunken product, which is graded by carefully screening out the over- and under-sized particles. The volume of the interstitial space is calculated and high-grade fireclay added in just sufficient quantity to fill the interstitial space. Water is then added to produce a plastic mass. After thorough pugging the heavy paste is ready for use. It is extruded under heavy pressure or may be tamped into place to form a furnace lining. After preliminary drying the article is burned at approximately 1,000 deg. C. The approximate volume ratio is 53 parts graded carbon particles to 47 parts finely ground fireclay; the carbon particles for a standard 9-in. brick are approximately 0.03 in. in diameter.

The product has a distinct electrical conductivity, the specific resistivity is of the order of 0.04 ohm. per c.c. It is mechanically strong and does not shrink or crack on exposure to very high furnace temperatures. At furnace temperatures higher than 1,000 deg. C. silicon carbide will be formed, this transformation producing an extremely refractory article. (1,346,959; July 20, 1920.)

Removal of Cobalt From Zinc Solution.—The usual treatment for the removal of impurities from the solution obtained by leaching zinc calcine with spent elec-

trolyte does not completely remove cobalt, the presence of which most adversely affects the subsequent electrodeposition of the zinc. DAVID AVERY and R. J. D. WILLIAMS have discovered that if the solution is treated with limestone for the precipitation of the iron and with finely divided zinc dust for the precipitation of any silver, arsenic, antimony, copper or cadmium that may be present (the usual method), the presence of arsenic more effectively secures the removal of cobalt. It is necessary to have a soluble arsenic compound present after the treatment with limerock; the treatment is more effective if the solution be heated to about 60 deg. C. and the addition of the zinc dust be made in stages. For complete removal of the cobalt a soluble compound of copper is also necessary and the presence of a small quantity of free sulphuric acid facilitates the precipitation. The agitation of the solution should be made without the access of air. (1,347,-200, assigned to the Electrolytic Zinc Co. of Aust. Prop. Ltd.; July 20, 1920.)

Refining of Metal in Electric Furnace.—When refining steel in an electric furnace of the Heroult type it is necessary, in order to operate economically using the basic process, to charge the furnace with molten metal and refine with low voltage arc. This low voltage limits the length of the arc, and a current of relatively high amperage is initially required to properly refine the charge. Following this treatment the amperage is reduced and treatment continued with a reduced power input at practically the initial voltage. This method of operation is slow and uneconomical, unless the metal be added in the molten state, and to be able to refine a solid charge it has been necessary to use a longer arc at a higher voltage; this brings up the output but introduces difficulty from the overheating of the walls and roof of the furnace.

In order to overcome these and other difficulties R. H. BULLEY, of Syracuse, N. Y., has developed a method of treatment which consists of initially applying a high-voltage relatively long arc to the charge and then reducing the length of the arc, at the same time keeping the kilowatt load practically constant. Suitable transformer and regulator equipment is described. (1,347,838; July 27, 1920.)

Electrolytic Concentrating Table.—H. H. GODFREY combines the action of a shaking concentrating table and that of electrolysis for the extraction of metals from ores. The bed of the table consists of a cathode and is made of a suitable material. At an adjustable distance above and parallel to the bed is a plate which constitutes the anode. The material to be treated is made into a pulp by the addition of a suitable electrolyte. (July 20, 1920; 1,347,026.)

Method of Producing Tungsten Alloys. — In the manufacture of tungsten steel considerable difficulty as well as a material loss of tungsten is experienced in adding the tungsten powder, the most suitable form of this metal, to the molten metal. Many methods have been tried to overcome these difficulties. J. H. DEPPELER has found that it is possible to compress the tungsten powder into dense coherent tablets and that these when added to a molten bath of the alloying metal sink to the bottom of the bath, the addition being accomplished without material loss of tungsten. (1,350,709, assigned to the Metal & Thermit Corp.; Aug. 24, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cymene.—*p*-Cymene is prepared from residual terpenes, boiling at about 175 deg. C., from the manufacture of artificial camphor or pine-needle oil fractions boiling at about 175 deg. C., which consist essentially of *i*-limouene, by chlorination followed by steam distillation of the product. The *p*-cymene may be purified by treating with zinc chloride or other condensing agent or oxidizing-agents such as potassium permanganate. (Br. Pat. 142,738—1919. BRITISH & FOREIGN CHEMICAL PRODUCERS LTD., London, July 7, 1920.)

Organo-Metallic Compounds.—Aromatic arsenic acids are obtained by the reaction of aromatic diazo compounds upon acids, neutral, or alkaline aqueous or dilute alcoholic solutions of arsenious acid, in the presence of a copper salt and a reducing-agent appropriate to the medium used. Suitable reducing-agents are: for acid solutions, hypophosphorous acid or a mixture of sodium hypophosphite and hydrochloric acid, or cuprous hydrate; for neutral solutions, sodium hydrosulphite or sodium formaldehyde sulphoxylate; for alkaline solutions, sodium hydrosulphite, formaldehyde hydrosulphite, or formaldehyde sulphoxylate, or the sodium arsenate itself used in excess. The process may be carried out in cold or at a moderate temperature; when working in acid solution, the diazo compound may be replaced by the aromatic amine in conjunction with sodium nitrite. Examples are given of the preparation of phenylarsinic acid in acid, neutral, and alkaline solutions, using copper sulphate as the copper salt, sodium arsenite Na_2HAsO_3 or a solution of arsenious acid in caustic soda or sodium carbonate solution as the source of arsenic, and sodium hypophosphite, sodium hydrosulphite, or the excess of sodium arsenite as the reducing-agent in the acid, neutral, or alkaline solutions respectively. The following products are specified also: *p*-methylphenylarsinic acid, *p*-chlor-phenylarsinic acid, *p*-chlor-*m*-nitrophenylarsinic acid, *p*-bromphenylarsinic acid, *p*-brom-*m*-nitrophenylarsinic acid, *p*-methoxyphenylarsinic acid, *p*-methoxy-*m*-nitrophenylarsinic acid, *p*-ethoxyphenylarsinic acid, *p*-ethoxy-*m*-nitrophenylarsinic acid, phenylsulphonyl-*p*-aminophenylarsinic acid, *p*-oxyphenylarsinic acid, *p*-oxy-*m*-nitrophenylarsinic acid, and *p*-oxy-*m*-urethanophenylarsinic acid. Sodium arsenite of the formula Na_2HAsO_3 is obtained by fusing arsenious oxide with two molecular parts of sodium carbonate, in absence of air, dissolving the product in water, evaporating to a sirupy consistency, and allowing to stand for some time at 30-40 deg. C. (Br. Pat. 142,947—1919. A. MOUNEGRAT, Paris, France, July 14, 1920.)

Indophenols. — Indophenols are obtained by finely grinding and intimately mixing together equi-molecular parts of *p*-nitrosophenol and the free bases diphenylamine carbazole or other amines yielding indophenols, and introducing the mixture slowly with stirring into cold concentrated sulphuric acid. Liquid amines such as *o*-toluidine are similarly mixed to a paste with *p*-nitrosophenol, and the paste treated as described above. The indophenol from *p*-nitrosophenol and phenol is prepared similarly. The provisional specification also describes a process in which *p*-nitrosophenol is ground and mixed with the sulphate of a liquid amine as *o*-toluidine, and

further treated as above. (Br. Pat. 143,014—1919. BRASSARD & CRAWFORD, Wakefield, Yorkshire, and E. A. BUCKLE, Westminster, July 14, 1920.)

Treating Lead and Silver Ores.—The lead and silver in complex sulphide ores containing zinc such as Broken Hill ores, are treated by mixing the ore with hydrochloric in quantity sufficient for the desired reaction, and heating to a temperature above 100 deg. C. The ore is mixed with the acid, dried at a temperature below 100 deg. C., and heated at a higher temperature which may be 500 to 600 deg. C., preferably in a closed vessel. The operation is facilitated if some copper is present in the ore. The mixture of ore and acid may be allowed to stand some time before drying, and the furnace product may be moistened and left for some time before leaching. The product may be leached with hot brine containing some ferric chloride to dissolve both lead and silver chlorides with a minimum time of contact between liquor and ore. (Br. Pat. 142,854—1919. AMALGAMATED ZINC (DE BAVAY'S), LTD., Melbourne, Australia, July 14, 1920.)

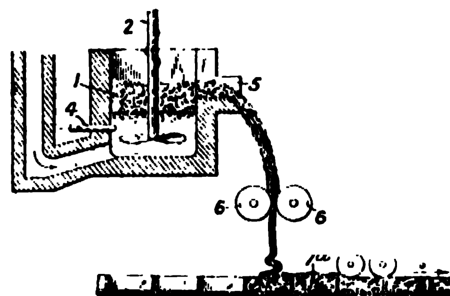
Chloropicrin.—Consists in preparing this by the action of chlorine or picric acid or other suitable nitro-derivative of a phenol or of a naphthol in the presence of water and a basic material, such as metallic oxides, carbonates, or borates, preferably sodium or potassium hydroxide or carbonate. The basic material may be added in successive stages or wholly at the beginning. The temperature is preferably kept below normal atmospheric pressure. (Br. Pat. 142,878—1919. K. J. P. ORTON, University College, Bangor, Carnarvonshire, and W. J. POPE, University Cambridge, July 14, 1920.)

Arylarsenious Halides.—Monoarylarsenious halides are obtained from di- or tri-arylarsines by treatment with arsenious halides; and diarylarsenious halides are also obtained from triarylarsines by treatment with monoarylarsenious halides or with arsenious halides. Solvent and catalysts may be added. On a large scale, mono- and di-arylarsenious chlorides are obtained by vaporizing arsenious chloride and passing the vapor through or over the surface of the molten triarylarsine. In other cases, the reaction is performed by heating a mixture of the ingredients in an autoclave or under atmospheric pressure. (Br. Pat. 142,880—1919. W. J. POPE, The University, Cambridge, July 14, 1920.)

Treating Rubber Tree Bark.—Bark shavings from rubber trees are ground and masticated between rollers heated to about 275 deg. F., so as to knead the rubber with the bark and convert the whole into a dough-like or plastic mass. The product, after being mixed with a vulcanizing-agent and vulcanized, is suitable for the manufacture of tapping-cups, coagulating-dishes, floor matting, etc. Alternatively, the vulcanizing agent may be added prior to grinding, and the raw material may be treated in a scrap-washer and creping machine in the known manner for the extraction of raw rubber. (Br. Pat. 142,926—1919. R. T. SMITH, London, July 14, 1920.)

Recovering Material From Linoleum Scrap.—In a process for working up linoleum scrap into new linoleum by treating with organic solvents, only sufficient solvent is used to soften the scrap and enable the jute fibers to be separated by mechanical means from the softened mass of binding cement, ground cork, coloring matter, etc. For example, 1,000 kg. of broken up linoleum scrap is treated with 500 kg. of alcohol in an autoclave for about two hours at a temperature of 80 to 140 deg. C., resulting in the reduction of the scrap to a soft crumby pulp. The alcohol is then distilled off, and the pulp is fed on to vibrating sieves to separate the jute fibers from the linoleum pulp. The regenerated substance is finally heated to a temperature of 100 to 120 deg. C. to restore the qualities of toughness and glutinousness of the binding cement, which had been depolymerized during the treatment with the solvent. (Br. Pat. 143,561—1919. V. SCHOLZ, Jauer, and C. TIEDEMANN, Coswig, both in Germany, July 28, 1920.)

Treating Slag.—Molten slag is converted into foam by blowing steam or other gas through it, and this foam is rapidly cooled to a temperature at which the slag is still plastic, but the porosity becomes stable, the resulting material being molded into bricks or the like and allowed to solidify. In an example, a slag



having the composition 50 per cent silica, 15 per cent alumina, 30 per cent lime and 5 per cent magnesia is introduced into a vessel 1 provided with a stirrer 2, at a temperature of about 1,400 deg. C. Water or water and steam or other gas is introduced through an opening 4, and, on stirring, a foam is produced at a temperature of about 1,000 deg. C, which flows through a conduit 5 on to water-cooled rollers 6, whence it emerges as a ribbon at about 800 deg. C., which falls into cast-iron molds on a conveyer 7" which moves in the direction of the arrow. Rollers 8 level the surface and remove any excess of foam. The foam may be further cooled by an air or like blast between the rollers 6 and the molds. If objectionable gases are produced during the conversion into foam, the operation should be carried out in an oxidizing atmosphere. (Br. Pat. 143,500—1919. NORSKE AKTIESELSKAB FOR ELEKTROKEMISK INDUSTRI, Christiania, July 21, 1920.)

Waterproofing Paper.—Paper is waterproofed and rendered impervious to air so that it may be used as a substitute for rubber or leather for making diaphragms for gas meters and gas lighters, or for the manufacture of purses, etc., by impregnation with a warm solution of animal and vegetable glutinous substances, followed, after drying, by rubbing in fat, whale oil, etc. Long-fibered paper, such as japan paper, is preferably employed. A suitable impregnating solution consists of gelatine 2 parts, agar-agar or arrowroot 1 part, potassium bichromate 0.5 part, calcium chloride or glycerine 3 parts, and ammonium carbonate for reducing flammability 3 parts, all dissolved in 100 parts of water. Gelatine alone may be used when brittleness is not objectionable, and the after treatment with fat or oil is necessary only when the material in use is alternately wetted and dried. (Br. Pat. 143,235—1919. L. HEILBRONNER, Stuttgart, July 21, 1920.)

Anthraquinone.—Crude anthraquinone is purified by heating it dissolved in an inert solvert with alkaline substances (aqueous solutions of caustic alkalis, alkali carbonates, calcium hydroxide, etc.) or sulphuric acid; chlorbenzene or coal-tar naphtha are specified as suitable solvents. (Br. Pat. 143,885—1919. KINŽLBERGER & Co., Prague, Czechoslovakia, July 28, 1920.)

Acetaldehyde.—In the manufacture of acetaldehyde by passing acetylene into acid solutions containing mercury salts, the catalyst is continuously regenerated in the reaction liquid by electrolytic oxidation, the arrangement being such that excess of metallic mercury is always present at the anode. The reaction liquid may contain large quantities (over 10 per cent) of mercury salt, the rapid reduction of such concentrated solutions to mercury being offset by the anodic oxidation of the reduced mercury. Examples are given in which (1) the liquid contains at the commencement both dissolved mercury salt and a mercury anode; (2) the liquid at the start contains only mercury salt, the reduced mercury collecting and being oxidized at a platinum anode; (3) the liquid at the start contains only a mercury anode, the current of acetylene not being passed until sufficient mercury salt has been formed by the electrolysis. Sulphuric acid is employed as reaction liquid in the above-mentioned examples, but other inorganic or organic acids may be used. The cathode may be of mercury, lead, platinum, etc., and may be enclosed in a diaphragm chamber or not. (Br. Pat. 143,891—1919. CHEMISCHE FABRIK GRIESHEIM-ELEKTRON, Frankfurt-on-Main, July 28, 1920.)

Artificial Filaments and Fabrics.—An artificial textile fabric is made from filaments prepared from solutions of, for example, viscose, cuprammonia cellulose, collodion, gelatine or cellulose acetate, and in which are incorporated bubbles of air or inert gas; fabrics manufactured of such hollow filaments are very light, opaque and soft to the touch. The introduction of air, etc., bubbles is effected by forming an emulsion of the selected solution and air—for example, by directly blowing in air, or by means of injectors, or by heating devices—and the emulsion can be made more permanent by the addition of soap, albumen, gelatine, etc. The process is applicable to the manufacture of continuous filaments such as threads for spinning, or films, plates or bands, and also of non-continuous filaments such as tops and noils. (Br. Pat. 143,253—1919. L. DRUT, Villeurbanne, France, July 21, 1920.)

Fibrous Compositions.—Vegetable fibers are mixed with casein in the form of paste and the mixture is molded under pressure and heat. In an example, fibers are immersed in a bath containing one kilo of casein paste consisting of 88 per cent casein and 12 per cent ammonia to 15 liters of water. The fibers are drained, placed in molds, compressed, and heated to about 130 deg. C. to drive off the water and ammonia. Lime, carbonate of magnesia, borate of soda, etc., may replace the ammonia. Articles may be ornamented by coating them with sawdust before molding. (Br. Pat. 143,258, 1919. E. E. MOUGEON, Monteux, France, July 21, 1920.)

Dialkyl Sulphates.—Dialkyl sulphates are prepared by the reaction of sulphur trioxide as such or in the form of fuming acid, upon the alcohols in the presence of dehydrating-agents—e.g., phosphorus pentoxide or anhydrous sodium or copper sulphate; diluents such as carbon tetrachloride may be added; the product of the reaction is worked up by distillation *in vacuo*, extraction by solvents, etc. Examples are given of the preparation of diethyl sulphate. (Br. Pat. 143,260—1919. L. LILIENFELD, Vienna, July 21, 1920.)

Purifying Fats, etc.—Edible oils, fats and the like are purified by converting any fatty acids present into glycerides *in situ*. In an example, 1 lb. of palm or coconut oil and 2 lb. of glycerine, with a contact substance, such as kieselguhr or titanium dioxide deposited on kieselguhr, are sprayed or agitated together in a vessel maintained at about 140 deg. C. and under a vacuum of about 28 in. for, say, fifteen hours. The product is allowed to settle and the oil decanted, washed with water and filtered. Hydrogenation, deodorization and purification as described in Specification 135,295 may proceed at the same time or after esterification. (Br. Pat. 143,321—1919. G. CALVERT, Twickenham Park, Middlesex, July 21, 1920.)

Dyeing With Mordant Dyes.—Meta-tungstic acid or compounds or salt thereof—e.g., phosphotungstic acid, silicotungstic acid or antimony-tungstic acid—are employed in dyeing textile fibers, paper, wood, leather, gelatine, etc., with acid dyes containing amino and sulphonic groups; either the tungstic acid compound is added to the dye-bath or the dyeing is after-treated therewith. The tungstic acid compounds are also used in making lakes from the dyes in question. Examples are given of the dyeing of wool, paper pulp, and leather, and of the manufacture of barium-aluminum lakes, phosphometatungstic acid being used in each case. (Br. Pat. 143,242—1919. FARBENFABRIKEN VORM. F. BAYER & Co., Leverkusen, near Cologne, July 21, 1920.)

Gray Iron.—In the production of gray iron in two stages, a white iron is first obtained by smelting at a temperature of 1,200 to 1,300 deg. C. and the product is refined in an electric or other furnace at a temperature of 1,500 deg. C. with additions of carbon and silicon. The white iron, if smelted in an electric furnace, contains carbon 2 per cent, silica 0.5 per cent and sulphur 0.3 per cent; when a blast furnace is used the iron contains 3 per cent of carbon. The refined product contains 3 per cent of carbon and 1.5 per cent of silicon. (Br. Pat. 143,596—1919. G. J. STOCK, Bradford, Yorkshire, July 28, 1920.)

Purifying Coal Gas.—Carbon disulphide, thiophene and similar impurities in coal gas are dissociated to form sulphuretted hydrogen by passing the heated gas over heated alumina, bauxite or ignited magnesite. The sulphuretted hydrogen is then removed from the gas by the usual methods. When the efficiency of the material has become impaired, owing to the deposition of carbon, it may be revivified by the passage of air over the heated mass. (Br. Pat. 143,641—1919. F. W. BERK & Co. and J. J. HOOD, both of London, July 28, 1920.)

Cementation.—A mixture used in the cementation of iron and steel at a temperature of 700 to 800 deg. C. contains potassium ferro and ferri cyanides, potassium chromate or bichromate, and charcoal. Large articles are preferably preheated before insertion into the mixture. The metal may afterward be hardened in a bath containing seasalt together with ammonium chloride or caustic soda, or both. (Br. Pat. 143,746—1919. M. L. M. LUTTENSCHLAGER, Mulhouse, July 28, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Sub-Committee on Standardization of Petroleum Specifications to Convene

The Technical Sub-Committee of the Committee on Standardization of Petroleum Specifications, appointed some time ago by President Wilson, will hold a meeting at the offices of the Bureau of Mines, Washington, D. C., on Monday, Oct. 18, at 10 a.m., to give further consideration to Government specifications on gasoline, kerosene, fuel and lubricating oils. The meeting is to be open to all persons interested, and it is the desire of the committee that as many representatives of the oil refining and automotive industries as possible be present.

Dr. G. W. Gray, of New York, chairman of the committee, particularly requests that any refineries who feel that the present specifications may be unjust send their technical men to this meeting, as the committee intends to take up all the specifications for petroleum products that have been issued up to the present time with a view to possible revisions. This includes the specifications for Government purchase of gasoline, kerosene, fuel and lubricating oils.

The committee also plans to consider new specifications for lubricants and other products.

Coal-Tar Trust Formed in Germany

Official advices reaching Washington tell of the formation in Germany, under legal authority, of an economic union to regulate the coal-tar trade. The organization is composed of practically all concerns engaging in the coal-tar industry. The organization is to supervise import and export matters, but is precluded from reducing importations for the purpose of maintaining high levels or prices in Germany. A committee has been appointed to fix prices at which coal tar, tar oil and briquet tar are to be sold. Another committee is to decide what amount of crude tar is to be assigned to the various plants.

Only such plants will be recognized as legal refineries as conform to certain technical standards and agree to abide by prevailing prices.

The formation of this union is regarded as very significant by some officials in Washington since they see in it a continuation of Germany's pre-war methods of meeting competition abroad.

Plenty of Cars for Fertilizers

Through an arrangement made between the National Fertilizer Association and transportation authorities the movement of fertilizers during the season just closed was highly satisfactory despite the transportation shortage. Under the agreement box cars were to be furnished for 75 per cent of each plant's daily requirements. To offset the smaller number of cars furnished the shipping season was begun one month earlier. By extending the season the entire tonnage was moved to the complete satisfaction of the National Fertilizer Association.

Working for Soil Improvement

The work of the Soil Improvement Committee of the National Fertilizer Association is to be expanded materially. The main office of the committee has been moved from Chicago to Washington. A branch office will be continued in Chicago, but the Baltimore office of the committee has been closed. W. D. Hurd is the director of the committee. The main function of Dr. Hurd's organization is to encourage the proper use of fertilizer and to conduct an educational campaign among the farmers of the country looking to the more general recognition of the importance of fertilizers in economical farm management.

Dr. Hurd is of the opinion that fertilizers are going to be called upon to play an increasingly important part in agriculture, due to the increase in labor and other costs. Each year more farmers become aware that there are few soils which possess all the constituents for the maximum plant growth. During the transportation shortage and other conditions arising out of the war fertilizers have not been used to the extent necessary. As a result the demand for fertilizer is expected to increase very materially as soon as conditions are nearer normal.

One of the matters now receiving particular attention by the Soil Improvement Committee is the effort to bring home to the farmer the advantage of purchasing high-analysis fertilizers in preference to those of low analysis. There is an additional reason for urging such purchases since the increase in freight rates because the more concentrated product is relatively cheaper to transport.

Industrial Information Bureau in China

Of interest to those who do, or desire to do, business in China is the announcement that beginning with February, 1921, the Government Institute of Technology at Shanghai, China, will open a Bureau of Information for Alumni. The school is under Chinese Government support and prepares engineers and railway administration men with a technical education equivalent to that of an engineering school. These men often are located away from the port cities, and when they desire information regarding equipment they find it difficult to obtain it. To meet this need the school is about to open this bureau. Manufacturers who are interested are invited to send catalogs, specifications, designing data, approximate costs, samples or models. In case samples are sent an attempt will be made to place them in running order. No sales will be made or attempted. Impartial information alone will be offered.

A member of the faculty is now in America on leave and he will be glad to communicate further with any who desire information regarding the Chinese field. Address H. A. Vanierbeck, 5 Canmann Pl., Somerville, N. J., until Dec. 1, 1920, and Box 951 U. S. P. O., Shanghai, China, after that date.

Exports of Dyes and Dyestuffs From the United States

Dyes and dyestuffs exported from the United States to the various countries during August amounted to $2,111,095, of which $1,151,196 worth was aniline dyes and $336,718 worth was logwood extract. China was by far the largest importer of these goods, the trade being valued at $547,311. Exports to England amounted to $318,332. The value of the exports of dyes and dyestuffs to the various countries from the United States during August, 1920, is shown in the following table:

Countries	Aniline Dyes	Logwood Extract	All Others
Belgium	$73,765	$4,557	$9,000
Denmark	1,749	1,553	664
Finland	2,060		
France		57,581	19,756
Greece	7,848		4,688
Italy	46,989	88,969	9,697
Netherlands	416	8,069	940
Norway	1,644		
Portugal	9,746	3,000	10,424
Spain	4,748	4,670	19,329
Sweden	27,857		290
Switzerland	2,860	3,462	3,500
Turkey in Europe	3,500		
England	41,617	130,759	145,956
Scotland	1,400		14,507
British Honduras			18
Canada	96,957	17,747	78,756
Costa Rica			580
Guatemala			16
Honduras			31
Nicaragua			30
Panama			1,245
Salvador	1,100	13	
Mexico	99,957	428	5,064
Newfoundland and Lab.			1,555
Trinidad and Tobago	17		106
Cuba	3,873	7,568	1,240
Dominican Republic	1,338		
Argentina	81,931		19,274
Brazil	41,045	1,453	14,492
Chile	4,700		627
Colombia	6	100	870
Ecuador	1,977	50	100
British Guiana			9
Peru	17,303	145	130
Uruguay	3,291	.	252
Venezuela	1,742		
China	366,893	84	180,334
British India	77,935		34,956
Straits Settlements	240		959
Dutch East Indies	1,060		
French Indo China	9,400		
Hongkong	71,916		28,474
Japan	33,454	3,000	8,744
Turkey in Asia			1,060
Australia		3,510	1,318
New Zealand	379		158
Philippine Islands	5,800		1,985
British South Africa			2,197
British East Africa			650
Egypt	2,683		
Total	1,151,196	336,718	623,181

Chemical Manufacturers Participating in Crop Protection Institute

Eleven manufacturers of insecticides and fungicides have already indicated their desire to become company members of the Crop Protection Institute, organization of which was completed under the auspices of the National Research Council on Sept. 28. This organization has planned to foster research and co-operation in plant life protection, use of insecticides and fungicides, and similar or related activities. The officers who are serving at present are: Chairman, W. C. O'Kane, New Hampshire State Entomologist; secretary, H. E. Howe, National Research Council; treasurer, G. R. Cushman, General Chemical Co. The board of trustees will be made up of thirteen persons appointed as follows: Three by the American Association of Economic Entomologists, three by the American Phytopathological Society, two by the Association of Official Agricultural Chemists, one by the National Research Council, three by manufacturers of insecticides and fungicides and one by the manufacturers of equipment and supplies used in this industrial work.

Additions to Carnegie Tech Faculty

The faculties of the division of science and engineering and of the division of industries of the Carnegie Institute of Technology have been strengthened this year by a large number of new appointees. In the division of science and engineering are C. R. Clutter, Lauren C. Hand and Frank E. Rupert, instructors in chemical engineering; R. W. Boreman, W. H. Michner and A. Press, instructors in physics; Charles A. Blodgett and Fred J. Evans, instructors in civil engineering; W. S. McKee, instructor in machine design; David C. Saylor, instructor in mechanical engineering; W. A. Copeland, instructor in metallurgical and mining engineering; W. Z. Price, assistant professor in mining engineering, and C. G. Simpson, instructor in the mechanics department. In the division of industries are Charles B. Walker and F. N. Talley, instructors in chemistry, and James Creech, instructor in presswork, in the printing department.

May Load Less Phosphate Rock

Loading and unloading requirements applying to phosphate rock have been reduced on Shipping Board vessels. This concession is the result of conferences, extending over several months, between officials of the Shipping Board and of the National Fertilizer Association.

Prior to the new arrangement it was necessary to load and discharge vessels at the rate of 1,200 tons daily. In the future the requirement will be 1,000 tons daily in loading vessels and 800 tons daily in removing the cargo.

The new regulation affects the large tonnage of phosphate rock which moves in coastwise traffic from Tampa, Port Tampa and Boca Grande, Fla., to Savannah, Charleston, Wilmington, Norfolk, Baltimore, Philadelphia, Carteret, N. J., and Boston.

Personal

E. B. BALL, Assistant Secretary of Agriculture, spoke before the Chicago Chamber of Commerce recently on the world food supply's dependence on science.

Dr. G. HOWARD CARTLEDGE has recently been appointed associate professor of chemistry in Johns Hopkins University.

CLINTON V. CONLEY, who received his master's degree at the University of Chicago this month, is now research chemist for Procter & Gamble Co., Cincinnati, Ohio.

HERBERT HOOVER has been appointed a member of the advisory board for the Eastern Industrial Region Superpower Survey, now being conducted by the Geological Survey. Mr. Hoover will serve as consulting mining engineer on the board, which is assisting the Government in the development of plans for a vast superpower system stretching from Boston to Washington and designed to supply electrical power to railroads, public utilities and private industry throughout that territory.

Dr. OLIVER KAMM has resigned his position as assistant professor in organic chemistry in the University of Illinois in order to accept one as director of research for Parke, Davis & Co., of Detroit, Mich. Dr. Kamm was formerly chief of the research section of the department of technical control of the American Writing Paper Co., Holyoke, Mass., and still retains his connection with that company as a member of its consulting staff.

DR. A. B. MACCALLUM, formerly administrative chairman of the Honorary Advisory Council for Scientific Research of Canada, has been appointed professor of biochemistry at McGill University, Montreal, Canada.

R. J. QUINN has recently been appointed Chicago district sales manager of the Mathieson Alkali Works, with an office at Room 617, Webster Bldg., 327 South La Salle St. The plants of this company are located at Niagara Falls and at Saltville, W. Va.

HENRY N. THOMSON, at one time head chemist for the Anaconda Co. and later superintendent of International Smelter, Tooele, Utah, has been appointed to the chair of metallurgy, University of British Columbia, Vancouver.

The following have become members of the staff of the department of chemistry of the College of the City of New York: Wyly McGee Billing, Harry P. Coats, Alexander Cohen, Alexander C. Glennie, Nathan Hecht and Foster D. Snell.

Additional appointments of research associates at the Bureau of Standards have been made as follows: E. N. Turnquist and G. G. Sward, appointed by Sears, Roebuck & Co., to study methods of standardization of mechanical devices and physical properties of products and standardization of commercial articles from a chemical basis. H. M. Westergaard, by the American Concrete Association, to work on investigation of flat-slab concrete and tile structures. C. J. Whittlesey, by the Gypsum Industries Association, to work upon the properties of gypsum products. J. P. Cockey, by the Super Cement Co., Ltd. (America), to participate in oil investigations in connection with cement.

Current Market Reports

The Iron and Steel Market

Pittsburgh, October 8, 1920.

The iron and steel market, generally speaking, is losing strength at the moment more rapidly than was expected. That a general readjustment had begun was recognized some time ago, but of late it has been thought that the momentum of the industry would carry it through the year or perhaps through the winter, with respect to tonnage output. By a close analysis it may be taken that the real turning point occurred as early as June 1, buying since then having been on a conservative scale, except that on account of the Steel Corporation quoting much lower prices than the independents its business kept up, no decrease in unfilled obligations being shown until the month of August. In the case of pig iron there were advances in nearly all districts in August, but the buying movement was extremely small, and the price advances could almost be said to be simply "on paper." The advanced prices were at any rate paid in few cases except for very early deliveries, so that in essence they represented a delivery premium.

Even should the production of steel decline sharply in the next few weeks, the industry woudl really have run on its momentum for some time. The market had been supported, moreover, by the scarcity of deliveries produced by rail transportation conditions, which became poor before consumers had been able to stock up after the scarcity produced by the steel strike inaugurated only a trifle more than a twelvemonth ago.

PRODUCTION

The beginning of curtailment in steel production seems to have begun, but the cases are few, involving only some mills that had been seeking the highest possible prices, and thus had leaner order books than the average mill. Production of steel at the present time is at the highest rate since before the rail strikes began April 1, there having been a continuous increase since July. The probability is that October as a whole will show the heaviest production since March, and the output may even make a new record entirely, as the operations of the larger mills easily overbalance such curtailment as is in prospect for some of the smaller mills. The March production rate in ingots was about 45,200,000 tons per annum.

PIG IRON DECLINING

In the past pig iron prices have always been more sensitive to adverse influences than steel prices, perhaps because pig iron contracts are customarily carried out, while many steel contracts are in the nature of options, and if a mill reduces its open prices it is likely to be called upon to adjust contracts it is carrying on its books. At the present time, therefore, particular attention is being given in trade circles to the pig iron market. Actual values are recognized as being distinctly lower than the prices attained in the advance last August, but a difficulty is that inquiry is so light that actual market prices are but slowly developed, and in most cases there is simply a nominal market price, the real value not having been indicated by actual transactions. At the end of August the valley market was quotable, after the advances, at $48.50 furnace for bessemer and basic and at $50 for foundry and malleable. On a small transaction, as noted in last report, the valley foundry iron market became quotable at $47. Now there are negotiations on basic iron, one or two buyers expecting to do about $40, and quotations are understood already to have been made at $44 or $45. There is a report of one sale at $46. In the course of a few days enough business will probably have been done to show where the market stands for the time being.

NO INQUIRY IN BESSEMER

In bessemer there has been no inquiry and the market has to be quoted at $48.50 in lieu of any distinct information to the contrary, although no one doubts that on an inquiry for a few thousand tons one could secure a considerably lower price. The one thing that seems clear at the moment is that those who predicted, during recent advances, that pig iron would eventually decline as rapidly as it was then advancing were conservative. Indications now are that it will decline more rapidly.

STEEL PRICES

On account of the large amount of business independent steel makers as a whole have on books there is resistance to price declines, but the resistance is not adequate in all cases. In the case of plates 3.25c., which it was thought would prove a sticking point for the market as the delivery premiums disappeared, is now not a minimum but a price "to shoot at," to use an expression common in the trade, the mill usually feeling that the price must be shaded in order to secure an order. A very unattractive specification has been placed at 3.15c., while a fairly desirable order can be placed at 3.10c. and on a lot of several thousand tons of car plates the flat price of 3c. has been made. The Steel Corporation, which has adhered to the Industrial Board price of 2.65c., is receiving the bulk of such business as comes out. In structural shapes the 3.10c. price which was recognized as the minimum of the independents has been shaded to 3c. Bars, however, seem quite firm at 3c.@3.25c. Sheets are softening a trifle, but mills are so well sold up that there is little competition.

The Chemical and Allied Industrial Markets

New York, October 8, 1920.

Conditions remaining about the same, there is very little to be noted in any of the markets. Buying interests are still inactive, and as a matter of fact they have had no reason to change their attitude, as the list in general has been well sustained.

The following table will give an idea of a few items that during the past year have remained fairly steady:

	Today	Last Week	Last Month	Last Year
Ammonium sulphate	$0 07@$0 08	$0 07@$0 08	$0 06@$0 07	$0 05@$0 06
Calcuim peroxide	1 50@ 1 70	1 50@ 1 70	1 50@ 1.70	1 50@ 1 70
Potassium bichromate	.34@ 36	.34@ 36	36@ 40	28@ 30
Potassium chlorate	.18@ 20	.18@ .20	17@ .20	.19@ 20
Sodium borate	.09@ 11	09@ .11	.09@ .11	.07¼@ 08¼
Sodium hyposulphite	03@ 04	03@ .04	.03@ 04	02¼@ .03¼

Naval Stores

Far from advancing the *rosin* market has rather continued on the decline, which has been brought about by the extremely dull condition existing in the South. *Turpentine* is not an exception and the recession can be traced daily by a 1@2c. drop below the previous day's closing price. Current quotations are $1.30 per gal., which, compared with the price a week ago, represents a 9c. drop. The following table shows the course of *turpentine* and the *rosins* for the past year:

	Today	Last Week	Last Month	Last Year
Turpentin	$1 30	$1 39	$1 55	$1.70
Rosins:				
B-D	12 90	13 00	14 00@16 25	18 00@18 25
E-I	12 90@13 00	13 00	16 60@16 75	18 50@20 50
WG-WW	13 00	13 00	17 25@17 50	23 50@25 50

The Baltimore Market

Baltimore, Md., October 6, 1920.

The local market on fertilizer materials continues in a demoralized condition, with a general downward trend of prices. A number of manufacturers report that orders for fall shipment have not come up to their expectations; as a consequence it will be necessary for them to carry over rather heavy stocks of materials until spring. The car situation is reported as greatly improved and we hear few complaints as to shortage of cars. As mentioned above, prices of materials are generally working lower and for that reason the buyers are showing hesitation in purchasing, thinking that the bottom has not yet been reached.

Acid Phosphate

It is generally believed that the manufacturers have covered fairly well on their requirements for spring, also that the producers of this commodity are well sold up. An occasional export order is noted and spot parcels are changing hands around $18 per ton, basis 16 per cent bulk, run of pile.

Nitrate of Soda

Importers are quoting this commodity at $3.30@$3.40, ex-vessel Atlantic ports for arrival prior to Jan. 1. For arrival after the turn of the year, asking prices are 10@20c. higher. Spot lots of nitrate, however, are being offered around $3.15 and a sale was reported recently on this market at that price. It is said that at the present rate of exchange it is costing about $3.70 to deliver nitrate to Atlantic ports at this time, which would indicate that sales at prices mentioned involve rather heavy losses for nitrate merchants.

Sulphate of Ammonia

Resales of sulphate of ammonia, basis 25 per cent bulk, have been noted on this market at $4.75. This shows a drop of 75c. per cwt. from the nominal quotation given in last report.

Potash

The various grades of potash salts are also showing a downward trend on price. Kainit and manure salts were reported being offered recently as low as $1.60 per unit of K_2O. Nominal quotations on this market are slightly higher than this figure. Muriate of potash is quoted nominal at $2.20 per unit. Nebraska potash is held under contract for forward delivery at the price of $2 per unit f.o.b. mines. There is no report of any sales for delivery forward from Nov. 1.

Fish Scrap

The price of menhaden fish scrap worked as low as $6 per unit, delivered Baltimore, but has since shown some recovery, as a sale was reported this week at $6.25 and 10c. delivered Baltimore. The fishing in Chesapeake Bay has been exceptionally good for the last few weeks and as a consequence good tonnages of scrap are being made. It is also reported that the fish are yielding considerably more oil than they did through the summer months.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4 50
Acetic, 56 per cent	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent, carboy	cwt.	14.00 – 16 00	16.25 –
Boric, crystals	lb.	.15½ – .16	.16½ – .19
Boric, powder	lb.	.15½ – .16½	.17 – .20
Citric	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal)	cwt.	2.00 – 2.50	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	10 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.06 .07	.07½ – .08½
Nitric, 42 deg	lb.	.07½ .08	.08½ – .09½
Oxalic, crystals	lb.	.45 – .50	.52 .55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 – 23	.24 – 25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2 30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 – 16 00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	16.00 – 17.00	18 00 – 20.00
Sulphuric, 66 deg., drums	ton	26 00 – 28.00	–
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28 00 – 30 00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35 00	40 00 –
Tannic, U. S. P.	lb.	1.45 – 1 50	1.55 – 1.65
Tannic (tech)	lb.	.60 – .70	.80 – .90
Tartaric, crystals	lb.	–	.74 – .77
Tungstic, per lb. of WO	lb.	–	1.20 – 1 40
Alcohol, Ethyl (nominal)	gal.	5.50 – 5.75	6.00 – 7.00
Alcohol, Methyl (see methanol)		–	–
Alcohol, denatured, 188 proof (nominal)	gal.	–	1.12 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	–	1.05 – 1.10
Alum, ammonia lump	lb.	.05 – .05½	.05½ – .06
Alum, potash lump	lb.	.08½ – .08½	.09 .09½
Alum, chrome lump	lb.	– .17	.18 – .19
Aluminum sulphate, commercial	lb.	.04½ –	–
Aluminum sulphate, iron free	lb.	.06 –	–
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ – .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 – .35½	.36 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – 18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 13½	.13½ – .14½
Ammonium nitrate	lb.	.09 .10	11 – .14
Ammonium sulphate	lb.	.07 .07½	08½ –
Amylacetate	gal.	–	5 00 –
Amylacetate tech	gal.	–	4 75 5 25
Arsenic, oxide, lumps (white arsenic)	lb.	15 – .16	.16½ 17
Arsenic, sulphide, powdered (red arsenic)	lb.	16 – .18	.19 – .23
Barium chloride	ton	130 00 – 150 00	–
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .12	.12½ – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.70 – .90	1.00 1.05
Calcium acetate	cwt.	3 50 – 3 55	–
Calcium carbide	lb.	04½ 04½	.04½ – .05½
Calcium chloride, fused, lump	ton	33.00 – 34 00	35 00 – 45.00
Calcium chloride, granulated	lb.	02 – 02½	.03 – .03½
Calcium hypochlorite (bleaching powder)	cwt.	7 25 – 7 50	8.00 – 8.50
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Carbon bisulphide	lb.	.08 – 09	.10 – .11
Carbon tetrachloride, drums	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)	lb.	–	1 25 – 1 50
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.40 – .43	.44 – .47
Cobalt oxide	lb.	–	2.00 – 2.05
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	1.10 – 1.30	1.40 –
Ethy Acetate pure (acetic ether 98% to 100%)		–	1 75 –
Formaldehyde, 40 per cent (nominal)	lb.	.48 – .50	–
Fusel oil, ref	gal.	–	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	–	–
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb.	–	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate (copperas)	cwt.	2 00 – 2.25	2.35 – 2.75
Lead acetate, normal	lb.	–	.13½ .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – 17
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.14 – .15	15½ – 16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.12½ – .13½	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 3.90	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	–	3 50 – 3 60
Methanol, 95%	gal.	–	3 25 3 30
Methanol, pure	gal.	–	3 50 – 4 50
Nickel salt, double	lb.	–	.14 – .16
Nickel salt, single	lb.	–	.13 – .14
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.34 – .36	.39 – .40

Item	Unit	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0 52 – $0 56	$0.57 – $0.58
Potassium bromide, granular	lb.	–	.70 – .73
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.20 – .21	.23 – .25
Potassium chlorate, crystals	lb.	.18 – .18½	.19 – .20
Potassium hydroxide (caustic potash)	lb.	.27 – 28	.29 – .33
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.17 – .17½	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.85 – .95	1.00 – 1.05
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .40
Potassium sulphate (powdered)	ton	$240.00 – 255.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	
Salt cake	ton	–	48.00 – 50 00
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.60 – .62
Soda ash, light	100 lb.	–	2.80 – 3.00
Soda ash, dense	100 lb.	–	3.25 – 3.50
Sodium acetate	lb.	.10 – .15	.20 – .25
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.50
Sodium bichromate	lb.	.22 – .24	.26 – .27
Sodium bisulphate (nitre cake)	ton	7 00 – 8.00	9.00 – 11.00
Sodium bisulphite Powered, U.S.P.	lb.	08¾ –	.10 – .11
Sodium borate (borax)	lb.	09 – .10	.11 – 12
Sodium carbonate (sal soda)	100 lb	2 00 – 2.10	2.15 – 2.25
Sodium chlorate	lb.	11 – .12	.12½ – .14
Sodium cyanide, 96-98 per cent	lb.	.25 – .30	.32 – .35
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	5 60 – 5.70	5.75 – 6.00
Sodium hyposulphite	lb.		.03 .04
Sodium molybdate	lb.	2 50 –	3.25½ –
Sodium nitrate	100 lb.	3 00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03¼ .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb		.39 .40
Sodium prussiate, yellow	lb.	.25 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	2.25 – 2.50	2.60 – 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	09½ 10	.10½ – .11
Sodium sulphite, crystals	lb	.04 – 0 4½	.04½ .05
Strontium nitrate, powdered	lb	.15 – 18½	.19 – .20
Sulphur chloride red	lb	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20 00	–
Sulphur dioxide, liquid, cylinders	lb.	09 –	10 – .12
Sulphur (sublimed), flour	100 lb.	–	3 80 – 4.35
Sulphur, roll (brimstone)	100 lb	–	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½ – .44	45 – .46
Tin oxide	lb.	–	.55 – 65
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.13 – .13½	.13½ – .17
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, U. S. P.	lb.	.17 – .25	–
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Item	Unit	Price
Alpha-naphthol, crude	lb.	$1.30 — $1.40
Alpha-naphthol, refined	lb	1 50 — 1.65
Alpha-naphthylamine	lb	.48 .52
Aniline oil, drums extra	lb	.30 .33
Aniline salts	lb.	.34 .36
Anthracene, 80% in drums (100 lb.)	lb	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb	1.35 — 1 40
Benzidine sulphate	lb	1.15 — 1.25
Benzoic acid, U S P.	lb.	.85 – .90
Benzoate of soda, U.S.P.	lb.	.80 .90
Benzene, pure, water-white, in drums (100 gal.)	gal	.35 — .40½
Benzene, 90%, in drums (100 gal.)	gal	.33 — .38½
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech.	lb.	.25 — .35
Beta-naphthol benzoate (nominal)	lb.	3 50 4.00
Beta-naphthol, sublimed (nominal)	lb.	.70 – 75
Beta-naphthol, tech (nominal)	lb.	65 – .70
Beta-naphthylamine, sublimed	lb	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — 19
Ortho-cresol, in drums (100 lb.)	lb.	.23 – .25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10 – 1 15
Cresylic acid, 95-97%, dark, in drums	gal	1.05 1.10
Cresylic acid, 50%, first quality, drums	gal	.65 — .75
Dichlorbenzene	lb.	.07 — 10
Diethylaniline	lb.	1 50 — 1.60
Dimethylaniline	lb.	.90 — 1.00
Dinitrobenzene	lb	.30 — .37
Dinitroclorbenzene	lb.	.32 — .35
Dinitronaphthalene	lb.	.45 — .55
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	— .40
Dip oil, 25% tar acids, car lots, in drums	gal	38 — .40
Diphenylamine (nominal)	lb.	80 – .85
H-acid (nominal)	lb.	1.90 — 2.05
Meta-phenylenediamine	lb.	1.25 – 1.30
Monochlorbenzene	lb	.18 — .20
Monoethylaniline	lb.	2.00 — 2.40
Naphthalene crushed, in bbls. (250 lb.)	lb.	.12 — 14
Naphthalene, flake	lb.	.16 — .17
Naphthalene, balls	lb.	.16 — .17
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzene	lb.	.14 — .19
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.35 — .38
Para-amidophenol, base	lb.	2.50 — 3 00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlorbenzene	lb	08 — 12
Paranitraniline	lb.	1 10 — 1.15
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.50 — 2.65
Para-toluidine	lb.	2.00 — 2 25
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — 20
Pyridine	gal.	2.00 — 3 50
Resorcinol, technical	lb.	4.25 – 4 50
Resorcinol, pure	lb.	6.25 – 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45 — .50
Salicylic acid, U. S. P.	lb.	.45 — 50
Salol	lb.	.90 — 1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	30 — .35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.20 — .26
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.70 — 2 50
Toluidine, mixed	lb	.45 — .55
Toluene, in tank cars	gal.	.35 — ....
Toluene, in drums	gal.	.38½ — .40½
Xylidines, drums, 100 gal.	lb.	.50 — .65
Xylene, pure, in drums	gal.	.47½ — .50½
Xylene, pure, in tank cars	gal.	.45 — ...
Xylene, commercial, in drums, 100 gal	gal	.32½ — .35½
Xylene, commercial, in tank cars	gal.	.30

Waxes

Prices based on original packages in large quantities.

Item	Unit	Price	
Beeswax, refined, dark	lb	$0.33	$0 58
Beeswax, refined, light	lb.	.34	37
Beeswax, white pure	lb.	.60	.65
Carnauba, No. 1 (nominal)	lb.	.90	.95
Carnauba, No. 2, regular (nominal)	lb	.85	.86
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.18	.20
Montan, crude	lb.	.14	.15
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¾	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	.11½
Paraffine waxes, refined, 125 m.p.	lb.	.12¾	.
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18½
Stearic acid, single pressed	lb	.20	.21
Stearic acid, double pressed	lb	.22	.23
Stearic acid, triple pressed	lb.	.24	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Item	Unit	Price
Pine oil, steam dist., sp. gr., 0 930-0.940	gal.	$2 15
Pine oil, pure, dest. dist.	gal.	1 80
Pine tar oil, ref., sp. gr. 1 025-1.035	gal	.48
Pine tar oil, crude, sp. gr. 1.025-1 035 tank cars f.o.b. Jacksonville, Fla.	gal	.35
Pine tar oil, double ref., sp. gr. 0 965-0 990.	gal	.85
Pine tar, ref., thin, sp. gr., 1 080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0 900-0 970.	gal	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0 990.	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Item	Unit	Price	
Rosin B-D, bbl.	280 lb.	$13.00	
Rosin E-I	280 lb.	13 10	
Rosin K-N	280 lb.	13.15	
Rosin W. G.-W. W.	280 lb.	13.25	
Wood rosin, bbl	280 lb.	12.50	
Spirits of turpentine	gal.	1.30	
Wood turpentine, steam dist.	gal.	.	
Wood turpentine, dest. dist.	gal.	...	
Pine tar pitch, bbl	200 lb.	....	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	15 00
Retort tar, bbl.	500 lb.	15 00	15 50
Rosin oil, first run	gal.	.72	
Rosin oil, second run	gal.	.75	
Rosin oil, third run	gal.	.92	

Solvents

Item	Unit	Price
73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Item	Unit	Price	
Para—Upriver fine	lb	$0.26	–$0.26½
Upriver coarse	lb	17	– .18
Upriver caucho ball	lb	.17½	– .18½
Plantation—First latex crepe	lb.	.25	
Ribbed smoked sheets	lb	.24½	
Brown crepe, thin, clean	lb	.22½	
Amber crepe No. 1	lb.	.22	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Item	Unit	Price
Castor oil, No. 3, in bbls.	lb.	$0.16½ — $0.18
Castor oil, AA, in bbls.	lb.	.17 — .17½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.17½ — .18
Coconut oil, Ceylon grade, in bbls.	lb.	.15 — .16
Coconut oil, Cochin grade, in bbls (nominal)	lb.	.16 — .17½
Corn oil, crude, in bbls.	lb.	.12 — .13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½ — .11
Cottonseed oil, summer yellow	lb.	.14 — .15
Cottonseed oil, winter yellow	lb.	.. —
Linseed oil, raw, car lots (domestic)	gal.	1.22 — ....
Linseed oil, raw, tank cars (domestic)	gal.	1.16 —
Linseed oil, boiled, car lots (domestic)	gal.	1.24 —

Item	Unit	Price		
Olive oil, commercial	gal	3 00	--	3 50
Palm, Lagos	lb	.10½	—	.
Palm, bright red	lb		—	..
Palm, Niger	lb	.09½	—	.10
Peanut oil, crude, tank cars (f o.b mill)	lb	.10½	—	.12½
Peanut oil, refined, in bbls	lb	.17	---	.18
Rapeseed oil, refined in bbls	gal	1.30	---	1 45
Rapeseed oil, blown, in bbls	gal.	1.60		1.70
Soya bean oil (Manchurian), in bbls N. Y.	lb.	.14	—	.14½
Soya bean oil, tank cars, f.o b , Pacific coast	lb	10	-	.11

FISH

Item	Unit	Price		
Winter pressed Menhaden	gal	$0.85	--	$0.90
Yellow bleached Menhaden	gal.	.87	--	.90
White bleached Menhaden	gal.	.90	—	.92
Blown Menhaden	gal.	1.05	—	..

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Item	Unit	Price		
Barytes, ground, white, f o b Kings Creek, S C.	net ton	$22 00	--	$25 00
Barytes, ground, off color, f o b Kings Creek	net ton	18 00	--	20.00
Barytes, crude, 88% @ 94%, ba , Kings Creek	net ton	8 00	-	10 00
Barytes, ground, white, f.o b Cartersville, Ga	net ton	23 00	-	25 00
Barytes, ground, off color, f o b Cartersville	net ton	16 00	—	19 00
Barytes, crude, 88% @ 94%, ba , Cartersville	net ton	12 00	—	..
Barytes, floated, f o b St Louis	net ton	26 50	-	28 00
Barytes, crude, min 98%, ba , Missouri	net ton	11.00	-	11 25
Blanc fixe, dry	lb	.05½	—	.06
Blanc fixe, pulp	net ton	60 00	-	80.00½
Casein	lb.	.15	-	.18
Chalk, domestic, extra light	lb.	05	-	.06
Chalk, domestic, light	lb.	04½	-	05½
Chalk, domestic, heavy	lb.	.04	-	05
Chalk, English, extra light	lb	05		.07
Chalk, English, light	lb	.05		.06
Chalk, English, dense	lb.	.04½	-	.05
China clay, (Kaolin) crude, f o b mines, Georgia	net ton	9 00		12 00
China clay (Kaolin) washed, f o b Georgia	net ton	12 00		15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00	-	22 00
China clay (Kaolin) crude f o b Virginia points	net ton	8 00	-	12 00
China clay (Kaolin) ground, f.o b Virginia points.	net ton	15 00	-	40.00
China clay (Kaolin), imported, lump	net ton	25 00	—	35 00
China clay (Kaolin), imported, powdered	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50	-	8.00
Feldspar, crude, f.o.b Maine	net ton	7 50		10 00
Feldspar, ground, f o b Maine	net ton	21 00		23 00
Feldspar, ground, f o b North Carolina	net ton	17.00	-	21.00
Feldspar, ground, f.o b N Y State.	net ton	17 00	—	21.00
Feldspar, ground, f o b Baltimore	net ton	30.00		35 00
Fuller's earth, granular, f.o.b Fla.,	net ton	25 00	—	
Fuller's earth, powdered, f.o b Fla ,	net ton	18.00	—	
Fuller's earth, imported, powdered	net ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala	lb.	. . .	--	.01
Graphite (dust facing grade 50%) Ashland, Ala	lb.		—	.02
Graphite, crucible, 80%, carbon Ashland, Ala.	lb.	.....	—	.05
Graphite, crucible, 90%, carbon Ashland, Ala .	lb.	.. .	—	.10
Graphite, crucible, 85%, carbon	lb		-	.08
Graphite, crucible, 88%, carbon	lb	.	—	.09½
Graphite, crucible, 90%, carbon	lb.	.. .	—	.10½
Pumice stone, imported, lump	lb.	.04	-	.50
Pumice stone, domestic, lump	lb	.06		..
Pumice stone, ground	lb.	.04	-	.07
Quartz (acid tower) fist to head, f o b Baltimore	net ton	.....	—	10 00
Quartz (acid tower) 1½ @ 2 in , f o b Baltimore	net ton	.....	—	14 00
Quartz (acid tower) rice, f.o.b Baltimore	net ton	......	-	17 00
Quartz, lump, f o b. North Carolina	net ton	5.00	-	7.50
Shellac, orange fine	lb.	1 15		1.30
Shellac, orange superfine	lb.	1.10		1.20
Shellac, A. C. garnet	lb.	.90	—	.95
Shellac, T N	lb.	.85	—	.95
Soapstone	ton	15.00	-	25.00
Talc, paper-making grades, f o.b. Vermont	ton	12.00		22.00
Talc, roofing grades, f o b Vermont	ton	9 50		15.00
Talc, rubber grades, f.o b Vermont	ton	12.00	--	18.00
Talc, powdered, Southern, f o b cars	ton	12.00	--	15.00
Talc, imported	ton	60.00	—	70.00
Talc, California Talcum Powder grade	ton	20.00	—	35.00

Refractories

Item	Unit	Price
Bauxite brick, 56% Al , f o b Pittsburgh	1,000	160
Chrome brick, f o b Eastern shipping points	net ton	100-110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o.b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f o b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f o b. Mt. Union, Pa	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Item	Unit	Price		
Ferro-carbon titanium, 15-18%, f o b. Niagara Falls, N Y	net ton	$200.00	—	$250.000
Ferro-chrome, per lb of Cr. contained, 6-8% carbon, carlots	lb.	.18	—	19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	-	21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00	--	180 00
Ferro-manganese, 76 80% Mn, English	gross ton	170 00	-	175 00
Spiegeleisen, 18 22% Mn	gross ton	82 50	-	85 00
Ferro-molybdenum, 50 60% Mo, per lb. of Mo	lb.	2.00	-	2.50
Ferro-silicon, 10-15%	gross ton	60 00	--	65.00
Ferro silicon, 50%	gross ton	80 00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80%, per lb of contained W	lb.	.90	---	1.05
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb of contained V	lb	6.50	--	8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Item	Unit	Price		
Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20½% silica, not more than 1½% moisture	gross ton	$10.00	—	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70		.75
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.75	—	.85
*Coke, foundry, f o.b. ovens	net ton	....	--	18.00
*Coke, furnace, f.o b. ovens	net ton	16.50	--	17.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00		
Fluor spar, lump, f o b.Tonuco, New Mexico.	net ton	17.50	—	...
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	80.00	—	100.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	85.02
Manganese Ore, 50% Mn, c i f Atlantic seaport	unit	60	—	.70
Manganese ore, chemical (MnO_2)	gross ton	80.00	-	100.00
Molybdenite, 85% MoS_2, per lb of MoS_2, N. Y	lb.	.70	—	.75
Monazite, per unit of ThO_2	unit	42.00	---	....
Pyrites, Spanish, fines ,c i f , Atlantic seaport .	unit	.12	—	....
Pyrites, Spanish, furnace size, c.i f , Atlantic seaport	unit	.16½	—	.....
Pyrites, Spanish, run of mines, c i .f , Atlantic seaport	unit	.12	—	.14
Pyrites, domestic, fines	unit	.12	—	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00	---	.
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50	—	5.00
Uranium Ore (Carnotite) per lb of U_3O_8	lb.	2.75	--	3.00
Uranium oxide, 96% per lb. contained U_3O_8.	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25	—	.
Zircon, washed, iron free	lb.	.05	-	.....

*Nominal

Non-Ferrous Metals

New York Markets

Item	Cents per Lb
Copper, electrolytic	18.50
Aluminum, 98 to 99 per cent	34.80
Antimony, wholesale lots, Chinese and Japanese	7.00
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5 ton lots	44.50
Lead, New York, spot	8.50
Lead, E. St. Louis, spot	8.00
Zinc, spot, New York	8 50
Zinc, spot, E. St. Louis	7.70@8 05

OTHER METALS

Item	Unit	Price
Silver (Commercial)	oz.	$0.91¼
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	110 00
Iridium	oz.	350.00@400 00
Palladium	oz.	100.00
Mercury	75 lb.	72 00

FINISHED METAL PRODUCTS

Item	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33 50
Copper bottoms	38 00
Copper rods	38.00@40 00
High brass wire and sheets	30.25
High brass rods	27 00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.	15.00	17.00	14 00	15 00
Copper, heavy and wire	14 00	16 00	13.50	14 50
Copper, light and bottoms	12.50	14 00	12.00	13 00
Lead, heavy	7.00	4 75	7.00	7.00
Lead, tea	5.00	3.75	4.00	6.00
Brass, heavy	9 50	10.50	10.00	14.50
Brass, light	7.00	7.50	7.00	8.00
No. 1 yellow brass turnings	8.50	10.00	7.50	8 00
Zinc	5.00	5.00	4.50	5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.58	$4.47	$3 47	$5.00	$3.37	$4.08	$3 47
Soft steel bars	4.73	4.62	3.37	4.50	3.27	3.98	3 37
Soft steel bar shapes	4.73	4.62	3.37	....	3.27	3.98	3.37
Soft steel bands	6.43	6.32	4.07	6.25	....	....	.
Plates, ¼ to 1 in. thick	4.78	4.67	3.67	4.50	3.57	4.28	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

ANSONIA The Amer. Brass Co., 58 Liberty St., will soon award the contract for the construction of a 1-story, 340x400 ft. addition to its factory Estimated cost, $700,000. Noted Sept. 22.

NEW BRITAIN--The Vulcan Iron Wks., 63 John St., has awarded the contract for the construction of a 1-story, 90x100-ft. foundry, to John Kung Co., 50 Green St Estimated cost, between $15,000 and $50,000

NEW HAVEN—The Connecticut Adamant Plaster Co., River St., plans to build a 2-story plaster plant. Estimated cost, $150,000.

District of Columbia

WASHINGTON The Bureau of Yards & Docks, Navy Dept., will receive bids until Oct. 15 for the construction of a 3-story, 60x200-ft. office and laboratory, 2-story, 82x300 ft. machine and testing shop, 1-story, 60x100-ft. foundry, etc. at the Naval Exper[illegible]al [illegible]nd R[illegible]ch Labs at Bellevue

Florida

WEST PALM BEACH (Palm Beach P. O.) -The State Bd. of Health, Jacksonville, will receive bids until Oct. 22 for the construction of a branch laboratory building here.

Illinois

CHICAGO—The Kroeschell Bros. Ice Machine Co., 460 West Erie St., plans to build a new plant, including a machine shop, etc., on the south side of Diversey Ave., west of the St. Paul R.R. tracks.

Indiana

INDIANAPOLIS — The Link Belt Co., South Addison St. and the Big Four R.R., has awarded the contract for the construction of a 1-story factory on Belmont Ave., to W. P. Jungclause, 825 Mass. Ave.

Iowa

FORT DODGE--The Bd. Educ. will receive bids until Oct. 27 for the construction of a 3-story, 190x260-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $650,000. P. E. Gustafson, secy. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., archt.

Maryland

BALTIMORE- James J. Lacy Co., Philpot and Wells Sts., has awarded the contract for the construction of a foundry addition, to R. B. Mason, 308 West Madison St. Estimated cost, $14,000.

BALTIMORE — The Natl. Bituminous Enamel & Paint Corp., Keyser Bldg., has awarded the contract for the construction of a paint and enamel plant, to the Price Constr. Co., Maryland Trust Bldg. Estimated cost, $23,000.

CUMBERLAND—The Amer. Cellulose & Chemical Mfg. Co. plans to build an addition to its plant.

Massachusetts

WORCESTER—The Worcester Fdry. Co. Inc., 180 Prescott St., will build a 1-story, 60x150-ft. addition to its foundry on Prescott St. Estimated cost, $30,000. Work will be done by day labor.

Minnesota

FRIDLEY—The Walsh Creosoting Co., St. Louis, Mo., plans to build a creosoting plant here. Estimated cost, $200,000.

Missouri

CLAYTON—The city rejected all bids for the construction of sewers in sewer districts 1, 2 and 3. A septic tank will be installed in each. Work will be readvertised.

Nebraska

DANNEBROG—The Bd. Educ. is having plans prepared for the construction of a 2-story, 53x90 ft. school. A septic tank will be installed in same. Cost, between $115,000 and $120,000. W. Mape, Sheriden Bldg., Kansas City, Mo., archt.

MINATARE- The Great Western Sugar Co., Sugar Bldg., Denver, Col., will build a sugar factory to have a capacity of 1,200 tons of beets per day. Estimated cost, $2,000,000. Work will be done by day labor Noted Aug 18.

New York

BROOKYLN - The Grand Corrugated Paper Co., 30 Crosby St., will soon award the contract for altering a factory on 32nd St. Estimated cost, $50,000. P. Tillion & Son, 103 Park Ave., New York City, archt. and engr.

FORT NIAGARA The Construction Dept., War Dept., Wash., D. C., plans to construct a filtration plant here Estimated cost, $25,000.

North Carolina

GASTONIA -The city has awarded the contract for the construction of a sewage disposal plant, to B. W. Harris, Durham. Estimated cost, $60,000.

North Dakota

MARMARTH - The Bd. Educ. has awarded the contract for the construction of a 2-story, 61x91-ft high school, to the Colewell-Long Co., 351 Plymouth Bldg., Minneapolis, Minn. A chemical laboratory will be installed in same. Estimated cost, about $125,000. Noted Sept. 15.

Ohio

CLEVELAND HEIGHTS (Cleveland P. O.) The Bd. Educ., Lee Rd., will receive bids until Oct. 20 for furnishing school building equipment, including chemical laboratory equipment, etc. Estimated cost, $100,000. F. C. Warner, Hippodrome Annex Bldg., Cleveland, archt.

COLUMBUS--The Amer. Rolling Mill Co., Toledo & Ohio Central R.R., Parsons Ave., Columbus, O., has awarded the contract for the construction of an addition to its present plant, to Dwight P Robinson, 125 East 46th St., New York City. Estimated cost, $300,000.

Pennsylvania

PHILADELPHIA--Dill & Collins, Richmond and Tioga Sts., has awarded the contract for the construction of a 3-story, 28x58-ft. filter and pulp mill, on Manayunk St., to W. Steele & Sons Co., 16th and Arch Sts.

UNIONTOWN The Uniontown Hospital will receive bids until Nov 1 for the construction of a 3-story, 60x170-ft. hospital A chemical laboratory will be installed in same. H. W Altman, archt.

Tennessee

MEMPHIS—The Dixie Rubber Co has awarded the contract for the construction of a 1-story, 75x290-ft. building to the Hydraulic Steelcraft Co., Hydraulic Ave., Cleveland, O.

Texas

DALLAS -The Trinity Paper Mills, 101 Marvin Bldg., and G. A. Beeman, Comanche, plans to construct three mills in Texas and will be in the market for equipment.

Wisconsin

FOND DU LAC - J. B. Fellrath, 180 North Main St., will build a 1- and 2-story, 70x120-ft. concrete block manufacturing plant on Brook Ave. Work will be done by day labor.

HORICON -The Van Brunt Mfg. Co. will build a 1-story, 80x200-ft. foundry addition and a 40x80-ft. dry kiln. Work will be done by day labor

MILWAUKEE—Backer & Pfaller, archts., 216 West Water St., will soon award the contract for the construction of a 1-story, 90x150-ft. factory on State St., for the manufacture of cement blocks, for the Shope Brick Co., 216 West Water St

MILWAUKEE—The Modern Steel Casting Co., 1400 33rd St., plans to build a 1-story, 80x500-ft. or a 70x350-ft foundry on 33rd St.

Quebec

MONTREAL The governors of McGill University will have plans prepared for the construction of a biological laboratory, a modern pathological institute and a psychopathic hospital. Estimated cost, $1,250,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deshler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

THE C. & G. COOPER Co., of Mt. Vernon, O., at the regular June directors' meeting, elected B. B. Williams president of the company to succeed D. B. Kirk, deceased; F. H. Thomas was elected vice-president to succeed Mr. Williams and N. L. Daney was elected treasurer to succeed Mr. Thomas. The Chapman Engineering Co., the Chapman-Stein Furnace Co., and the Marion Die, Tool & Machine Co., with its well-equipped plant at Marion, O., are subsidiaries of the Cooper company. The complete service of the combined companies therefore now includes not only the Cooper gas engines and Cooper Corliss engines, it covers also Chapman gas producers and Chapman-Stein furnaces. This complete combustion engineering service enters practically every line of industry which utilizes gas for power or for industrial heat.

THE OXWELD ACETYLENE CO., New York City, has established Pacific Coast sales and distributing headquarters at San Francisco, with offices at 1077 Mission St. This company also announces that the export department, which was formerly located at the company's factory in Newark, N. J., has been removed to the Carbide and Carbon Bldg., 30 East 42d St., New York. The department has been reorganized and is now under the direction of R. G. Noble, who will co-operate with the general sales department of the company.

D. M. LIDDELL announces the removal of his offices to 2 Rector St., New York City

DICKS-DAVID & Co., of New York, and DICKS, DAVID & HELLER, of Chicago, manufacturers of dyes and intermediates, have consolidated into one firm under the name of the former.

DR. ROBERT P. FISCHELIS, consulting chemist, of Philadelphia, has removed his business office to the Foster Bldg., 280 Madison Ave. (corner 40th St.), New York City. He is specializing on investigations of markets and sources of supply for chemical, pharmaceutical and biological products

and the preparation of scientific and commercial literature along chemical, pharmaceutical and medical lines. Dr. Fischelis will continue as a member of the faculty of the Philadelphia College of Pharmacy and as director of the technical department of the Matos Advertising Co., of Philadelphia. He has also been retained by the National Research Council to assist in securing the support of the chemical industries in the matter of publishing an American volume of critical tables of physical and chemical constants.

OLIVER CONTINUOUS FILTER CO., manufacturer of the Oliver Continuous Filter, dry vacuum pumps, air compressors, centrifugal pumps, etc., has appointed J. F. Mitchell-Roberts as its special representative in England and Europe. Offices have been established at No. 2 Broad St. Place, London, E. C. 2, England. In connection with its offices at 33 West 42d St., New York, and 503 Market St., San Francisco, Cal., this company maintains laboratories for investigation of filtration problems and similar arrangements will be made at its new London office.

WHITING FOUNDRY EQUIPMENT CO., of Harvey, Ill., and the AMERICAN FOUNDRY EQUIPMENT CO., of New York, consolidated to form the Whiting Corporation, capitalized at $5,000,000. J. H. Whiting becomes chairman of the board and V. E. Minich president of the company. The Whiting plant at Harvey will retain the manufacture of cranes, cupolas, hoists, mills, core ovens and all other items of the established Whiting line, together with sand-blast equipment and dust arresters. Sand-cutting machines and steel castings will comprise the bulk of the work at the new American plant at 2935 West 47th St., Chicago, under the direction of E. A. Rich, Jr. Molding machines, jolts, slabs, specialties and pattern-mounting materials will continue to be manufactured at the York, Pa., plant of the American company in charge of R. S. Buch.

THE MIDWEST ENGINE CO. has sent its exhibit which was at the National Exposition of Chemical Industries to the office of Charles F. Ames & Co., Ltd., 90 West St., New York.

FRANK LABORATORIES FOR CHEMICAL INDUSTRY, San Francisco, announces the beginning of work on a new chemical factory in Oakland, Cal., on Oct. 1, for the production of organic chemicals from crude oil tars and shale oil.

CHARLES PIEZ, president of the Link-Belt Co. and former director general of the Emergency Fleet Corp., has written a report on the steel strike. Copies of the article can be secured by applying to the executive offices of the Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.

WILEY & CO. announces the removal of its laboratory and offices to the northwest corner of Calvert & Read Sts., Baltimore, Maryland.

INDEPENDENT CHEMICAL CO., INC., of Hartford, Conn., has recently been organized and incorporated with a capital stock of $25,000, to engage in manufacturing chemicals, etc. Further information can be secured from M. A. Flerberg, 16 Westland St., Hartford, Conn.

THE PETROLEUM RECTIFYING CO. OF CALIFORNIA announces the engagement of the services of Sanderson & Porter, consulting engineers, to supervise research work and the development of apparatus and equipment for the dehydrating of petroleum emulsions by the electric process. The basic Cottrell patents controlled by the company have recently been adjudicated by the United States Supreme Court. It is now proposed to further develop the apparatus with the view of increasing the capacity and efficiency.

DWIGHT P. ROBINSON & CO., INC. (with which Westinghouse, Church, Kerr & Co., Inc., has recently consolidated), engineer and constructor, of New York, has established a new branch office in Youngstown, O., in the Home Savings & Loan Bldg., in charge of C. I. Crippen. The company recently moved its Cleveland office from the Leader-News Bldg. to the Citizens' Bldg., and H. P. Clawson, who was for several years a member of the Chicago staff, has been transferred to Cleveland to take charge of this office. The company now maintains branch offices in Pittsburgh, Youngstown, Cleveland, Chicago, Dallas and Los Angeles, and Sao Paulo, Brazil.

STANDARDIZATION COMMITTEE OF THE NATIONAL ASSOCIATION OF PURCHASING AGENTS considered four problems at its meeting at Chicago Oct. 9. They were: Standardization of catalogs; standardization of invoices; pricing on a decimal basis; standardizing shafting uses.

Manufacturers' Catalogs

QUIGLEY FURNACE SPECIALTIES CO., New York, is distributing a new booklet on "Hytempite in the Gas Plant." This 16-page booklet contains illustrations showing how Hytempite serves, and how the life of brick work is increased by proper bonding of refractories, also Hytempite in the gas plant, laying firebrick and tile, in gas generators, flue linings and valves, for patches and repair work, the spraying of Hytempite for filling cracks, coating walls and other brickwork, sealing coke oven jamb joints, gas producer linings and for industrial gas fired furnaces.

THE MERRILL CO., San Francisco, Cal., has issued a booklet on the Nordstrom Lubricated Plug Valve.

MAURICE A. KNIGHT, East Akron, O., has issued a folder which, although it is not a full catalog or a complete list of what he manufactures, is a guide to the possibilities of design of acid-proof chemical stoneware apparatus, which can be made in any shape or design mechanically possible. In this folder are various explanatory and instructive articles on the subject of chemical stoneware, its uses and limitations.

UEHLING INSTRUMENT CO., 71 Broadway, New York, has just issued Bull. No. 111 describing Style U Uehling CO_2 equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous (not intermittent) record, showing all changes in boiler adjustments that are conducive to either waste or economy.

THE WESTERN REINFORCED CONCRETE PIPE CO., Los Angeles, Cal., calls attention to a catalog on Reinforced Concrete Pipe. In this book is pointed out the unique adaptability of reinforced concrete pipe for sewers, storm drains, culverts, pressure lines and irrigation systems. Many interesting illustrations are given together with descriptions and letters from users.

PYROLECTRIC INSTRUMENT CO., Trenton, N. J., has issued Bull. 14, which contains an article on hydrogen ion determinations, together with descriptive apparatus and notes on technical applications of the methods.

ALBERGER CHEMICAL MACHINERY CO., Grand Central Palace, New York City, has just published several booklets. One folder describes Agitator Drives for stirring, mixing, agitating, dissolving and digesting, while Bull. 26, also on Alberger Agitator Drives, describes the six sizes of bevel gear drives and six sizes of worm gear drives, together with several designs of stirrers, which are illustrated. Bull. 28, on Chemical Apparatus, illustrates and describes autoclaves, nitrators, heat interchangers, sulphonators, mixing kettles and digestors.

GRISCOM-RUSSELL CO., New York, has issued Bull. 260, on the Reilly Water Heater. Many interesting types of this multicoil heater are illustrated and described.

THE SMITH GAS ENGINEERING CO., Dayton, O., is distributing Bull. 16, on the Smith Type "G" Gas Producer, which produces cold clean producer gas for power and industrial heating. Typical gas analyses are given, together with the design of the producer, the process of gas production, the rating, the practical uses for Smith cold clean producer gas and the Smith recording gas calorimeter.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has issued leaflet 3461, which describes and illustrates its automatic current regulator for electric arc furnaces with movable electrodes. Schematic wiring diagrams and photographs of detailed parts of this apparatus are produced.

THE BUFFALO FORGE CO., Buffalo, N. Y., has published an attractive catalog, No. 460, on Buffalo Standard Heaters. The catalog has been prepared with the view of making it most useful to architects and engineers in figuring the heater requirement for fan heating and ventilating work. The tables have been elaborated so as to include all the conditions usually met with in practice and to enable the user to read the values direct. To meet unusual conditions curves have been added which give values for various steam pressures and air velocities, and these enable any condition to be readily taken care of.

THE AMERICAN TOOL & MACHINE CO., Boston, Mass., has issued a catalog on Weston centrifugals for sugar-chemicals. Many illustrations and descriptive matter are given of the different types, together with a section on sprayers, dischargers, perforated linings and backings. There is also a very interesting write-up on scientific sugar washing. The booklet has been published in Spanish as well as in English.

THE ELECTRIC FURNACE CO., Alliance, O., is distributing Bull. 9-B, which illustrates and describes Baily electric furnaces for melting non-ferrous metals, also for heat treating and annealing.

THE LINK-BELT CO., Chicago, Ill., is now ready to distribute its 32-page book, No. 345, entitled "Link-Belt Silent Chain Drive for Cement Mill Equipment," which should be of advantage to engineers, superintendents and other officials of cement mills. This company has also published an engineering data book on the Link-Belt Roller Chain. This 78-page book, No. 257, shows photographs of roller chain drives operating motor trucks, tractors, cotton gins, industrial locomotives and other equipment. It is a handbook of value to power transmission engineers, and contains tables from which the proper size of chain and sprocket wheel can be selected to result in the best driving arrangement. This company also calls attention to the revised edition of catalog 380, which is now off the press and available for distribution. This 96-page book covers the Link-Belt line of standardized monorail electric hoists, as well as overhead electric traveling cranes in capacities of ½ to 3 tons inclusive. It completely describes these machines, giving tables of weights, clearance dimensions and speeds, together with illustrations, which include photographs of machines in operation.

ACHESON GRAPHITE CO., Niagara Falls, N. Y., announces a new publication on Brass Melting. This booklet presents information in regard to the electric melting of non-ferrous metals which is based upon statements by leading engineers of the industry and upon articles appearing in trade periodicals and the proceedings of technical societies. Short descriptions of various designs of arc and resistance furnaces have been contributed by the makers and are given in their own words.

BARBER-GREENE CO., Aurora, Ill., announces a new catalog, No. 1, on B-G Standardized Material Handling Machines, which consist of self-feeding bucket loaders, portable belt conveyors, and permanent belt conveyors for the handling of all kinds of bulk material. Many interesting illustrations are given, together with descriptive matter.

VIELE, BLACKWELL & BUCK, New York, has published Bull. 11, on Acids. This bulletin is an attempt to set up in convenient form descriptions of the acids which constitute a very large proportion of those commercially manufactured and exported, together with mention of a few of the principal uses of each of the acids in order to assist foreign purchasers in the development of business.

CUTLER-HAMMER MANUFACTURING CO., Milwaukee, Wis., has issued five new booklets on: The Value of Accurate Measurements of Gases and Air; Electric Heating of Water; Charging Equipment for Miner's Lamp Batteries; Metal Melting Pots; Battery Charging Equipment.

ARMSTRONG CORK & INSULATING CO., Pittsburgh, Pa., has published two booklets. "Armstrong's Cork Tile" gives illustrations and descriptions of tile suitable for banks, offices, libraries, museums, residences, stores, hotels, etc. The other booklet describes "Linotile Floors," suitable for offices, churches, banks, libraries, kitchens, pantries, theatres, stores, museums, elevators, sun rooms, etc. Many interesting illustrations are given in color, showing actual floors of Linotile. Anyone interested in flooring materials will be furnished copies upon request.

E. I. DU PONT DE NEMOURS & CO., Wilmington, Del., has published an attractive booklet on Dyestuff Intermediates.

NORTON CO., Worcester, Mass., has published a booklet on Snagging, which deals with the selection, care and use of snagging wheels.

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Industrial Editors
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The Long Road to Scientific Control

THERE has been organized a Canadian Society of Technical Agriculturists at Ottawa, and at the first convention, held in June, Professor W. P. THOMPSON, of the University of Saskatchewan, addressed the members on Scientific Research in Relation to Agricultural Problems. The address was printed in the October 1 number of *Science*.

The purpose of the association is to foster and develop the application of science to agricultural industry. The difficulties are many, despite the immense efforts that have been made, both here and abroad, to make of farming a real profession. The public at large, as Professor THOMPSON points out, thinks chemistry, for instance, a highly complex and mysterious study, capable of performing all sorts of wonders, whereas nearly every one thinks he understands agricultural operations. Now agricultural problems are as complex as those of any other industry, and progress is possible only through the application of scientific facts and principles by those who have been properly trained. The scope of necessary research is no less than immense. It involves the physics, chemistry, biology and geology of the soil, physiology and pathology of both plants and animals, systematic biology, entomology, foreign plant introduction, genetics, bacteriology, mechanics, climatology, sociology and economics. It makes the operation of a blast furnace, for instance, look like a scientific toy; and nobody complains that the operation of a blast furnace is too easy. There is so much to do, or to put it a little differently and yet to mean the same thing, our present ignorance is so general and all-encompassing that a mere list of the sciences involved looks impractical. It certainly is enough to frighten anybody who owns a farm.

Nevertheless, the benefits which already accrue as the result of research in agriculture are not surpassed by those of any other industry, although the real study is hardly more than begun. The day may come within the next generation when some other method of settling labor difficulties will take the place of the strike, and as soon as this happens industrial, large-scale farming with its own warehouses, its villages, its transportation systems for labor, etc., will probably become profitable, because scientific control, properly applied, always pays. And scientific control in farming involves the co-ordination of many trained minds.

In the meantime other industries less complex in their nature and requirements had better provide for scientific control—or else look for the road that leads into the tall timber. Who would now undertake to produce iron from ore with an old furnace doctor to judge materials by "the look of them" and to dose the furnace with secret medicines when trouble appears? Where will the automotive industry be unless more liquid fuel of the right kind is developed to operate the engines? But cracking petroleum is a simple problem compared with the long list of things yet to be done on the farm. The rubber industry has made a start. Some tanners, but far from all, have begun to see the light. A few iron founders are scientific, but more are not. Only a few years ago makers of brass were enlightened by Egyptian traditions, and they had little inspiration of later date. A large part of the ceramic industries is still operated under the rule of thumb. The enlightenment of science in industry is only beginning; just beginning.

Metallic Oxides Soluble in Steel

WHILE a great deal of the space occupied by Messrs. RAWDON, GROESBECK and JORDAN in this issue is devoted to a study of nitrides in arc-welded iron, one very suggestive remark about oxides is made which may be worthy of rather more emphasis. Following MILLER and COMSTOCK, the present authors have labeled "oxide" the small rounded spots occurring in the micrographs, which spots, by the way, are identical in appearance with those in vacuum-fused electrolytic iron of high purity, but oxidized on the surface before melting. Whether the spots are FeO—a compound whose very existence is questioned—higher oxides of iron or more complex mixtures of various metallic oxides and silicates is not known, nor can such problems be solved without much more experimental information than is available at present.

The notable fact developed by our present contributors, however, is this: That whenever arc-fused iron was heated to 1,000 deg. C. in a relatively high vacuum for several hours there resulted a great decrease in the number of small rounded inclusions originally present, together with a marked increase in size of the still remaining ones. Here is the first instance coming to attention of the migration of non-metallic inclusions. As pointed out recently in these columns, no one ever has affirmed such movements, and many have testified they have looked for it without avail. WHITELEY, at the fall meeting of the British Iron and Steel Institute, in vainly attempting to remove deep-seated oxide spots from ingot iron by annealing in hydrogen, says: "No indication of such migration [of oxide inclusions to the surface] occurring to any appreciable extent was observed in a strip after it had been heated *in vacuo* for three hours at 1,050 deg. C." Yet RAWDON and his collaborators present undoubted evidence of changes in the disposition of insoluble oxidized inclusions. Such movement, we take it, involves a certain solubility of the oxidized particle in the hot solid metal. The authors

do not agree to this inference, but their view expressed in correspondence, that "during the agglomeration of the originally small ferrite grains during the stay above A_3, the oxide inclusions in the various and adjoining small ferrite grains were in some unexplained manner brought together to form a single and larger inclusion," appears to be only another way of saying that the grains were observed to be larger after heating. MAHIN'S work also has a tendency to show that non-metallic inclusions are slightly soluble in solid ferrite.

Oxygen has popularly been held to be of utmost danger to sound steel. Volumes have been written about refining operations in bessemer and open-hearth, and about blowholes and dead-melted steel, much of which involves the ultimate assumption of the presence of quantities of oxide in the metal. Yet ROSENHAIN says that it is extremely doubtful whether iron oxide is soluble in molten iron—notable constancy of results which various investigators have reported for the melting point of pure iron is strong support of this idea. In this connection it may be noted that evidence of the insolubility of FeO in liquid iron is pretty good evidence of insolubility at lower temperatures because of the well-established rule that "solubility decreases with lowering temperature."

It is quite unfortunate that we have no precise quantitative method for determination of oxygen in steel, and our knowledge of the nature of non-metallic inclusions is but scanty, consequently it has been possible to infer that iron oxide is insoluble in solid metal only from the fact that oxidized inclusions are unaffected by ordinary heat treatments. Yet several recent researches, including the one printed in this number of CHEMICAL & METALLURGICAL ENGINEERING, have thrown doubt upon this popular supposition.

Thus, HUMPHREY found that pure iron heated in air acquired a superficial layer of oxide but apparently was not otherwise affected. If the oxygen pressure was reduced to less than 10 cm. the surface was oxidized only in spots after annealing at 1,000 deg. C., yet the piece acquired great intercrystalline brittleness, a defect which could be cured by annealing in hydrogen, or by heating above Ar_3 and quenching. To explain these facts he assumed two kinds of oxides—the ordinary scale, which is insoluble, and an embrittling sub-oxide, which collects at the grain boundaries—even though invisible under the microscope—and which is soluble in gamma iron. MILLER explains the brittleness of fusion welds and its cure by a reducing anneal, by the same "invisible oxides." LE CHATELIER and BOGITCH more recently maintain that the macrostructure revealed by STEAD'S reagent is due to oxygen distribution rather than phosphorus, while MCCANCE goes further and ascribes the micro-ghost lines to oxygen, since this appearance can be destroyed by hydrogen at 1,000 to 1,100 deg. C. (supposedly without difficulty), yet the phosphorus analysis shows no difference. WHITELEY has also proved that micro-ghost lines persist in areas where uniform distribution of phosphorus has been attained, and therefore must be due to some other substance which diffuses with extreme slowness at temperatures below 950 deg. C.

These researches all appear to indicate that there is one extremely tenuous and extremely dangerous oxide commonly observed in steels, besides the well-known and relatively less harmful particles of scale, slag or mixed reaction products. The latter seem to be reduced to metal with extreme difficulty by a hydrogen anneal, while the former, either by reason of its existence in solid solution or by reason of a different composition, reacts much more readily with occluded hydrogen. Under certain circumstances the insoluble oxide apparently may pass into a soluble modification and again revert to insolubility.

Even though one might disagree with MCCANCE that much of the bad reputation of sulphur and phosphorus is due to FeO in the steel, and with GIOLITTI that the phenomenon of transverse fragility is largely enhanced by oxidized inclusions in the steel, it behooves all of us to turn our attention to the many unsolved problems collateral with this recently raised query regarding soluble metallic oxides in steel, their origin and prevention, their effect and cure.

A Thermal Flow Sheet

IN CERTAIN industrial operations it is common to strike a weight balance and a heat balance at appropriate intervals in order to check up on otherwise unsuspected losses. However, this program apparently is not as widely followed in chemical industry as is desirable. If every source of energy is taken into consideration, and the ways in which this energy is used or dissipated ineffectively are recorded regularly, means are often suggested for correcting losses that have not previously been noted.

One can take as an excellent example of the need of thermal analysis the problems connected with the coking of a ton of bituminous coal with production of coke and byproducts. The figures reported recently on the coking of Illinois coal illustrate the importance of this problem. Two thousand pounds of this material averaging 12,500 B.t.u. per pound gives 25,000,000 heat units to account for. Approximately 1,400 pounds of coke of a heating value of about 11,000 B.t.u. per pound accounts for approximately 62 per cent of the original heat available, or, to be exact, 15,400,000 B.t.u. The five and one-half "M" of surplus gas formed would account for approximately 3,100,000 B.t.u. The eight gallons of tar averaging perhaps 140,000 B.t.u. per gallon represents 4½ per cent of the original heat, or, roughly, 1,100,000 B.t.u. Slightly less than four gallons of light oil having about 135,000 B.t.u. per gallon represents 2 per cent more of the original heat, or a little over 500,000 B.t.u. In these products and the ammonia we find about 85 per cent of the heat originally in the coal. The remainder has been consumed in the processes. To be exact, the test referred to showed that 1,430 B.t.u. was used for the coking of each pound of coal as charged to the battery. The analysis of heat dissipated by radiation from the battery, sensible heat in the gas, sensible heat in the coke as pushed from the oven, and heat carried off in the flue gases from the heating chambers of the ovens would be very enlightening to show what has become of this amount of heat, which represents more than 10 per cent of the total originally available. To a certain extent such analyses have been made, but by no means as many such studies of the industrial processes in general have been accomplished as would seem to be well worth while.

Energy these days costs too much money to waste, even if purchased in the form of the cheapest bituminous coal. The chemist, being thoroughly familiar with the physical changes and thermal relations of various stages of the process, may well apply himself to problems like

this. In any industry, that is well standardized, the variations in process are often most clearly pointed out by such study. In new industries means for improvement in efficiency are quickly discovered. In other words, no matter in what stage the industry may be, the thermal study will be well worth while.

In such a study, however, great accuracy may not usually be possible. This, however, is no excuse for omitting attention to the subject. We need more data as to heat conductivity and heat capacity of materials of construction as well as for materials entering into the processes themselves. Without such data an accurate analysis of heat utilization and wastes can, of course, not generally be made. Conditions in this respect are, however, continually improving and increased attention to the application of thermal chemistry will accelerate our investigations of thermal data quite to the advantage of both the industry and the investigations.

Steel Production And Processes

THE steel production statistics for 1919, just made public by the American Iron and Steel Institute, furnish some interesting information as to the vogue of the various producing processes. The amount of production as a whole has been fairly well known since the end of the year through the medium of trade estimates. The output of ingots was 33,694,795 tons, against the record output of 43,619,200 tons, in 1917, and against a capacity that may be estimated at about 52,500,000 tons, which is 50 per cent above the estimated capacity in 1914, when the war began. Thus the output was only about 64 per cent of capacity, but at that it was 11 per cent in excess of the output in 1912 and 1913, the two best tonnage years before the war.

The output of steel castings did not make as good a showing as the ingot output, being 976,437 tons in 1919, against 1,441,407 tons in the record year of 1917 and 1,020,744 tons in 1913, the best year before the war.

The output of rolled material amounted to 24,042,093 tons of rolled steel and 1,059,451 tons of rolled iron, making a total of 25,101,544 tons. The output of rolled iron was the smallest for many years, and was only half the output in 1905, 1906 and 1907, when the wrought iron industry experienced a redivivus. It was about the year 1892 that the production of wrought iron began to decline, there having been growth previously even though the new material, "soft" steel or "mild" steel as it was then generally called, was making great inroads.

The proportion of rolled steel to steel ingot production has undergone some interesting changes. The percentage has been as follows:

Year	Per cent	Year	Per cent
1908	77.5	1914	75.1
1909	77.0	1915	70.2
1910	79.9	1916	73.8
1911	76.3	1917	71.6
1912	76.0	1918	68.6
1913	76.1	1919	71.5

A mere scrutiny of the table would suggest that American steel manufacturers have grown progressively more wasteful, producing more scrap and scale before arriving at the finished rolled material. For the earlier years in the table it is to be remarked, however, that previous to 1912 the semi-finished steel exported was not ascertained and thus some steel was lost in the statistics, though there was no pecuniary loss to the works. The drop in the percentage during the war years was doubtless caused by the heavy cropping involved in the manufacture of shell steel, and this influence appeared in the production of steel for forged shells, since rolled forging blooms and billets are reported as rolled steel output. As for the low percentage in 1919, that is doubtless to be attributed to labor inefficiency. A return to approximately a 76 per cent proportion is to be expected.

The vogue of the duplex process has not increased as much as was expected. The tonnage of "duplex" steel reported, as part of the basic open-hearth output of steel ingots and castings, and the percentage the tonnage comprised of the total basic open-hearth steel output, are shown below:

	Duplex, tons	Percentage
1912	1,438,654	7.3
1913	2,210,718	11.4
1914	835,690	5.1
1915	1,781,491	8.0
1916	3,436,457	11.6
1917	3,791,830	11.8
1918	3,870,017	11.9
1919	2,819,785	11.0

If, however, the steel works had had as much difficulty in the past few years in securing scrap as it was predicted years ago would be the case, there would have been much more employment of the duplex process than is shown, for 11 per cent is no high proportion for the duplex process.

Electric steel makes an excellent showing for 1919, the production, in ingots and castings together, being 384,452 tons, this being the largest output on record outside the 511,364 tons produced in 1918, largely against certain special war requirements.

Two Hundred Academic Ambassadors

GERMANY is planning to continue her ante-bellum practice of exporting scientists stamped with the familiar mark "Made in Germany." Dr. CHARLES SOLF, after ninety days of Ambassadorship in Japan, has established cordial relations and obtained an invitation from Marquis OKUMA for two hundred Herr Doktors to spend their time in Japan, each receiving $10,000 per annum. Two million a year is said to be cheap for the service Japan expects to receive. Half of the Ph.D.'s will be placed in the universities. The others will be engaged in industrial research and development work.

Conditions in Germany are without doubt bad. Many eminent scientists and engineers there cannot obtain remunerative occupation and must emigrate either from their profession or from their country. By going to Japan under the able leadership of Dr. SOLF they can escape the first alternative and technically avoid the second. They will be part of the German Embassy, so to speak, and will function with due regard to the rules of Berlin diplomacy. The doctrine of German supremacy will be taught first, last and always. Science will be gesprochen und gelesen while Kultur is taking root. Japan may get her two million dollars worth of science yearly but if she has to pay the price of subjection to a foreign leader in scientific thought in addition she will be the loser. However, all other nations will owe her a debt of gratitude for harboring this horde of academic ambassadors, for they certainly will build an undesirable propaganda system wherever they go.

Notes on French Industries

From Our Paris Correspondent

Paris, France, September 15, 1920.

THE industrial situation in France will continue to be precarious as long as the coal question is unsolved.

Before 1914 France had to depend on import for 40 per cent of the needed fuel; today its dependence is more accentuated due to the destruction during the war of the greater part of the coal mines in the fighting regions. France needs now annually at least 76,000,000 tons, this being the tonnage used during 1913. As the country is expected to produce only 24,500,000 tons, the remaining 51,600,000 tons—i.e., more than 73 per cent of the fuel needed—must be imported. With Germany supplying 19,000,000 tons, Great Britain, United States and Belgium about 15,000,000 tons and 5,000,000 tons from the Saar district, France will have only 63,500,000 tons instead of the 76,000,000 tons needed. The deficit of 12.500,000 tons works great hardship especially on the chemical and metallurgical industries. It is hoped that the government will find a way to remedy this shortage of coal.

Hydro-Electric Industry

The chemists and metallurgists have great hopes that the development of the French hydro-electric power will alleviate the fuel shortage. It is estimated that one hydro-electric horsepower is equivalent to five tons of coal. The country is very rich in waterfalls, especially in the regions of the Alps and Pyrenees. It is estimated that there is available 10,000,000 hp., of which 5,000,000 might be used for the industries. Of this only 2,550,000 hp.—i.e., 1,800,000 kw.—will be in use when all the work now under construction is completed. This figure could easily be doubled if the government would do its share to facilitate development by according concessions and hastening the reclaiming work.

It is safe to state that the present investment in the French hydro-electric industry amounts to over one billion francs. Further water-power developments require vast capital, especially when it is considered that instead of the 500 to 800 fr. pre-war cost per horsepower developed, the post-war cost is from 1,000 to 1,600 fr. Money is not scarce in the country, but the French capitalists are timid and not enterprising. They prefer to stick to the old custom of keeping the greater part of their wealth in cash and investing the remainder in bonds and shares securing them a fixed revenue. It is also a fact that the farmers have grown rich during the war and still continue to grow rich. The French farmer working his small piece of land by the rudimentary methods of a hundred years ago earns enough and does not care to become interested in the industry of the country and in the resulting progress in agriculture.

Alsatian Potash

The annexation of Alsace resulted in France having now the petroleum it needs from the Pechelbrom oil field and the rich potash mines of the Mulhouse district. The potash lies at a depth of about 600 m. in two seams, one of an average thickness of 3.5 m. (about 11 ft.), the other of about 1 m. (about 3 ft.). It is estimated that there is a reserve of 300,000,000 tons of pure potash. Unfortunately the working of the mines was not as active as it ought to have been, due to the difficulties resulting from the uncertainty as to the definite allotments of the mines. The solution lately arrived at is the buying of the mines by the French Government and the leasing to responsible persons or concerns. The government paid 150,000,000 fr., but this sum is simply to mark the entrance in possession; the real value of the mines is estimated to be between two and three billion francs. The leasers, it would seem, will have to abide—in a certain degree at least—by the desiderata formulated by the workmen for the nationalization of the mines. It is to be hoped that the French administration will not lose much time in placing the mines in actual and extensive working order.

Synthetic Ammonia

Up-to-date agriculture would afford a great market for synthetic ammonia. Georges Claude is working now on its production by a process[1] differing from that of Haber in that he uses 1,000 atm. pressure instead of Haber's 200. France requires yearly about 100,000 tons of ammonium sulphate.

The French Dyestuff Industry

The Compagnie Nationale des Matières Colorantes, founded with the moral support of the French Government, which has put at the disposal of the company the powder plant of Oissel (near Rouen), for the first time since its foundation in 1917 has declared a 5 per cent dividend. The company, with which is consolidated the Société des Colorants Français, is now capitalized at 71,000,000 fr.

The most important product manufactured by the company is synthetic indigo, the production being more than 200 tons per month, of which a great part is exported to the United States.

Other products manufactured are direct cotton dyes and acid dyes for wool, and sulphur dyes. The company is working on a program for the manufacture of basic and anthraquinone dyes. It is expected that this program will be in working order by 1921.

The total production of the French plants of various dyes is at present about 600 tons per month, say in round figures about 7,000 tons per year. The French consumption, including that of Alsace and Lorraine, is estimated to be 12,000 tons per year; this shows that much is still to be done in the dye industry to make the country independent of foreign dye products.

The French manufacturers are directing their activities toward the production of special dyes.

Coal and Coke Production in the Saar District During the First Half of 1920

The production of the Saar mines during the first half of 1920 is given in the following table:

	Coal, Metric Tons	Coke, Metric Tons
January	727,465	18,224
February	743,063	18,292
March	839,874	20,141
April	734,665	19,099
May	709,766	18,571
June	763,616	19,676

At the end of June the entire personnel consisted of 69,056 miners and 2,573 engineers and other employees. The net production of coal per man per day reached 470 kg. (about 1,030 lb.).—*Echo des Mines et de la Métallurgie*, Sept. 10, 1920.

[1] See Chem. & Met. Eng., vol. 23, No. 9, Sept. 1, 1920, p. 395.

Foundrymen and Institute of Metals Meeting

Reports on Papers Presented at the Columbus, Ohio, Annual Joint Meeting of the American Foundrymen's Association and Institute of Metals Division of the Mining and Metallurgical Engineers

THE American Foundrymen's Association and Institute of Metals Division of the Mining and Metallurgical Engineers held their annual joint meeting in Columbus, Ohio, Oct. 4 to 8. As is their custom, an exhibit of foundry equipment was also held at the same place, occupying seven of the group of permanent buildings erected on the State Fair Grounds. As pointed out by the president in his annual address, it has rapidly become a problem how to handle this very desirable adjunct to the annual meeting. There is a constantly growing number of applications for space, and it does not seem possible to restrict the amount allotted to each exhibitor. It is the policy of the organization to hold the general meetings in different cities, so that every so often a meeting is held in each section of the country, yet there are few cities which have the necessary exhibition space for a show such as the Foundrymen now stage. Or, given the exhibition space, hotel accommodation for the large number of visitors may not be available, as indeed was the case at Columbus. Lucky were they who were accepted by a hotel—those who came from a distance and wished to stay for more than a day had to scurry around town for accommodation in a private residence.

Simultaneous sessions of the two main organizations, with a meeting of the Electric Furnace Association and a continuous performance at the exhibit, made it rather hard for the man in attendance to be in as many places as he would like. On page 769 of this issue will be found the proceedings of the Electric Furnace Association. Hereafter will be given notes on several papers appearing before the Foundrymen and Institute—subsequently also we hope to give a full account of a very interesting session on Malleable Iron. Little mention will be now made of some important papers read before a session devoted to metallography and general subjects, reserving them for presentation in future issues.

In general, it may be said that the technical sessions were well up to their previous high standard, and in many respects excelled. Particularly noticeable was the large attendance of interested men at all the meetings. As a guarantee of continued improvement in the quality of its transactions, announcement was made at the banquet of the establishment of a fund of $21,000, presented to the Foundrymen's Association by five donors, the income of which is to be awarded to the authors of the best contributions on certain phases of the industry.

Social events of the sort which have come to be expected of the annual event—plant visitation, golf tournament, smoker and banquet—were enjoyed by the members journeying to Columbus. Unfortunately, however, it is a Presidential year, and the committee on arrangements seemed to have forgotten that all who must listen to the speeches might not be of their political faith!

Meeting, American Foundrymen's Association

THE opening session of the American Foundrymen's Association was to receive a number of papers on Gray Iron, but after reading his short paper giving a few experiments using 30 per cent ferrozirconium as a deoxidizer, the meeting became a class in elementary principles of cupola practice, with Dr. Moldenke as instructor, even continuing all afternoon. All his ideas radiated from a main thesis that there were three essentials in good foundry practice, neglect of any one being fatal to the final result. First, one must start with good materials; second, melting practice must be correct; and third, proper gating of the molds must be provided. Defects not obviously due to slovenly workmanship could always be traced to one of these three steps.

George K. Elliott, of the Lunkenheimer Co., presented a brief note drawn from his experience in refining cupola-melted iron under a carbide slag in a basic electric furnace. Sulphur may be reduced from 0.13 to 0.05 in from forty minutes to one hour, depending upon the condition of the slag and the furnace atmosphere. Cost is largely for electricity. Current consumption in such a run would be from 200 to 350 kw.-hr., depending upon the time and superheat required, and the entire cost would range from ¼c. to ½c. per lb. iron. In return for this, the castings, especially if small, machine easier with a large decrease in defectives; transverse test bars are 50 per cent stronger (tensile tests about the same); and carbon is under closer control. Mr. Elliott suggests that a large share of these advantages is due to deoxidation rather than desulphurization. A sulphur content of 0.05 or even 0.07 is in practice now handled so as to be harmless. In other words, one would be unable to fix positively any pronounced advantage in gray iron castings with 0.03 per cent sulphur, due to this low content exclusively. On the other hand, since sulphur has such a tendency to segregate, 0.15 per cent sulphur will harm cast iron much more than three times as much as will 0.05—more like three times three. So well known is this that high-sulphur iron in good service is occasion for remark. Extremely low sulphur, 0.02 per cent, on the other hand, would be chiefly valuable in the assurance that one is far below any danger from this metalloid. A more natural use for foundry duplexing is the production of say 0.06 sulphur castings from 0.15 mixes, a practice which is easily and demonstrably economical in these days of poor coke, costly freight and high sulphur scrap. Electric-refined iron is materially harder than cupola iron from which it is made, more especially when made into small castings. This is largely due to the fact that the manganese otherwise used in making sulphide now exists as carbide, which is a hardener. "This question of hardness is intermingled with the closely related subjects

of the increased attraction of high-manganese irons for carbon, and of the protective influence of high manganese against oxidation in the cupola."

Castings for Machine-Tool Builders

Two interesting talks on making castings for machine-tool builders were given by L. M. Sherwin, of the Brown & Sharp Manufacturing Co., and A. N. Kelley, of the Modern Tool Co. Such castings are seldom produced in large quantity, and, like most others, are made by more or less unskilled men, yet they must be of very high grade, for they are bought by men who know good castings when they see them. A large proportion must be finished all over, so that the slightest porosity would be ruinous. Tables, columns and arms must not warp; must have a fine grain and take a high finish; must be hard to resist wear yet not so hard as to give difficulty in machining. Much of the molding—even to the core making—is done by machines. Green sand molds, properly made of carefully selected sand and faced with 7 to 1 sand and sea-coal mixture, have been very successful. When chills are necessary, they should be sectional, separated somewhat one from another—large chills warp badly and have a very short life. For green molds chill blocks should first be washed with linseed oil, sprinkled with silica sand, and then baked in a core oven. Cupola mixtures must be carefully maintained, and the melting so done as to produce hot clean iron. A siphon tap and mixing ladle are advantageous, but even then special attention must be given to skimming the pouring ladles carefully. Long, flat castings may be poured simultaneously from both ends through horn gates—such rapid filling insures hot iron in all parts of the mold. Another method is to incline the mold so that the flat surface is tilted at about 6 deg. (gated at the lower end). This prevents the iron thinning out and chilling in layers.

Heat Treatment of Steel Castings

A meeting devoted to Steel Castings paid considerable attention to complex heat treatments to produce special qualities. Steel founders in general think of heat treatment as meaning annealing to break up ingot structure. The possibilities of more complex treatments—normalization at various temperatures, drawing or tempering at various temperatures, and quenching at different speeds from different heats—are by no means realized as yet, and a great amount of educational work on fundamentals will be necessary to establish the heat treater in steel foundries. Such papers as that by Fred Grotts, of the Holt Manufacturing Co., will therefore do much to open the eyes of steel founders to the possibilities of their materials, and may also cause the forge-shop men to look to their laurels.

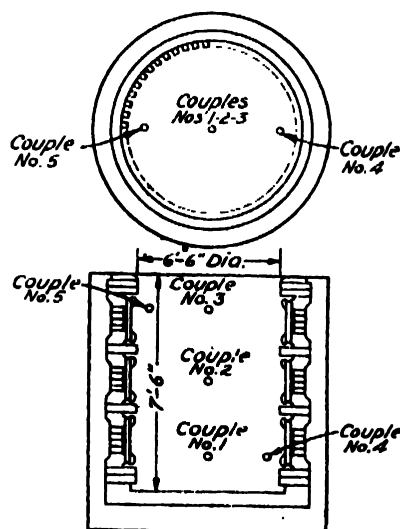


FIG. 1. TEST DATA SHOWING HEAT UNIFORMITY OF ELECTRIC FURNACE



FIG. 2. BATTERY OF THREE VERTICAL ELECTRIC HEAT-TREATING FURNACES FOR GUN FORGINGS

C. H. Gale, of the Pressed Steel Car Co., produced some interesting figures on the absorption of carbon and sulphur when annealing 0.26 carbon steel castings with pulverized coal (2½ per cent S). While no details of the furnace, method of burning, or analysis of furnace atmosphere were shown, the author gives chemical tests tabulated in Tables I and II.

TABLE I CARBON AND SULPHUR ON REPEATED ANNEALING

	Original Analysis	First Anneal	Second Anneal	Third Anneal	Gain
Carbon	0 265	0 291	0 317	0 326	0.061
Sulphur	0 042	0 052	0 055	0 056	0.014

TABLE II—CARBON AND SULPHUR IN SURFACE LAYERS AFTER FIRST ANNEAL

	Original	1/8 In Deep	1/4 In Deep	1/2 In Deep	3/4 In Deep
Carbon	0 286	0 298	0 293	0 288	0.285
Sulphur	0 046	0.055	0 052	0 049	0.047

These results were sufficient to convince the author that increased tensile strength but decreased ductility and transverse bending were due to the change in chemical composition.

Some data on the operating costs and the temperature distribution in vertical furnaces heated by electrical resistors of looped metallic ribbon were given by E. F. Collins, of the General Electric Co. Fig. 1 is a sketch of a moderate sized automatic furnace of this type, and a temperature survey given in Table III shows a remarkable uniformity. Fig. 2 gives a view, with covers rolled back, of a battery of three such furnaces

TABLE III

Time	Thermocouples—Temp. Deg. C. 1	2	3	4	5
11:30	25	25	25	25	25
3:30	527	537	532	530	545
7:30	670	679	671	666	669
11:30	777	783	776	766	780
3:30	858	864	857	849	864
7:30	860	865	862	862	863
11:30	928	934	930	930	928
3:30	933	932	927	925	927
4:30	950	950	952	952	955

6 ft. diameter by 25 ft. deep. Average furnace charge was eleven tons, which was heated uniformly to 1,450 deg. F. with the expenditure of 178 kw.-hr. per ton. After quenching, the forgings were drawn at 1,150 deg. F. in similar furnaces with the expenditure of 85 kw.-hr. per ton. Both heatings together cost $2.23 for power (rate = $0.0085 per kw.-hr.). Total cost of heat treatment on 24-hr. operating basis for the month before the armistice totaled $2.76 per ton.

Institute of Metals Sessions

A STUDY of Brass Foundry Fluxes was presented by C. W. Hill, T. P. Thomas and W. B. Viez of the Westinghouse Company. Such fluxes are added to molten metals preparatory to casting, in order to remove small amounts of impurities introduced by the melting process. Popular materials are NH_4Cl, $ZnCl_2$, NaCl, and borax. Chemically the chloride flux is supposed to effect double decomposition with dissolved or admixed oxide, or to be reduced by the metal itself. However, the authors have been able to cause good fluxing of finely divided aluminum particles by adding aluminum chloride, which is the reaction product of any possible chemical interchange with contained chlorides, and which is itself without any chemical action on the metal or its oxide. Careful tests on molten aluminum have given the same chemical analyses both before and after fluxing, yet the physical effect is marked and extremely rapid. The authors conclude, therefore, that the action is largely physical or mechanical, and suggest that perhaps rapid evaporation of the flux at the points of contact with the surface film may burst this film, allowing the molten particles to unite. Gillett has caused complete coalescence of hot particles by pressure and heat, using no flux whatever. A secondary action of a flux may also be the partial or complete solution of the surface films in the flux before its volatilization.

Fluid covers are supposed to prevent gas absorption—borax, in addition, will dissolve metallic oxides which reach the metal: flux interface. However, most of the common coverings are permeable to hydrogen, which indeed easily passes through a hot crucible wall. In this connection the same authors have studied the solubility of hydrogen in molten copper and brass by bubbling the gas through a silica tube for twenty to thirty minutes, allowing the molten metal to rest at constant temperature for ten minutes, then teeming it into a closed crucible and aspirating the gas evolved upon solidification. The amount dissolved in copper varies with the temperature, as follows:

Saturation Temp., Deg. C.	Hydrogen Evolved on Solidification Mg. per 100 g. metal
1,100	0.60
1,150	0.725
1,200	0.85

Similar tests were made on brasses; plotting against composition, the curve has a minimum at 71 per cent copper and a maximum at 61 per cent copper, thence running off to zero at 36 per cent copper. Preliminary experiments on CO and CO_2 show about the same characteristics as were found for hydrogen.

Since soundness of castings, especially large castings, is dependent upon gas evolution during solidification, it is essential to regulate the composition of the flame, even in covered crucible melting. Phosphor-copper does not remove hydrogen—copper oxide will, but the melt in that case must be further doctored for its oxygen content.

Testing of Sands, Cores and Binders

Recognizing that the ideal test of a new product is its actual use in comparison with a satisfactory article regarded as a standard of excellence, it is also true that the personal equation and a multitude of difficultly controlled variables make it necessary for such a service test to continue for some little time. Preliminary laboratory examinations are then of value even if only to indicate whether a proposed new product has any reasonable chance of succeeding in the plant. F. L. Wolf and A. A. Grubb, of the Ohio Brass Co., have therefore devised certain tests for foundry sands, cores and binders. An ideal core, for instance, should be fairly strong while green, very strong when baked, easily destructible after use, smooth surfaced, permeable, of low gas content, work easily and pleasantly in coremakers' hands. Low-power microscopic examination will give some information to the skilled observer. Shape of grain is not so distinctive as lack of mica, feldspar, calcite, clay and loam. Grains covered with dark films may be expected to absorb an unduly large amount of binder. Screen analysis, up to 200-mesh, will also give considerable information. However, the shape of the grain will have great influence on the relative permeability of sands of similar fineness, even though the percentage of voids is little different. Permeability may be measured by placing a measured amount of sand in a 6-in. U tube. This tube is connected to a 400-c.c. water column aspirator, and the time necessary for this water column to draw a measured quantity of air through the sand gives a figure inversely proportional to the permeability. Cores may also be tested by the same aspirator. A ⅞ x 3-in. core is dipped in melted paraffine, the ends cleaned and then closely fitted into a metal tube connected to the water column. Time necessary to draw a measured amount of air lengthwise through this core is taken as an inverse measure of permeability. Gas content is measured by noting the loss in weight after burning a baked core in an electric furnace at 1,400 deg. C. Linseed oil as binder ordinarily gives less than 1 per cent gas content, and the burned core will usually crumble easily between the fingers. Strength of green cores can be taken by observing its self-supported length as a cantilever. Baked cores are tested in the standard cement testing machine for tensile strength.

Reclaiming Metal From Slag and Sweepings

F. L. Wolf and G. E. Alderson described the methods used by the Ohio Brass Co. for reclaiming metals from slag and sweepings, presenting figures derived from a study of a week's operations. A quantity amounting to 8,666 lb. of "slag" (skimmings) from seventy-one tons metal melted was crushed through a 4-mesh riddle, the undersize, analyzing about 20 per cent Cu, sent to a feed bin, and the oversize, amounting to 1,967 lb., returned to stock, it being clean metal. Credited at 17c. per lb., it represented a value of $335, recovered at a cost of $15.50.

Clean-up from thirty-five molding floors amounted in a week to 21,600 lb. of sweepings, consisting of heavy metallics, spillings, cores and sand. Undersize of 40-mesh screen amounted to 14,050 lb., analyzing less than 1 per cent copper, and was wasted. Through 3-mesh on 40-mesh amounted to 3,770 lb., analyzing 25 per cent copper, and was sent to the feed bin for further concentrating. Metallics amounting to 1,296 lb. were picked from the oversize, which at 17c. per lb. was alone worth $220; recovery cost $41.

Brass-castings sweepings represented material resulting from clean-up after handling small valve and railway castings poured from seventy-one tons of metal, and amounted to 10,000 lb., consisting of light and heavy metallic particles, nails, wires, broken cores, and core sand. Its treatment is similar to that given for foundry sweepings, with the following results:

Through 10-mesh, 6,620 lb. containing less than 1 per cent Cu, to waste. Through 3-mesh on 10-mesh, 2,000 lb. containing 10 per cent Cu, to feed bin. Metal picked from oversize 440 lb. at 17c.; value $75; cost $18.

Simple screening and hand picking costing $75 has thus been able to eliminate 60 per cent of waste, very low in values— mostly metallic oxides which would need elaborate methods for recovery—with a saving of $630 worth of good metal, and 12,469 lb. of a byproduct containing 23.6 per cent copper. Almost any brass foundry should be able to go this far. Whether this byproduct should be marketed or concentrated depends largely upon the quantity being produced. At the Ohio Brass Co. it is treated according to the flow sheet, Fig. 3, in a plant costing about $6,000, with the recovery of 2,300 lb. coarse jig concentrate (metal) valued at $391, and 1,655 lb. fine concentrates, sold to a smelter for $132. Labor and power costs totaled $35 for the wet concentration only. Fig. 4 shows one corner of their clean-up department.

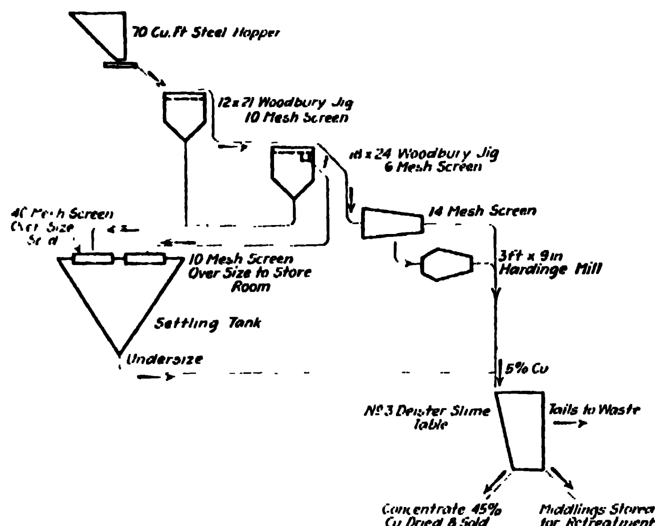


FIG. 3. FLOW SHEET OF RECLAMATION PLANT FOR BRASS FOUNDRY REFUSE

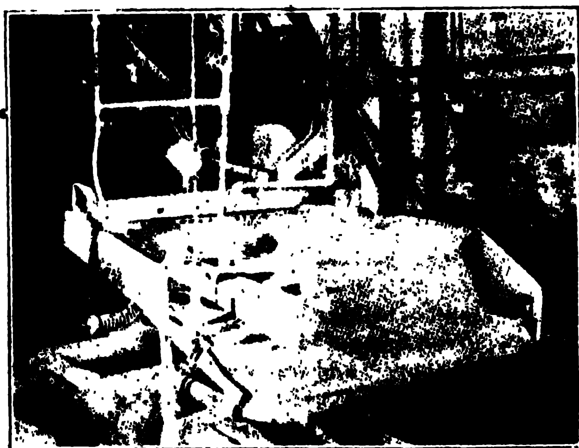


FIG. 4. CONCENTRATING TABLE MILL AND JIGS IN BACKGROUND

Relation of Die-Casting to Foundry Practice

The Relation of Die-Casting to Foundry Practice was briefly discussed by Charles Pack, of the Doehler Die-Casting Co. He noted that the use of permanent molds for lead and tin base alloys having melting points below 650 deg. F. dated centuries back. More recently low-melting alloys were produced with a zinc base. By adding aluminum and copper, lead alloys having 40,000 lb. per sq.in. were produced; elongation was controlled by adding varying amounts of tin. Upon these alloys the present die-casting industry was established. Within the last ten years aluminum: copper alloys have been successfully produced; aluminum: zinc alloys are not so satisfactory, however.

Die-casting brass is purely a problem of discovering metal for the molds. It must not scale at 1,600 to 1,800 deg. F. It must have a low coefficient of expansion and heat conductivity, together with a high elastic limit in order to withstand stresses induced by heat. Extraordinarily high strength is necessary in cores. Since it took about five years to develop a die steel which could be used for aluminum castings melting at about 1,200 deg. F., and the difficulties increase enormously with the temperature, dies for brass and bronze do not seem to be immediate possibilities. Beautiful samples can easily be made in so-called permanent molds, but Mr. Pack knew of no metal which could be used for rapid repetitive work and not produce defectives within a hundred castings. Present experience indicates that die-casting is not economical short of 5,000 pieces.

New Method for Making 15 Per Cent Phosphor Copper

A new method for making 15 per cent phosphor copper was described by P. E. Demmler. It is thought to be safer than commonly used operations where phosphorus is handled in the open, and to be less wasteful than smelting phosphate rock. If copper in the form of ½-in. clean scrap is heated to 750 deg. F. in a closed retort into which is led phosphorus vapor, there immediately results an exothermic combination resulting in local fusion to a black, brittle mass. Equilibrium seems to be reached at 15 per cent P, even though a study of the equilibrium diagram reveals no compound of this percentage. The resulting mass can be remelted under carbon with little loss in phosphorus, and cast in ingots. Phosphorus alloys with zinc, tin and cadmium in the same manner. The same principle may also be used in making such alloys as of arsenic or selenium. Phosphor-tin is unstable on remelting if it contains more than 2 per cent phosphorus, but particles of a crude 13 per cent alloy will readily dissolve in molten tin.

Casting Losses in Aluminum Foundry Practice

Robert J. Anderson of the Bureau of Mines presented general information on Casting Losses in Aluminum Foundry Practice, gained from a questionnaire. It appeared that about 10 per cent of the castings made were rejected. On the basis of 81,000,000 lb. total output, this waste at 12½c. per lb. involves $1,125,000 money loss. Few records are available as to the cause of rejection; one large foundry reported 2.3 per cent defectives due to cores, 3.2 per cent due to molding errors, 2.6 per cent due to cracks, 2.3 per cent due to faulty pouring or run-outs, 2.4 per cent broken in handling and 1.0 per cent due to miscellaneous causes.

Refractories for Electric Furnaces

AN INTERESTING symposium on refractories for electric furnaces was held by the Electric Furnace Association in Columbus, Ohio, Wednesday, Oct. 6. Requirements for high-temperature service were first listed, and then stock was taken of our present raw materials and finished products, contrasting their good points against their shortcomings, with definite recommendations for usage apt to develop the best service. Finally an account was given of some investigative work under way from which might be expected the development of a more useful refractory for extremely high temperatures.

Superlative Requirements for Electric-Furnace Refractories

A contribution from the Foote Mineral Co. outlined the superlative requirements for electric-furnace refractories, noting first that refining furnaces, handling metal and corrosive slag at temperatures limited only by the melting point of the furnace itself, have about reached the limit of their possible development. A new, cheap, dependable refractory with a melting point higher than 1,750 deg. C. is now required, a substance which is highly resistant to sudden temperature variation so as to permit intermittent operation, which has been calcined at electric-furnace temperature and which therefore may possess reasonable constancy of volume. It must resist the scour of slag—or if a roof brick, must withstand the action of fume, hot gases and splatters of liquid. It must be a poor conductor of electricity, else leakage of current may be serious. Lastly, it must have sufficient strength at high temperatures so that arches and side walls may hold up.

Manifestly none of our present refractories possesses all these properties at once, as pointed out by several speakers, notably R. M. Howe of the Mellon Institute, H. F. Staley of the Bureau of Standards and A. F. Greaves-Walker, of the American Refractories Co. Fireclay brick are in widest use in the general metallurgical industry, and many electric-furnace sidewalls are built up with them, but unless the walls are very thin and radiate heat very rapidly, or are water cooled, the inner surfaces melt down quickly, or soften and absorb quantities of slag and metal from the bath. Silica brick, particularly from Pennsylvania and Wisconsin materials, have given best service in roof arches. Silica brick melt at about the same temperature as fireclay, but retain their shape and much of their strength to a high temperature. On the other hand, they suffer wide variation in size if not properly burned, and in any case must be heated or cooled at a low rate. Calcined dolomite, although cheap, air slakes readily, consequently its use is confined to making tamped furnace bottoms and for patching.

Magnesite brick appears to be about the best and most usable of our refractories. Mr. Walker was loud in its praises, and was sure that when the Austrian magnesite re-entered the American market in quantity, much of the present complaint against unsuitable furnace linings would vanish. While MgO is reduced by carbon at 1,800 deg. C., at lower temperatures it withstands corrosion from most melts, fireclay and water vapor being its two greatest enemies. For best results its lime content should be low, and its tendency to spall may be successfully combated by keeping moisture away and preventing strong temperature changes. High lime magnesite or magnesite with 10 to 12 per cent slag admixture is often used for basic furnace bottoms. Mr. McCoy reported a microscopic examination of such a bottom after 200 heats. While the material tamped in contained 16 per cent CaO originally, it now analyzed but 4 per cent, the remainder having been fluxed or worked out. Structurally it was a complex consisting of periclase crystals (MgO) cemented by monticellite, the calcium-magnesium ortho-silicate. Rockwell called attention to the successful use of steel-clad magnesite blocks for bottoms, and particularly in panels built in sidewalls at hot spots near electrodes. A soft-steel box of brick size, with one end missing, is rammed hard with ground dead-burned magnesite. These are not burned, but after drying are laid as headers; upon heating, the iron case melts and a "jointless" surface results which by virtue of its manufacture is more porous than the pressed burned brick, and will stand more rapid temperature changes with less danger of spalling. An instance was cited of a furnace manufacturing chromium-vanadium steel. Whereas thirty heats were the best record on a brick lining, 111 heats were procured from the tamped blocks.

Chromite brick have also been of unsatisfactory quality for many years. Local ores contain only 30 to 40 per cent Cr_2O_3 and brick made of them fail at low temperature. Meantime open-hearth furnacemen have discovered that a layer of chromite is not necessary to separate magnesite from silica brick, consequently their greatest use has been lost. The brick themselves are difficult to make on account of lack of a good bonding substance, and they have a high thermal conductivity. On account of their resistance to either acid or basic baths, however, good chromite brick might be utilized for several courses in sidewalls, near the slag line.

Bauxite is favored as a lining for the hot zones of cement kilns. Other metallurgical uses have not been so successful. As a brick it is difficult to make because of the lack of a desirable binder; it shrinks continuously under heating unless the raw material has been calcined and the brick burned at the most extreme temperatures. After such treatment successful basic bottoms of bauxite have been reported analyzing as high as 15 per cent SiO_2, although 5 per cent would have been a much safer figure. Even fused alumina brick cannot be used in furnace roofs, since they react readily with lime vapors.

This list about exhausts the common refractories now on the market, firebrick which have been in use long enough and in such quantity as to be out of the experimental stage. Alundum and carborundum have been under examination as furnace refractories for some time. Despite their cost, their use may easily prove economical; particularly has this been demonstrated when used as door jambs. Carbon, either amorphous or graphitized, also has special applications in furnace bottoms.

Carborundum as a Refractory

Carborundum as a refractory was discussed at length by Dr. M. L. Hartman, in two papers—one at this meeting and the other read before the Foundrymen's convention. Four types are now on the market: (*a*) Recrystallized carborundum, which are shapes passed through the electric furnace the second time, the bond consisting of intergrown crystals; (*b*) three kinds of bonded carborundum, shapes composed of small crystals bonded with certain refractory mixtures; (*c*) various cements for molding shapes directly in furnaces and for

patching, consisting of carborundum with different bonding materials; and (*d*) firesand, a furnace byproduct consisting principally of silicon carbide and partially reduced oxycarbides, suitable for rammed-up linings.

From these products a wide variation in refractories can be obtained. In general, however, while carborundum has a very high decomposition temperature, it begins to dissociate appreciably under oxidizing conditions at about 1,500 deg. C., and under reducing conditions at 1,700 deg. C. Lead oxide reacts with silicon carbide very rapidly. Iron, steels and their ordinary slags also decompose carborundum. It has no softening or transition temperature short of decomposition; its thermal conductivity is high, its coefficient of expansion is low, it resists non-ferrous metals except lead, and it is extremely hard and durable. A bonded variety is made with good electric resistivity at high temperatures.

Detailed applications are cited. The Baily furnace may have the trough containing the carbon resistor molded of firesand, which has a high electrical resistance, is refractory, and is unaffected by carbon and CO. In the General Electric contact arc furnace, the walls may be of carborundum shapes, highly refractory and with a low coefficient of expansion, thus avoiding metal leakage. Arc furnaces in ferrous service may have roofs of carborundum held very close to the bath, which is desirable, but only if the electrodes enter through insulating sleeves. In non-ferrous practice, the rotative furnaces are popular, heating the metal largely from the lining, which of course must withstand the mechanical wear. To reduce the extreme first cost, an effort is being made to develop a composite lining, consisting of a thin inner coat of carborundum, a stout backing of cheaper refractory, and an outer sheath of insulator. As a matter of fact, the discovery of a really good insulator which stands up and still insulates when heated to a high temperature would cause a revolution in the use of refractories. At present low-melting brick are purposely cooled, wasting enormous quantities of heat in order to maintain the furnace structure. With an efficient insulator a thin lining of some really heat-resistant material could be used, whose present use to build walls is prevented on account of its high cost.

New and Better Refractories

After this discussion of the natural and artificial refractories which are now available in quantity, Mr. Stull, of the Columbus station, Bureau of Mines, together with H. F. Staley, of the Bureau of Standards, pointed out the direction from which new and better refractories might be expected. A study of the SiO_2: Al_2O_3 equilibrium diagram revealed one compound, sillimanite, with a melting temperature about 1,820 deg. C. This mineral is not available in commercial amounts, but a synthetic product of this composition has been made and used. For instance, Mr. Berry noted that aluminous brick containing high silica had proved very good for rocking brass furnaces. Commercially it is manufactured by mixing proper proportions of fireclay and bauxite, grinding, and calcining at 2,700 to 2,800 deg. F. in a fuel-fired kiln. The resulting clinker is then crushed, bonded with a little of the original slurry, slop molded, repressed, dried, and burned at the maximum temperature possible in the ordinary kiln (2,800 deg. F.—far below the melting point of sillimanite).

A similar compound, spinel ($MgO.Al_2O_3$), occurs in that system, melting at about 2,130 deg. C. Like sillimanite, it should remain rigid nearly up to its melting point—melting at a fixed temperature, and not, like a fireclay, through a temperature range. Spinel brick have double the life of magnesite when used as charging doorsills, and should be no more expensive in first cost.

Zirkite brick, made from calcined zirconium carbonate, are also in experimental use. Unfortunately the commercial carbonate usually is high in silica. Zirconia also reacts easily, forming carbides at high temperatures. The last fault does not apply to zircon brick, made of the mineral $ZrO_2.SiO_2$. This compound melts at about 2,560 deg. C., but it is very difficult to make brick with a satisfactory bond. Aluminous binders especially must be avoided. Ground ore is the best agent, but this requires a burning temperature far above the possibilities of any but an electric furnace. Even here the difficulties in getting a uniform high temperature throughout a large volume are obvious and almost insurmountable.

Fused zircon, according to Staley, has permanent volume. It is an acid refractory, being attacked by basic slags and hydrofluoric acid, but not by molten silica. It has a low coefficient of thermal expansion, but at the same time a low thermal conductivity; consequently it is liable to check badly on sudden temperature changes. It has a high electrical resistance. All in all, and especially in view of the occurrence of the mineral zircon in quantity, this refractory presents the best chances for immediate improvement for acid linings.

A Rapid Qualitative Method for Nickel in Steel

By Melvin B. Danheiser*

The method here described was developed as a reliable method for separating nickel steel from other steel without cutting samples for a regular chemical test. In many cases this test can be used on finished steel parts without destroying the piece. The complete test can be made in three to five minutes.

A few filings (about the amount that can be heaped on the head of a pin) are placed upon a watch glass 1½ in. in diameter. A drop of nitric acid sp.gr. 1.42 is added from the end of a glass rod. If action does not start immediately, warm slightly. Allow to effervesce for one-half minute. Add a drop at a time of the ammonia-dimethylglyoxime reagent until action ceases and the solution becomes pink. Allow to stand one minute, place under microscope using a 16 mm. objective and examine for crystals of nickel dimethylglyoxime, which occur as pink needles but when massed have the appearance of a pink pulp.

With a steel containing no nickel a pink or red solution is formed which turns brown on standing. No crystals occur until the solution has evaporated almost to dryness and then they are brown and distinctly different from the nickel dimethylglyoxime crystals.

In order to become familiar with this test a small crystal of a nickel salt is put through the same procedure as the steel and the crystals formed compared with the steel under test.

The ammonia-dimethylglyoxime reagent is made as follows: 5 g. of citric acid is dissolved in 90 c.c. of 1:1 ammonium hydroxide sp.gr. 0.90 and 10 c.c. of a 1 per cent solution of dimethylglyoxime in alcohol added.

*Metallurgist, Imperial Drop Forge Co., Indianapolis, Ind.

Varnish Fume Recovery

New Methods of Recovering Fume From Three Stages of Varnish Manufacture — Description of Plant at the Arco Co.—Other Installations—Experimental and Operating Data—Chemistry of Gum Distillation—Possible Future for Recovery Products

BY CHESTER H. JONES

AS SO often occurs in other industries, the necessity for the protection of the workmen and the neighborhood from objectionable fumes developed in the manufacture of varnish has resulted in an economy for this industry which will go far toward putting it on a scientific basis. It has only been a question of months since the making of varnish in all factories was simply a cooking operation similar to a high-class bakery or ordinary vegetable cannery. The gums were dumped into open copper or iron kettles in proportions dictated by secret "deathbed formulas" and cooked over a coke fire to a point where the "expert" varnish maker determined the batch to be finished. No chemical control was used, and as there was little to keep secret, deep secrecy was therefore maintained.

The fumes from the kettles, mingled with those from the fire, sometimes passed up the stacks—especially when the wind was right—as the builder hoped they would, and were dissipated in the form of a disagreeable "foreign" odor over the surrounding countryside. Fig. 1 shows an installation of this type so common today.

At the conclusion of the cooking the kettles were drawn to the cooling shed, thence to the reducer room, where certain thinners such as light oils and turpentines were poured into the warm mass. This was an occasion of more fumes, obnoxious to the workmen and incidentally a direct loss of the volatile thinner liquids to the manufacturer.

The foregoing paragraphs should be written in the present tense to be strictly accurate, for the description covers the operations in most plants today. The old-time stack process will, however, soon be superseded in progressive plants.

At any rate, the method continued in general use until the officials of a hospital in Providence, R. I., began to complain of the fumes from the plant of the U. S. Gutta Percha Paint Co., and after considerable study on the part of the technical staff the first modern recovery plant was installed there in January, 1918. Since that time the engineers, Perry & Webster, Inc., have issued licenses to sixteen different varnish makers either for the new type stackless plant or for installations in old-type stack plants, for the purpose of recovering values from the fumes developed in both the cooking and thinning operations.

Like most chemical engineering work, the new method comprises the simple application of well-known mechanical principles to existing chemical processes. One of the more recent installations is just going into operation at the plant of the Arco Co., Cleveland, Ohio, and is therefore most suitable for a detailed description of the method.

THE ARCO CO.

This organization is an excellent example of the progressive type of paint and varnish manufacturer, as evidenced by the employment over a number of years of a physical, chemical and japan testing laboratory in control of the plant operations and in research for better methods. Fig. 3 shows a section of the chemical laboratory. All raw materials are analyzed and samples from each batch of finished varnish are held for two years against complaint from the consumer. The laboratory work is divided into four departments—namely, house paint and enamels, machinery finishes, automobile color and varnish and finishes, and japanning and baking enamels.

Tests are made both at the finish of the batch and after thirty days' standing. If trouble is encountered, the goods are returned, but if laboratory tests prove satisfactory, trouble men are sent out to help the consumer.

Naturally a company pursuing such policies would be among the first to adopt the new recovery methods.

VARNISH RECOVERY PLANT

Fig. 2 is the building at the Arco plant housing the new sixteen-fire, two-story stackless varnish process. It is designed for future extension to forty-eight-fire capacity. Note the basement entrance in the foreground arranged for trackage to remove ashes. The ashpits are all below the operating floor and are so arranged that gas or oil firing may be substituted for the coke grates at any future time. The large stack has no connection with the process. The two steel stacks at the end of the building lead from the exhausters which create the positive draft on the coke fire. The door on the side of the building at the extreme left opens into the elevator shaft through which raw materials are lifted to the second floor, daily storage, shown in Fig. 4.

Here the solid materials are stacked in concrete compartments, while the various oils are pumped to tanks directly above. In charging, the gums are shoveled into the hoppers appearing in the center on the floor and the oils are emptied through a battery of pipes terminating near a Kron platform scale in the operating room.

Fig. 5 shows the melting or operating floor, with eight fires on each side. The pair of overhead rails carry a traveling weighing hopper which is filled with the gums through the spouts leading from the hoppers above described and empties directly into the cooking kettles conveyed on trucks beneath. When a kettle is charged with gums it is wheeled onto the platform scale to receive the necessary charge of oils. The traveling hopper may also be moved into the cooling and thinner rooms on the overhead rails.

The two Buffalo Forge Co. planing mill exhausters for the fire combustion smoke appear on the balcony at the extreme end of the room. (Exhauster stacks shown outside in Fig. 3.) The positive suction over each fire insures sufficient draft to secure nearly perfect

combustion with a scarcely noticeable smoke issuing from the stacks. These exhausters have no connection with the fume-recovery system.

COOKING OPERATION

The charged kettle is placed over the fire and fume exhaust cover is lowered as shown in Fig. 5. These covers are shown raised in the left hand bank. The lids are attached to a collapsible swinging pipe which is easily manipulated by hand. Tycos thermometers attached to long pipes are thrust through the kettle door into the mass as shown in the hand of the operator to the left in Fig. 5.

The cooking time required about an hour and a half under the old system, but thirty minutes is sufficient with the new arrangement. The temperature varies with the formula of the mix, but the maximum requirement is about 750 deg. F. (399 deg. C.). The lid and exhaust system minimizes the possibility of a batch flashing or burning as under the old method. Screens are inserted in the flues to localize spontaneous combustion. Before passing on to the fume recovery system compare the operating floor with the old method shown in Fig. 1 as carried on in the same factory.

COOLING THE BATCH

Because of the high temperature of the melt when removed from the fire it is not possible to add the volatile thinners until the batch has been considerably cooled. The kettles are therefore drawn to the cooling room on the same floor and placed beneath lids with flues connecting to the same fume exhaust recovery system as operates in the cooking process. A corner of the cooling room appears in Fig. 6. Here the electric switches are also located and from this point the operator may control any motor in the plant, including those in the third floor penthouse.

VARNISH FUME RECOVERY

The fumes from the two sources mentioned above are drawn through a water-scrubbing tank located in the penthouse where the heavy particles settle out and the remainder passes through the turbine, Spencer Turbine Cleaner Co., to a similar tank filled with lime water, where the finer particles are precipitated. The apparatus for one bank of eight fires is shown in the foreground of Fig. 7.

There are three points of recovery from the fume system. First, the product which condenses on the inner surfaces of the piping ahead of the water tank and which is piped back to the kettles from convenient points in the line; second, the condensate caught in the water-scrubbing tank which settles to the bottom and is drawn off to be eventually returned to the kettles; and third, the product of the lime water-scrubbing tank, a sort of lime soap or emulsion, which is boiled to remove the excess lime water and neutralized with acid before returning to the kettles.

The amount of fume which is finally released to the atmosphere is so small as to be scarcely discernible to the eye and has only a slight soapy odor. The vacuum maintained on the kettles is just sufficient to carry off the fume and give a minimum amount of work to the scrubbing tanks.

The thinner recovery system operates entirely separate from the combusion or fume recovery system. When the kettles are sufficiently cooled but still warm they are wheeled to the thinner room, a section of which appears in Fig. 8, and placed beneath the movable lids. The oils or thinners are added to produce a varnish of the desired consistency. These thinners are so volatile it is necessary to maintain a suction on the line during the operation to carry the fumes into the flues, where they are condensed in the cleverly constructed piping system, the condensate flowing back to the kettles. A Buffalo Forge Co. planing mill exhauster is installed on the roof to produce the required vacuum and the air, containing less than 2 per cent of the total volatiles used, is carried directly to the atmosphere. It is reported by one manufacturer that whereas 8 per cent of the total thinners employed were previously lost 6 per cent of the total is now recovered, giving a net loss of only 2 per cent.

CLARIFYING FOR THE MARKET

While this completes the description of the new process at the Arco plant, it seems pertinent to mention the method of finishing the product for the market. The varnish is pumped from the kettles in the thinner room to large settling tanks, thence through a centrifugal separator of the DeLaval type to the final storage. The centrifugal method of clarifying as shown in Fig 9 is thought much superior to other means involving filtration. Fig. 10 shows a battery of tanks containing separate manufacturing lots ready for the market.

OTHER INSTALLATIONS

Before taking up the economies effected through this system it may be helpful to show two other installations. The Patterson-Sargent Co., of Long Island City, N. Y., installed a six-fire unit several months ago. It has operated successfully from the start. Fig. 11 shows the building, with penthouse on top and condenser pipes on the outside. The large stack has no connection with the varnish recovery. The elbow pipe on top of the penthouse carries the final exhaust from the varnish kettles and the square stack emits the combustion gases. Room has been provided for installing an additional unit of six fires. Connersville blowers were used on the fume system.

Fig. 12 shows the fires in the melting room, and the cooling apparatus is seen through the doorway on the left. Fig. 13 also shows the cooling room and storage with provision for additional units. The building was planned to house an old-type stack plant, but during the process of erection was changed to accommodate the new fume recovery system. This accounts for the unnecessary amount of overhead space in the cooling room.

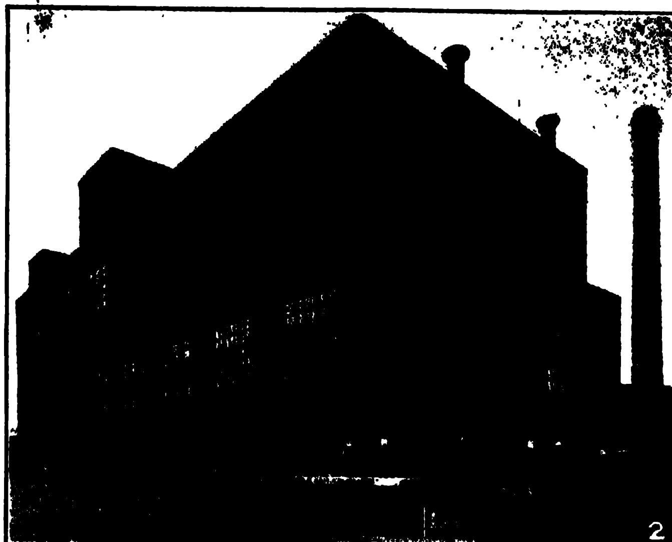
Fig. 14 is one of the fires in the original installation at Providence, R. I., where a stack plant was changed to accommodate the stackless system. Roots blowers were installed on the exhaust line.

One of the latest design two-story plants just being erected in the West is shown in plan and section, Figs. 15 and 16. Out of sixteen plants only two have been installed for the primary purpose of eradicating the nuisance to the neighborhood arising from the escaping fume; the benefits of recovery of fume value, fire prevention, increased efficiency and lessened cost of operation were inducements in the other instances.

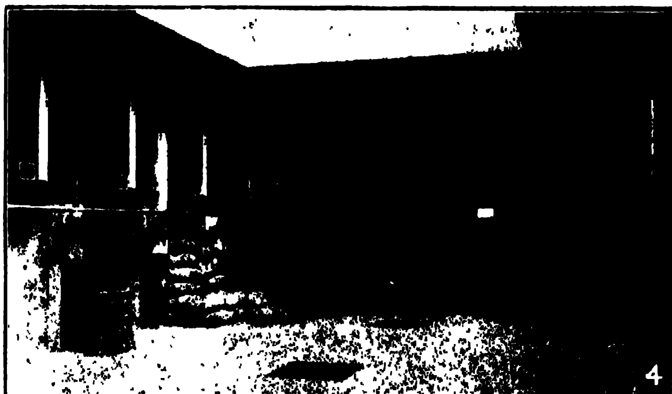
COOKING LOSSES IN STACK PLANTS

While operating losses are somewhat hard to determine accurately on a weight basis due to the fact that the blend or mix consists of several gums of varying specific gravities and values and to the fact that there are gains in weight through chemical reactions such as













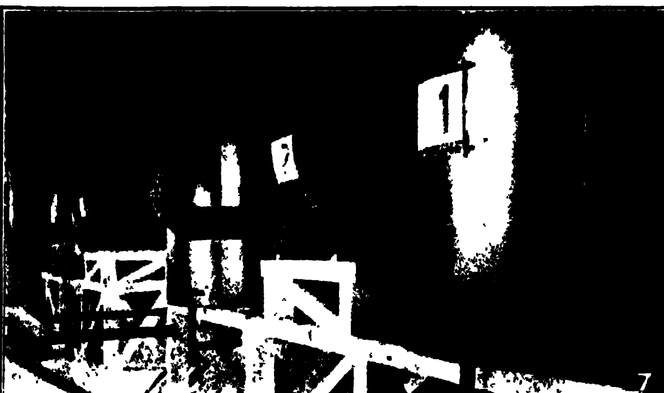




Fig. 1. Common type of varnish-making installation.
Fig. 3. Section of chemical laboratory.
Fig. 5. Melting or operating floor.
Fig. 7. Varnish fume-recovery apparatus.

Fig. 2. Arco Company plant.
Fig. 4. Storage room.
Fig. 6. Cooling room.
Fig. 8. Thinner recovery apparatus.









Fig. 9. Centrifugal clarifiers.
Fig. 12. Melting room.

Fig. 10. Storage tanks for finished products.
Fig. 13. Cooling room and storage.

oxidation, considerable data have been prepared by several operators. The following from Circular 96 issued by the educational bureau, scientific section of the Paint Manufacturers' Association of the U. S., in co-operation with the National Varnish Manufacturers' Association, shows that the over-all loss runs from 12 to 20 per cent and the actual gum loss may run from 30 to 42 per cent of the amount used in the varnish.

The figures are all on losses shown by varnish bases previous to reducing by turpentine or other thinners.

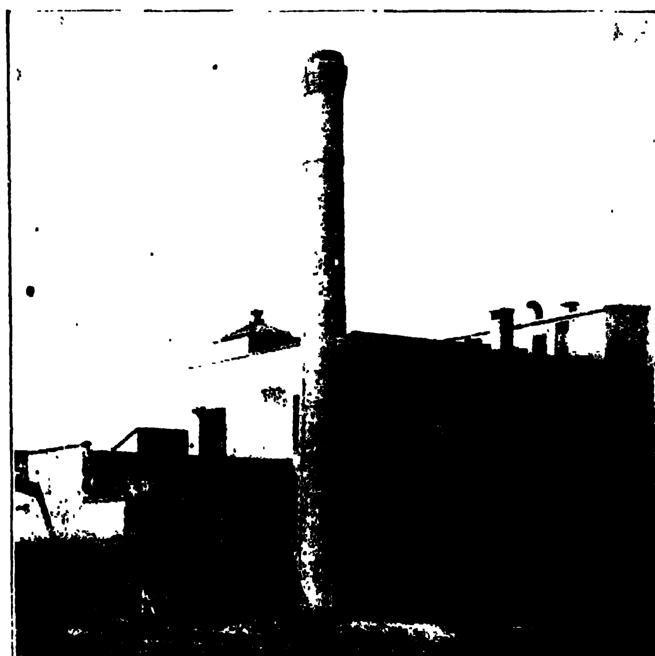


FIG. 11. THE PATTERSON-SARGENT PLANT

GUM LOSS IN KETTLE

	Over-all Loss by Weight, per Cent	Loss of Gum Used by Weight, per Cent
Long Oil Kauri Varnish	12.4	30
Short Oil Kauri Varnish	20.0	34
Long Oil Manila Varnish	16.0	40
Short Oil Manila Varnish	20.0	42

PROPORTION BY WEIGHT OF OIL AND OF GUM IN FUME

	Oil, per Cent	Gum, per Cent
Long Oil Kauri Varnish	33⅓	66⅔
Short Oil Kauri Varnish	11.5	88.5
Long Oil Manila Varnish	27.3	72.7
Short Oil Manila Varnish	12.5	87.5

This latter table shows that the gum loss is greater in weight. If the cash value is considered the proportionate loss is even greater, as follows:

FUME LOSS PROPORTIONS IN MONEY VALUE

	Oil, per Cent	Gum, per Cent
Long Oil Kauri Varnish	15	85
Short Oil Kauri Varnish	5.4	94.6
Long Oil Manila Varnish	24.7	75.3
Short Oil Manila Varnish	11.0	89.0

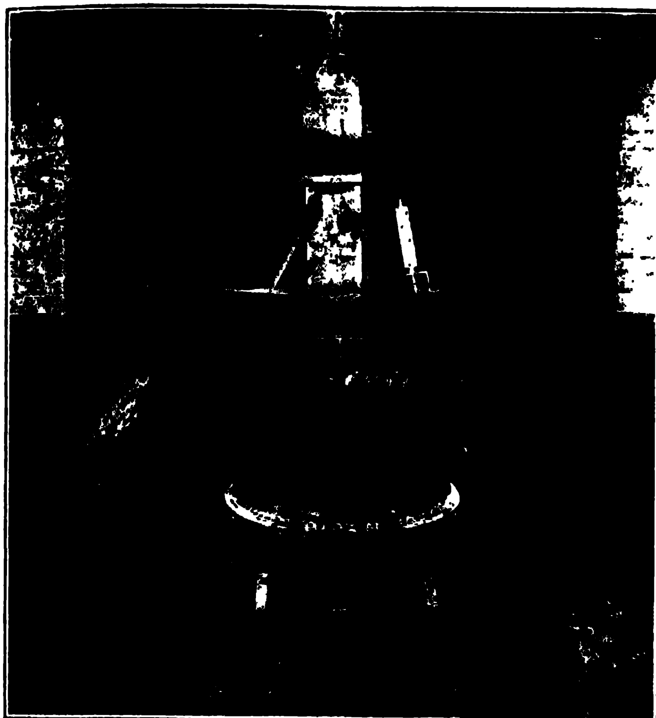


FIG. 14. ONE OF THE FIRES IN THE ORIGINAL INSTALLATION AT PROVIDENCE, R. I.

Further tests made on losses in cooking oils alone, given in Bulletin 95 issued by the Educational Committee are also of interest.

	Sp.Gr	Percentage Weight Loss	Percentage Volume Loss
Raw Linseed Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9477	2 90	4 46
550 deg. F. (290 deg. C.), for 4 hr	0.9690	8.60	12 05
Varnish Makers' Linseed Oil:			
500 deg. F. (260 deg. C.), for 4 hr.	0.9482	2.20	3.88
550 deg. F. (290 deg. C.), for 4 hr.	0.9666	5.40	8 79
Fish Oil (Menhaden):			
500 deg. F. (260 deg. C.), for 4 hr	0.9671	5.16	8.45
550 deg. F. (290 deg. C.), for 4 hr.	0.9800	9.16	13.47
Soy Bean Oil:			
500 deg. F. (260 deg. C.), for 4 hr.	0.9391	4.52	5.80
550 deg. F. (290 deg. C.), for 4 hr.	0 9498	8 57	10.81
Oriental Perilla Oil:			
500 deg. F. (260 deg. C.), for 4 hr.	0.9560	4.79	6 79
550 deg. F. (290 deg. C.), for 4 hr.	0 9800	8.73	12 83
Sunflower Seed Oil:			
500 deg. F. (260 deg. C.), for 4 hr.	0.9345	4 04	5 12
550 deg. F. (290 deg. C.), for 4 hr.	0.9430	9.33	11 16

In his bulletin "Fume Control in the Varnish Industry," Henry A. Gardner says: "The equivalent of a varnish kettle running continuously on one of these type varnishes would thus indicate a yearly fume loss on gum and oil equivalent in money to the cost of the products lost. It should, however, be pointed out that even entire recovery of fumes would not necessarily mean recovery of the original value of the products from which they were derived. This is due to the fact that oil and gum fumes recovered as condensates by any system are of different composition than the materials of their origin and of much less money value. Nevertheless, the data show the importance of fume recovery; and it is quite possible that certain products might be fractionated from condensed gum fumes that would have an even greater money value than the original gums."

Those who have witnessed the new plants in operation are strongly impressed with the facts that a negligible amount of fume is released to the atmosphere, that a large amount of material is directly recovered as primary condensate and that there is unlimited scope for development by research of the products taken in the water and alkali scrubbers. Manufacturers using the new plant are enthusiastic over this last point.

Considerable importance is given in Mr. Gardner's bulletin to the work done by Smith and dePierres as presented before the Eighth International Congress of Applied Chemistry as to autoclave determinations of varnish materials.

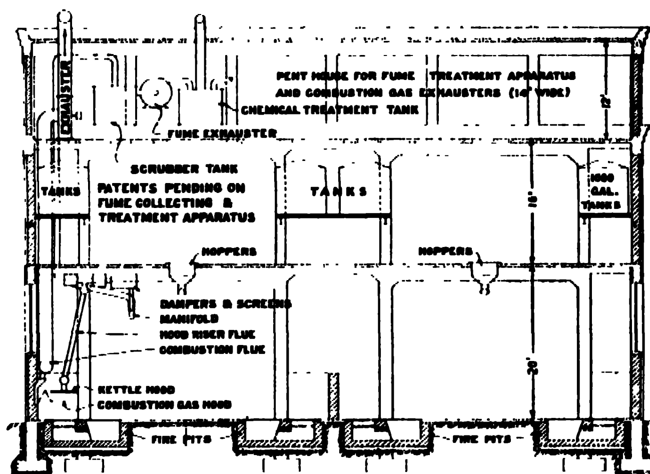


FIG. 16. CROSS-SECTION 2-STORY, 24-FIRE, STACKLESS VARNISH PLANT

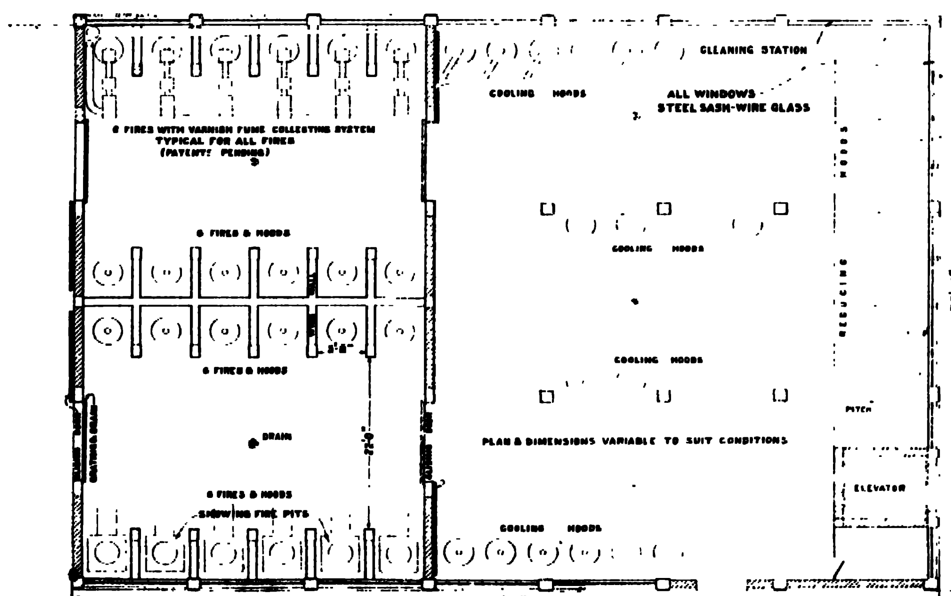


FIG. 15. FIRST FLOOR PLAN 2-STORY, 24-FIRE, STACKLESS VARNISH PLANT

RECENT DATA FROM ACTUAL PLANT OPERATION

The following fume loss data and calculations taken from a manufacturer's factory records on four typical high-grade batches under good practice with kettles covered while melting the gum and open during the cook-out and finishing, while unconfirmed by the writer, may be considered authentic. It is necessary only to figure the materials at present market conditions to see the large saving effected through fume recovery.

SHORT OIL MANILA VARNISH

Type, 10 gal. oil to 100 lb. gum

Actual formula:		Lb
Kettle Charge:		
Hard white manila		190 00
W.W.		10 00
Drier salts		6 00
Treated oil (20 gal.)		155 00
Total kettle charge		361 00
Thinner turps (5 gal.)		35 00
Texaco (55 gal.)		357 50
Total formula		753 50
Oil, loss prior treatment		12 00
Total materials used		765 50
Total yield of varnish		636.40
Loss, 20 per cent		129 10
Distribution of Above Loss	Lb.	
Oil loss.		
On previous oil treatment (8 per cent of bulk)	12 00	
Drier loss (figured at 50 per cent)		
Including loss of drier in oil treatment	6 00	
Thinner losses:		
Turps and Texaco 6 85 per cent of amount used	27.00	
Total		45 00
Gum losses (by difference)		
42 per cent of original weight of gum used		84 10

LONG OIL MANILA VARNISH

Type, 25 gal. oil to 100 lb. gum

Actual formula:		Lb
Kettle charge:		
Hard white manila.		200 00
Treated oil (50 gal.)		387 50
Total kettle charge		587 50
Thinners:		
Turps (5 gal.)		35 00
Texaco (55 gal.)		357 50
Total thinner used		392 50
Total formula		980 00
Oil loss on prior treatment		30 00
Total materials used		1,010 00
Total yield of varnish		870 00
Loss, 16 per cent		140 00
Distribution of Above Loss	Lb	
Oil loss:		
On previous oil treatment (8 per cent of bulk)	30 00	
Drier loss (at 50 per cent):		
Including loss of drier in oil treatment	3 00	
Thinner losses:		
Turps and Texaco at 7 per cent of amount used	27 50	
		60 50
Gum losses (by difference):		
40 per cent of original weight of gum used		79 50

SHORT OIL KAURI VARNISH

Type, 8 gal. oil to 100 lb gum

Actual formula:		Lb.
Kettle charge:		
Ex. No. 1 Kauri		200 00
Treated oil (16 gal.)		124 00
Drying salts		10.00
Total kettle charge		334 00
Thinners:		
Turps (50 gal.)		350 00
Total formula		684 00
Oil loss on prior treatment		8.85
Total materials used		692 85
Total yield of varnish:		
78 gal. at 7½ lb		585 00
Loss, 20 per cent		107.85
Distribution of Above Loss		
Oil loss:		
On previous oil treatment (8 per cent of bulk):	Lb.	
Volume loss 1.18 gal. at 7.75 lb	8.85	
Drier loss (at 50 per cent):		
Including loss of drier in oil treatment	7.00	
Thinner losses:		
Turps at 6.8 per cent of amount used	24 00	
		39.85
Gum losses (by difference):		
34 per cent of original weight of gum used.		68 00

LONG OIL KAURI VARNISH

Type, 25 gal. oil to 100 lb. gum

Actual formula:		Lb.
Kettle charge:		
XX Kauri		200.00
Oil not treated (50 gal.)		387.50
Drier salts		4.5
Total kettle charge		592 0
Thinners:		
Turps (50 gal.)		350
Total formula		942
Yield		825
Loss, 12.4 per cent		117
Distribution of Above Loss	Lb.	
Oil loss (8 per cent of bulk)	30 00	
Drier loss (at 50 per cent)	2.25	
Thinner losses:		
Turps at 7 per cent of amount used	24 50	56.75
Gum loss (by difference):		
30 per cent of original weight of gum purchased		60.00

The oil measured and weighed cold at the start 100 gal. and 750 lb. and at the finish 92.6 gal. and 717.65 lb., giving a volume loss of 8 per cent. Previously treated linseed oil was used in all cases excepting the Long Oil Kauri Varnish in the last batch, on which, being taken without previous treatment, all shrinkage occurred in the kettle. Where the oil had been previously treated the shrinkage on factory practice was 8 per cent by volume and the weight per gallon increased from 7½ lb. for the untreated to 7.75 per gal. for the treated oil.

Drier losses are calculated on basis of one-half of all drier salts dropped out or left in filters from batch and also from drier used in oil treatment.

CONCLUSION

The new stackless system then is the practical application of theories long extant. Its mechanical features are such as to secure the desired recovery without radical departure from habits of previous operations. A development at once extremely beneficial in its chemical accomplishments and conservative in its mechanical features should be especially valuable for installation in the plants of going concerns. As each new industry is added to the growing list of those which have entered upon the era where economies are effected through technological considerations, where progress is speeded up through scientific control and research, there comes an increased inspiration to technical men in every line carrying them forward toward the vision where science and craftsmanship merge into art.

In conclusion the author wishes to acknowledge the courteous co-operation of Perry & Webster, Inc., and officials of the Arco Co. and the Patterson-Sargent Co. in supplying information and opening their plants to inspection.

America's Tobacco Industry

In the production of tobacco, the United States leads all other nations, the annual quantity being estimated by the Department of Agriculture at 1,000,000,000 lb. British India is second with about 450,000,000 lb. Before the war, Russia was third with 177,000,000 lb., the Dutch East Indies fourth with 163,000,000 lb., and Austria-Hungary fifth with 158,000,000 lb.

Figures for the United States production in 1919 are given as 1,389,000,000 lb., which at the present time represents more than half of the world's production.

Likewise, the United States is the biggest exporter of tobacco, having sent abroad 765,000,000 lb. in 1919.

Metallography of Arc-Fused Steel*

Various Lines of Investigation Are Utilized to Support the Idea That Microscopic "Plates" Existing in Fusion Welds Are Due to Nitrogen; That the Plates Are Very Persistent, and Are Not Responsible for the Low Ductility of the Metallic Piece

BY HENRY S. RAWDON, EDWARD C. GROESBECK AND LOUIS JORDAN†

AN ARTICLE entitled "The Physical Properties of Arc-Fused Steel," published in CHEMICAL & METALLURGICAL ENGINEERING for Oct. 6, 1920 (vol. 23, p. 675) described the methods used in building up blocks of arc-fused metal of size large enough to furnish a tension specimen. Fusion welds evidently are fundamentally different from other types of joints in that the metal at the weld is essentially a casting. A preliminary study of a considerable number of specimens welded under different conditions confirmed the impression that the arc-fusion weld has characteristics quite different from other fusion welds.

In the present study, of which both the former contribution and the present form a part, two types of electrodes, a "pure" iron called "A" and a mild steel called "B," were used, in the bare condition, and also after receiving a slight coating. With these were included a set of similar specimens prepared outside of the Bureau by expert welding operators. During the fusion the composition of the metal of the two types of electrodes is changed considerably by the "burning-out" of the carbon and other elements, the two becoming very much alike in composition. A very considerable increase in the nitrogen content occurs at the same time, as shown by chemical analysis.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal. All of the specimens showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, lack of intimate union, etc. These features of unsoundness are, seemingly, a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of the arc-fused metal. The observed elongation of the specimen under tension is due to the combined action of the numerous unsound spots rather than to the ductility of the metal. That the metal is inherently ductile, however, will be shown by the changes in the microstructure produced by cold-bending. By taking extreme precautions during the fusion, a great deal of the unsoundness may be avoided and the mechanical properties of the metal be considerably improved. The specimens described, however, are more representative of actual present practice in welding.

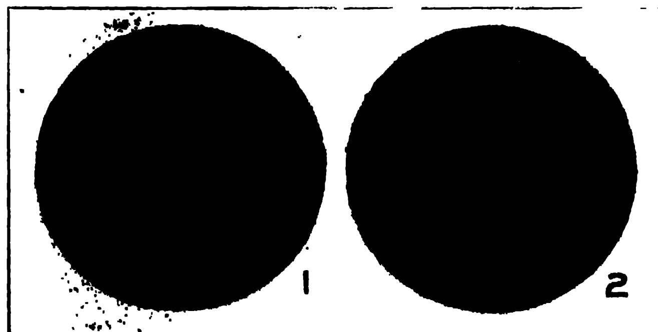


FIG. 1 "A" electrode, $\frac{5}{32}$-in. diameter. Annealed as received.

FIG. 2. "B" electrode, $\frac{5}{32}$-in. diameter. Cold-drawn.

Both × 100. Picric acid etching.

GENERAL FEATURES OF MICROSTRUCTURE

For purposes of comparison the microstructure of the electrodes before fusion is shown in Figs. 1 and 2. The "A" electrodes have the appearance of steel of a very low carbon content; in some cases they were in the cold-rolled state; all showed a considerable number of inclusions. The "B" electrodes have the structure of a mild steel and are much freer from inclusions than are those of the other type. It is undoubtedly true, however, that the condition of the arc-fused metal with respect to the number of inclusions is a result of the fusion rather than of the initial state of the metal.

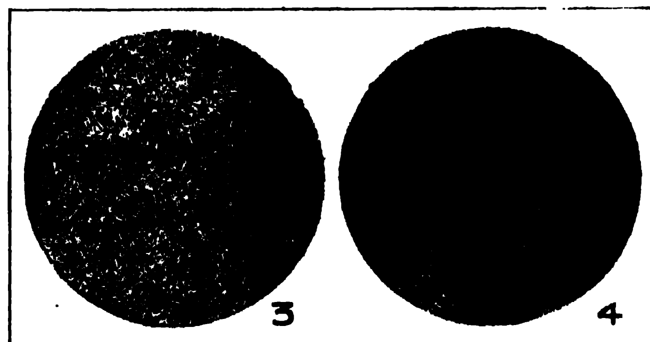


FIG. 3. Columnar structure of B_2 66. Five per cent picric acid etching.

FIG. 4 Equi-axed structure of AD, × 200. Two per cent alcoholic HNO_3 etching.

It is to be expected that the microstructure of the material afer fusion will be very considerably changed, since the metal is then essentially the same as a casting. It has some features, however, which are not to be found in steel as ordinarily cast. The general type of microstructure was found to vary in the different specimens and to range from a condition which will be designated as "columnar" (Fig. 3) to that of a uniform fine equi-axed crystalline arrangement (Fig. 4). This observation held true for both types of electrodes, whether bare or covered. In the examination of cross-sections of the blocks of arc-fused metal, it was noticed that the equi-axed type of structure is prevalent throughout the interior of the piece and the columnar is to be found generally nearer the surface—i.e., i-

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†Physicist, Physical Chemist and Associate Chemist, respectively, Bureau of Standards.

the metal deposited last. It may be inferred from this that the metal of the layers which were deposited during the early part of the preparation of the specimen is refined considerably by the successive heatings to which it is subjected as additional layers of metal are deposited. The general type of structure of the tension bars cut from the blocks of arc-fused metal will vary considerably according to the amount of refining which has taken place as well as the relative position of the tension specimen within the block. In addition it was noticed that the columnar and coarse equi-axed crystalline condition appears to predominate with fusion at high-current densities.

Microscopic Evidence of Unsoundness

In all of the specimens of arc-fused metal examined microscopically there appear to be numerous tiny globules of oxide as shown in Figs. 3 to 12. A magnification of 500 diameters is usually necessary to show these inclusions. In general they appear to have no definite arrangement, but occur indiscriminately throughout the crystals of iron.





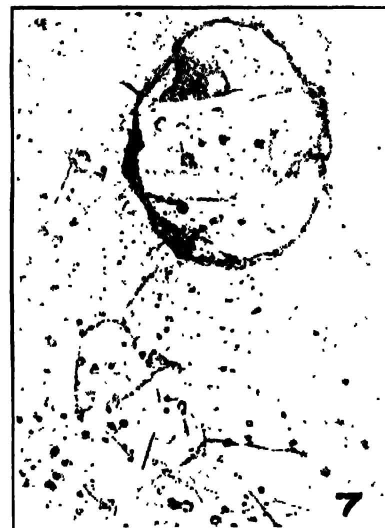


FIG. 5. SPECIMEN AD_9 FIG. 6. SPECIMEN A_{10} (HEATED 6 HR. IN VACUO) FIG. 7. SPECIMEN AD_{10}

"Metallic-globule" Inclusions in Arc-Fused Iron. Figs. 5 and 7 etched with 2 per cent alcoholic solution of HNO_3. Fig. 6 with 5 per cent picric acid. × 450.

A type of unsoundness frequently found is that shown in Figs. 5, 6 and 7; this will be referred to as "metallic-globule inclusions." In general these globules possess a microstructure similar to that of the surrounding metal, but are enveloped by a film, presumably of oxide. It seems probable that they are small metallic particles which were formed as a sort of spray at the tip of the electrode and which were deposited on the solidified crust surrounding the pool of molten metal directly under the arc. These solidified particles apparently are not fused in with the metal which is subsequently deposited over them—i.e., during the formation of this same layer and before any brushing of the surface occurs. By taking extreme precautions during the fusion, a great deal of this unsoundness may be avoided and the mechanical properties of the metal may be considerably improved.

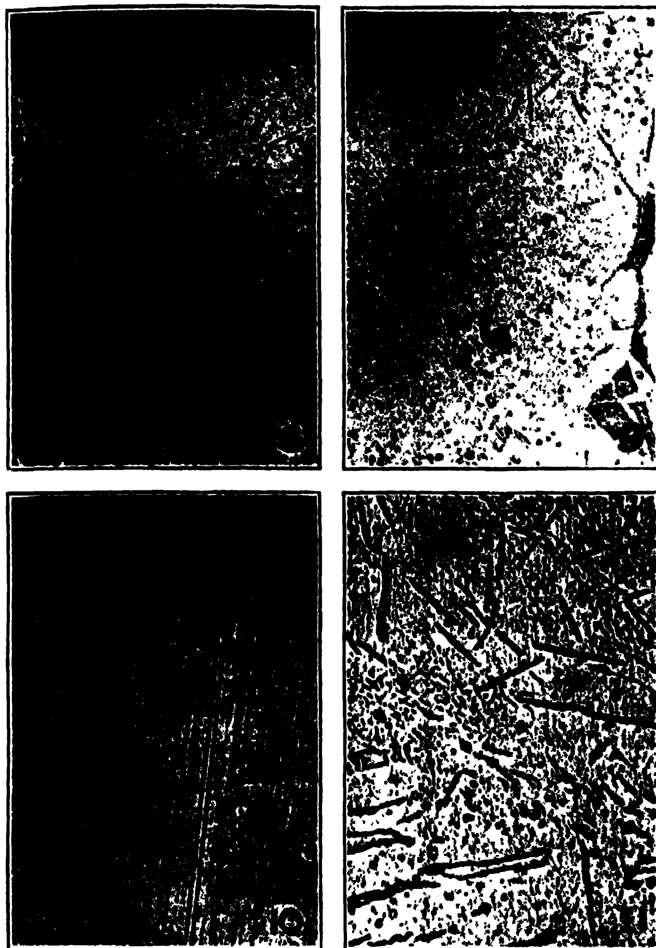
The most characteristic feature of the steel after fusion is the presence of numerous lines or needles within the crystals. The general appearance of this feature of the structure is shown in Figs. 8 to 11 inclusive. The number and the distribution of these needles were found to vary greatly in the different specimens. In general, they are most abundant in the columnar and in the coarse equi-axed crystals; the finer equi-axed crystals in some specimens were found to be quite free from them, although exceptions were found to this rule. In general, a needle lies entirely within the bounds of an individual crystal. Some instances were found, however, where a needle appeared to lie across the boundary and so lie within two adjacent crystals. Several instances of this tendency have been noted in the literature on this subject.[1] The needles have an appreciable width, and when the specimen is etched with 2 per cent alcoholic nitric acid they appear much the same as cementite—i.e., they remain uncolored, although they may appear to widen and darken if the etching is prolonged considerably. The apparent widening is evidently due to the attack of the adjacent ferrite along the boundary line between the two. The tendency of the lines to darken when etched with a hot alkaline solution of sodium picrate, as reported by Comstock,[2] was confirmed. Fig. 10 illustrates the appearance when etched in this manner. The needles are sometimes found in a rectangular grouping—i.e., they form angles of 90 deg. with one another. In other cases they appear to be arranged along the octahedral planes of the crystal—i.e., at 60 deg. to one another. This is best seen in specimens which have been heated, as explained below.

In some of the specimens certain crystals showed groups of very fine short needles (Fig. 11). The needles comprising any one group or family are usually arranged parallel to one another, but the various groups are often arranged definitely with respect to one another in the same manner as described above. Similar needles have been reported in the literature by Miller.[3]

[1] G. F. Comstock, "Microstructure of Iron Deposited by Electric Arc Welding," Bull. 145, American Inst. of Mining Engrs., p. 43. See Fig. 8. E. F. Law, W. H. Merrett, and W. P. Digby, "Some Studies of Welds," *Journal*, Iron and Steel Inst., vol. 83, (1911—I), p. 103. See Fig. 30. J. Caldwell, "Report to the U. S. Shipping Board, Emergency Fleet Corporation, on Electric Welding and Its Application in the United States of America to Ship Construction." (Published by the Emergency Fleet Corporation, 1918), p. 251. See Fig. 14B.

[2] G. F. Comstock, "Microstructure of Iron Deposited by Electric Arc Welding," Bull. 145, American Inst. of Mining Engrs., p. 43. See Fig. 8.

[3] S. W. Miller, "Path of Rupture in Steel Fusion Welds," Bull. 146, American Inst. of Mining Engrs. p. 311.



FIGS. 8 TO 11. CHARACTERISTIC "NEEDLES" OR "PLATES" × 375.

Fig. 8. Specimen BD_6 etched with 5 per cent picric acid in alcohol.
Fig. 9. Specimen BD_6 after using for thermal analysis, reheated in vacuo to 900 deg. C. four times. Picric acid etching.
Fig. 10. Same as Fig. 9 except etched in hot alkaline sodium picrate solution.
Fig. 11. Specimen of welded joint between slip-plate. Additional very small needles are noted. Etching: 2 per cent HNO_3 in alcohol.

An attempt was made by Dr. P. D. Merica to determine whether the so-called lines or needles were really of the shape of needles or of tiny plates or scales. An area was carefully located on a specimen prepared for microscopic examination, which was then ground down slightly and repolished several times. It was possible to measure the amount of metal removed during the slight grinding by observing the gradual disappearance of certain of the spherical oxide inclusions the diameter of which could be accurately measured. By slightly etching the specimen after polishing anew it was possible to follow the gradual disappearance of some of the most prominent needles and to measure the maximum "depth" of such needles. It was concluded from the series of examinations that the term "plate" is more correctly descriptive of this feature of the structure than "line" or "needle." The thickness of the plate—i.e., the width of the needle—varies from 0.0005 to 0.001 mm. and the width of the plate ("depth") may be as great as 0.005 mm. The persistence of the plates after a regrinding of the surface used for microscopical examination may be noted in some of the micrographs given by Miller.[4] The authors are not aware, however, of any other attempt to determine the shape of these plates by actual measurements of their dimensions.

Plates Probably Due to Nitrides

The usual explanation of the nature of these plates is that they are due to the nitrogen which is taken up by the iron during its fusion. Other suggestions which have been offered previously attribute them to oxide of iron and to carbide. The suggestion concerning oxide may be dismissed with a few words. The plates are distinctly different from oxide in their form and their behavior upon heating. It is shown later that the tiny oxide globules coalesce into larger ones upon prolonged heating *in vacuo*; the plates also increase in size and become much more distinct (see Figs. 32, 34 and 36). In no case, however, was any intermediate stage betwen the globular form and the plate produced such as would be expected if both were of the same chemical nature.

Regarding the assumption that they are cementite plates, it may be said that the tendency during fusion is for the carbon to be "burned out," thus leaving an iron of low carbon content. In all the specimens, islands of pearlite (usually with cementite borders) are to be found and may easily be distinguished with certainty. The number of such islands in any specimen appears to be sufficient to account for the carbon content of the material as revealed by chemical analysis. In some cases the pearlite islands are associated with a certain type of "lines" or "needles" such as are shown in Fig. 12. These needles, however, appear distinctly different from those of the prevailing type and are usually easily distinguished from them.

The fact that the plates found in the arc-fused metal are identical in appearance and in behavior (e.g., etching) with those found in iron which has been nitrogenized is strong evidence that both are of the same nature. Fig. 13 shows the appearance of the plates produced in electrolytic iron by heating it for some time in pure ammonia gas. These plates behave in the same characteristic manner when etched with hot sodium picrate as do those occurring in arc-fused iron—i.e., they darken slightly and appear as finest rulings across the bright ferrite. The fact that the nitrogen content of the steel as shown by chemical analysis is increased by the arc-fusion also supports the view that the change which occurs in the structure is due to the

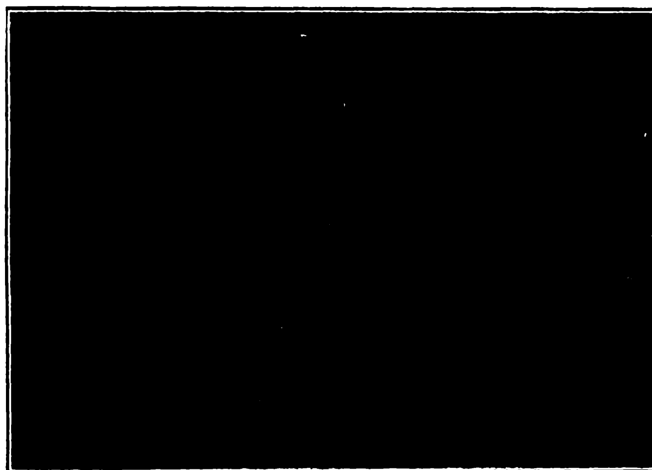


FIG. 12

Specimen AD_2, etched with 2 per cent alcoholic nitric acid. Shows pearlite islands, "needles" and oxide inclusions. × 750.

[4] S. W. Miller, "Some Structures in Steel Fusion Welds," *Trans.*, American Inst. of Mining Engrs., vol. 58, p. 700.

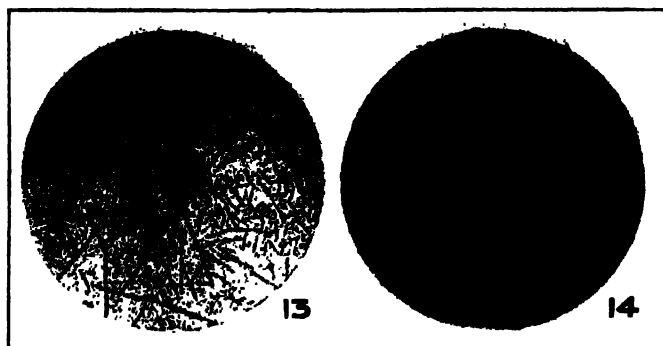


FIG. 13
Characteristic structure of electrolytic iron heated in NH_3 at 650 deg. C. Two types of nitride plates. Etched with 2 per cent alcoholic HNO_3. × 375.

FIG. 14
Arc-fused iron produced in CO_2 atmosphere. Type "A". $\frac{5}{32}$-in. electrodes, 150 amperes. Etched with 5 per cent picric acid in alcohol. × 375.

nitrogen. The statement has been made by Ruder[3] that metal fused in the absence of nitrogen—i.e., in an atmosphere of carbon dioxide or of hydrogen—does not contain any plates and hence the view that the plates are due to the nitrogen is very much strengthened. In Fig. 15 the appearance of specimens prepared at the Bureau by arc fusion of electrodes of type "A" in an atmosphere of carbon dioxide is shown. The microscopic examination of the fused metal shows unmistakable evidence of the presence of some plates, although they differ somewhat from those found in nitrogenized iron and in metal fused in the air by the electric arc. Evidently they are due to a different cause from the majority of those formed in the iron fused in air. For convenience, in the remainder of the discussion the "plates" will be referred to as "nitride plates."







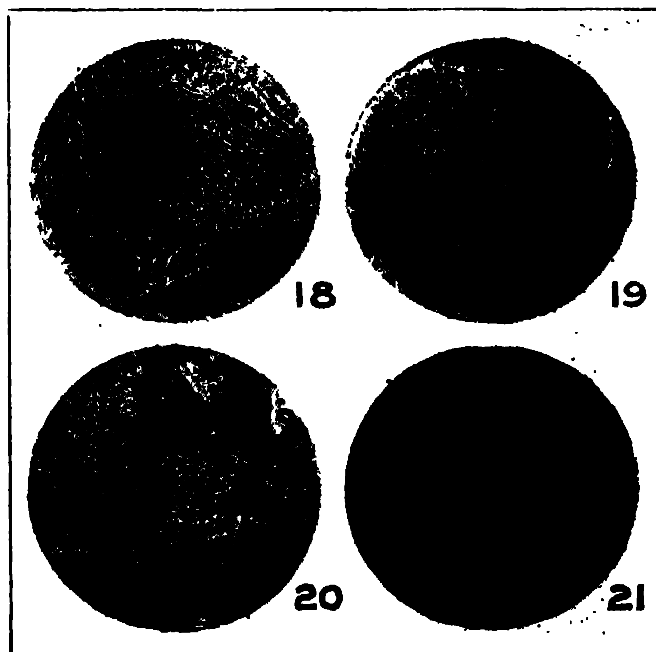
FIG. 15. SPECIMEN B_4 FIG. 16. SPECIMEN B_4 FIG. 17. SPECIMEN B_4
Electrolytic copper deposit for protection during polishing. Etching: 2 per cent HNO_3 in alcohol. × 280.

Relation of Microstructure to the Path of Rupture

The faces of the fracture of several of the tension specimens after testing were heavily plated electrolytically with copper so as to preserve the edges of the specimens during the polishing of the section and examined microscopically to see if the course of the path of rupture had been influenced to an appreciable extent by the microstructural features. In general, the fracture appears to be intercrystalline in type. Along the path of rupture in all of the specimens were smooth-edged hollows, many of which had evidently been occupied by the "metallic globules" referred to above, while others were gas-holes or pores. Portions of the fracture were intracrystalline and presented a jagged outline, but it cannot be stated with certainty whether the needles have influenced the break at such points or not. Fig. 16 shows the appearance of some of the fractures and illustrates that, in general, the "nitride plates" do not appear to determine to any appreciable extent the course of the path of rupture.

The behavior of the plates under deformation can best be seen in thin specimens of the metal which were bent through a considerable angle. Results of examination of welds treated in this manner have been described by Miller.[4] Small rectangular plates of the arc-fused metal, approximately $\frac{1}{32}$ in. thick, were polished and etched for microscopic examination and were then bent in the vise through an angle of 20 deg. (approximate).

In Figs. 18 to 21 inclusive are given micrographs illustrating the characteristic behavior of the material when subjected to bending. For moderate distortion the nitride plates influence the course of the slip-bands in much the same way that grain boundaries do—i.e., the slip-bands terminate usually on meeting one of the plates with a change of direction so that they form a sharper angle with the plate than does the portion of the slip-band which is at some distance away (Fig. 18). When the deformation is greater the slip-bands occur on both sides of the nitride plate, but usually show a slight variation in direction on the two sides of the nitride plate (Fig. 19); this is often quite pronounced at the point where the plate is crossed by the slip-band.



FIGS. 18 TO 21
Behavior of "nitride plates" during plastic deformation of the iron. Specimen RD_3, etched with 2 per cent alcoholic nitric acid before bending. × 500.

[3] W. S. Ruder, "Metallurgy of the Arc Weld," *General Electric Review*, vol. 21, p. 941.

[4] S. W. Miller, "Path of Rupture in Steel Fusion Welds," Bull. 116, American Inst. of Mining Engrs., p. 311.

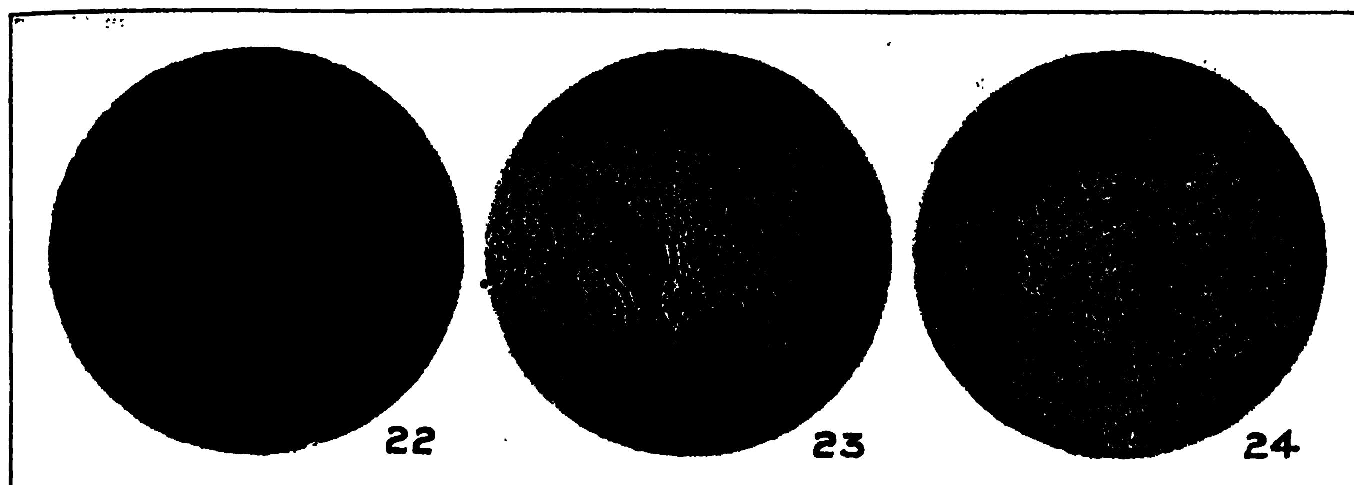


FIG. 22
Specimen AD$_{10}$ quenched in cold water from 1,000 deg. C., suppressing nitride plates and developing martensitic structure. Etched with 5 per cent alcoholic picric acid. × 500.

FIG. 23
"A" electrode quenched in cold water from 1,000 deg. C. Faint martensitic markings, especially near surface Etched with 2 per cent HNO in alcohol. × 500.

FIG. 24
Same as Fig. 23, but showing interior markings suggestive of "plates" of arc-fused metal. Etched with 2 per cent HNO_3 in alcohol × 500

In a few cases evidence of the "faulting" of the plate as a result of severe distortion was noted (Fig. 20). This was a rare appearance, however, because of the unsound nature of the metal.

On account of the inclusions and other features of unsoundness, rupture occurs at such points before the sound crystals have been sufficiently strained to show the characteristic behavior of the plates. Other micrographs show the beginning of a fracture around one of the "metallic globule" inclusions before the surrounding metal has been very severely strained. For this reason the influence of the plates on the mechanical properties of the crystals cannot be stated with certainty. It would appear, however, that on account of the apparently unavoidable unsoundness of the metal, any possible influence of the nitride plates upon the mechanical properties of the material is quite negligible.

Some of the same specimens used for cold bending were torn partially in two after localizing the tear by means of a saw cut in the edge of the plate. The specimen was then copper plated and prepared for microscopic examination, the surface having been ground away sufficiently to reveal the weld-metal with the tear in it. The nitride plates did not appear to have determined to any extent the path taken in the rupture produced in this manner.

Effect of Heat Treatment Upon Structure

With the view of possibly gaining further information as to the nature of the plates (assumed to be nitride), which constitute such a characteristic feature of the microstructure, a series of heat treatments were carried out upon several specimens of arc-fused electrodes of both types. Briefly stated, the treatment consisted in quenching the specimens in cold water after heating them for a period of ten or fifteen minutes at a temperature considerably above that of the Ac$_3$ transformation; 925, 950 and 1,000 deg. C. were the temperatures used. After microscopical examination of the different quenched specimens they were tempered at different temperatures which varied from 600 to 925 deg. C. for periods of ten and twenty minutes. The samples which were used were rather small in size, being only ⅛ in. thick, in order that the effect of the treatment should be thorough, and were taken from test bars A$_2$, A$_6$, AD$_{10}$, B$_2$, B$_4$ and B$_5$. These represented metal which had been deposited under different conditions of current density.[7] No plates were found to be present in any of the specimens after quenching. Fig. 22 shows the appearance of one of the quenched bars, a condition which is typical of all. The structure indicates that the material comprising the plates had dissolved in the matrix of iron and had been retained in this condition upon quenching. The needle-like striations within the individual grains are characteristic of the condition resulting from the severe quenching and are to be observed at times in steel of a very low carbon content. Fig. 23 shows the appearance of one of the "A" electrodes (⅛ in.) quenched in cold water from 1,000 deg. C. Some of the crystals of the quenched iron also show interior markings somewhat similar in appearance to the nitride plates (Fig. 24). These are, however, probably of the same nature as the interior tree-like network sometimes seen in ferrite which has been heated to a high temperature.[8] The striations were found to be most pronounced in the specimens of arc-fused metal which were quenched from the highest temperatures, as might be expected. Braune[9] states that nitride of iron in quenched metal is retained in solution in the martensite. The same may be inferred from the statement by Giesen[10] that "in hardened steel, it (nitrogen) occurs in martensite." Ruder[11] has also shown that nitrogenized electrolytic iron (3 hr. at 700 deg. C. in ammonia) after being quenched in water from temperatures 600 to 950 deg. C. shows none of the plates which were present before the specimen was heated.

The sets of specimens (A$_2$, A$_6$, AD$_{10}$, B$_2$, B$_4$ and B$_5$) quenched from above the temperature of the Ac$_3$ transformation were heated to various temperatures, 600, 700, 800 and 925 deg. C. In all cases the specimens were maintained at the maximum temperature for approximately ten to fifteen minutes and then cooled

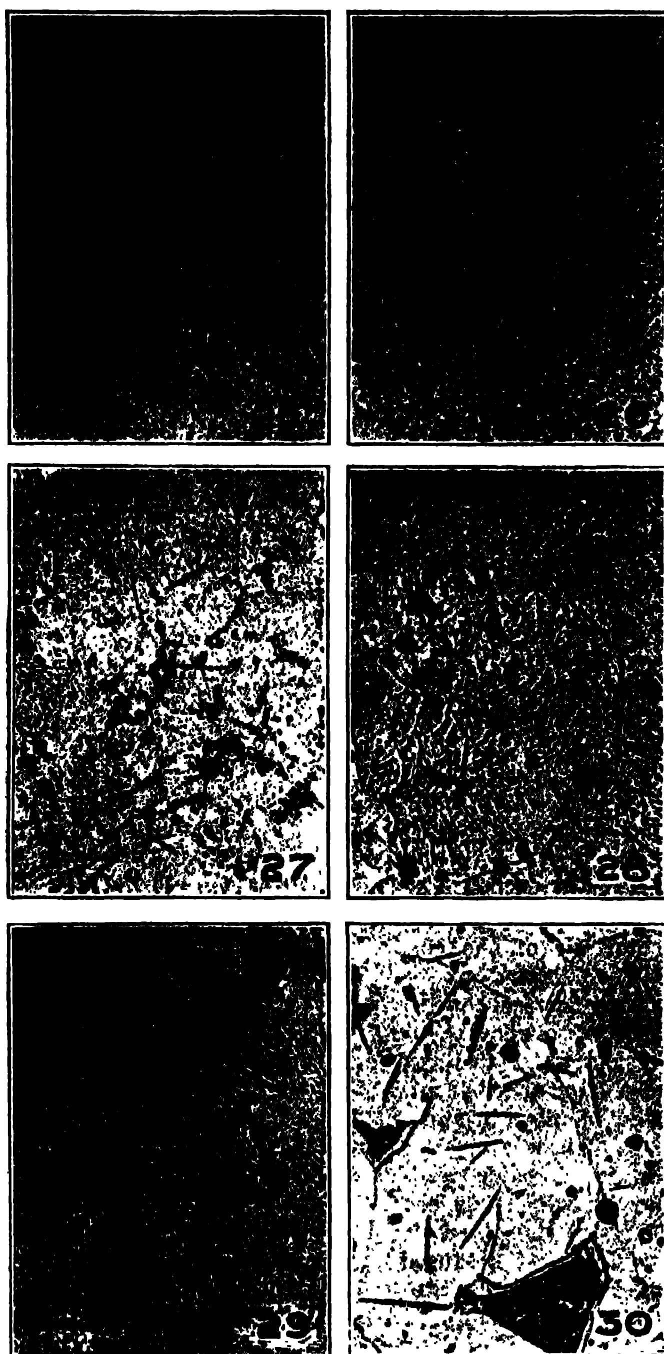
[7]See Table VI; "The Physical Properties of Arc-Fused Steel," CHEM. & MET. ENG., Oct. 6, 1920, vol. 23, p. 679.

[8]H. S. Rawdon and H. Scott, Bureau of Standards, Technologic Paper 356. Fig. 2B.

[9]H. Braune, "Influence de l'azote sur le fer et l'acier," *Révue de Met. Memoirs*, 1905, p. 497.

[10]W. Giesen, "Some Notes on the Influence of Nitrogen in Steel," *Carnegie Scholarship Memoirs*, Iron and Steel Institute, vol. 1, p. 1.

[11]G. F. Comstock and W. E. Ruder, "The Effect of Nitrogen on Steel," CHEM. & MET. ENG., vol. 22, p. 399.



FIGS. 25 TO 30. EFFECT OF HEAT-TREATMENT OF ARC-FUSED IRON

All etched with 2 per cent alcoholic HNO_3. × 450.

Fig. 25. Specimen AD_{10} as deposited.
Fig. 26. Same after quenching from above Ac_3 and reheating to 650 deg. C. No "plates" have formed.
Fig. 27. Specimen AD_{10} after quenching from above Ac_3 and reheating to 700 deg. C. "Plates" beginning to reform.
Fig. 28. Specimen B_9 after quenching from above Ac_3 and reheating to 800 deg. C.
Fig. 29. Specimen B_3 after quenching from above Ac_3 and reheating to 925 deg. C.
Fig. 30. Specimen A_3 after quenching from above Ac_3 and reheating to 925 deg. C.

in the furnace. Figs. 25 to 30 inclusive summarize the resulting effects upon the structure. Heating to 650 deg. C. is not sufficient to allow the plates to redevelop, but in the specimens heated to 700 deg. C. a few small ones were found. The effect is progressively more pronounced with the increased temperature of tempering, and in the material heated to 925 deg. C. they are as large and as numerous as in any of the arc-fused specimens. The heating also develops the islands of pearlite which are not always to be distinguished very clearly in the simple fused metal. The work of Ruder[11] referred to above shows that nitrogenized iron which has been quenched and so rendered free from the nitride plates behaves in a similar manner upon heating to temperatures varying from 700 to 950 deg. C.; the plates reappear after a heating for fifteen minutes at 700 deg. C. (or above), followed by a slow cooling. The similarity in behavior of the two is a further line of evidence that the arc-fused metal contains more or less nitrogenized iron throughout its mass.

Plates Remain After Long Annealing

The persistence of the nitride plates was also studied in specimens heated at 1,000 deg. C. *in vacuo* for a period of 6 hr. A set of specimens (one each of test-bars AD_3, A_3, AD_6, A_{10}, B_3, B_4, B_6 and BD_6) was packed in a "usalite" crucible, and covered with alundum sand; this crucible was surrounded by a protecting alundum tube and the whole heated in an Arsem furnace. A vacuum, equivalent to 0.2 mm. mercury, was maintained for the greater part of the 6-hr. heating period; for the remainder of the time the vacuum was equivalent to 0.1 to 0.2 mm. mercury. The specimens were allowed to cool in the furnace. Ruder[12] has stated that 1 hr. heating *in vacuo* at 1,000 deg. C. was sufficient to cause a marked diminution in the number of plates in both arc-weld material and nitrogenized iron and that at 1,200 deg. C. they disappeared entirely.

The results obtained are shown in Figs. 31 to 36 inclusive. In contradistinction to Ruder's work the plates are more conspicuous and larger than before, the oxide specks are larger and fewer in number. Many of the plates appear to have been influenced in their position by an oxide globule. It would appear that the conditions of the experiment are favorable for a migration of the oxide through an appreciable distance and for a coalescing into larger masses. Figs. 32, 34 and 36 all show some cementite at the grain boundaries which resulted from the "divorcing" of pearlite. The oxide is eliminated entirely in a surface layer averaging approximately 0.15 mm. in depth. Only in projections (right-angled corners, sections of threads of the tension bar, etc.), was there any removal of the nitride plates by the action of the continued heating *in vacuo*. This is shown in Fig. 37, which illustrates the removal of the oxide inclusions also. No evidence was found that the small amount of carbon present in the arc-fused metal is eliminated, particularly beneath the surface.

Fig. 6 (page 778) illustrates an interesting exception to the rule that the nitride plates are flat. The general appearance suggests that the "metallic globules" solidified under a condition of "constraint" and that this condition still persists even after the 6-hr. heating at 1,000 deg. C. which the specimen subsequently received.

TABLE I. CHANGE IN NITROGEN CONTENT UPON HEATING

Specimen	Wt. of Sample in Grams.	Average Nitrogen Content, per Cent Before Heating	After Heating in Vacuo.	Loss per Cent
A_3	1 39	0 127	0 062	51
B_4	6 0	0 124	0.078	37
BD_5	1 62	0 140	0 059	57
B_5	1 16	0.121	0 054	55

[11] G. F. Comstock and W. E. Ruder, "The Effect of Nitrogen on Steel," CHEM. & MET. ENG., vol. 22, p. 399.

[12] W. S. Ruder, "Metallurgy of the Arc Weld," *General Electric Review*, vol. 21, p. 941.

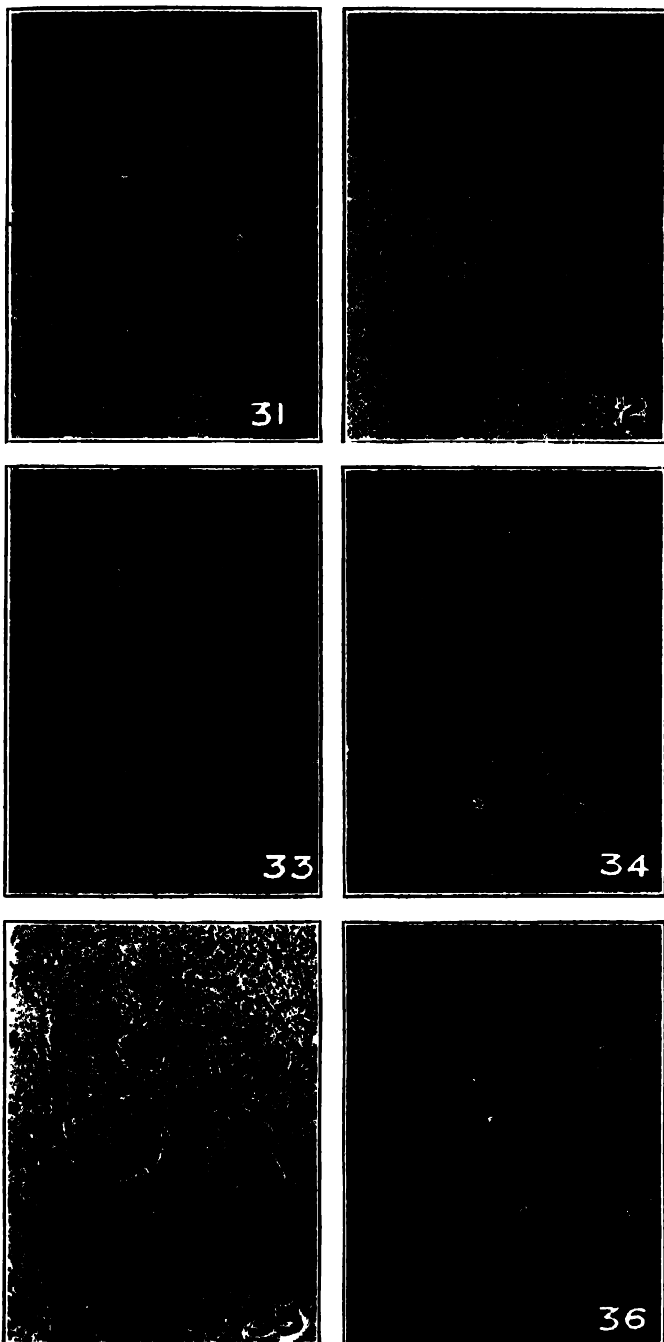
Several of the specimens which were heated *in vacuo* (6 hr. at 1,000 deg. C.) were analyzed for nitrogen. The results are given in Table I.

The fact that the specimens lose nitrogen upon heating (although the amount remaining is still many times the nitrogen-content of the metal before fusion), coupled with the fact that the "nitride plates" are larger and more conspicuous after heating than before, suggests very strongly that these plates are not simple nitride of iron. The method used for the determination of nitrogen gives only the "*nitride*" nitrogen, hence a possible explanation for the change in nitrogen content is that it has been converted into another form than nitride and may not have been eliminated from the specimen.



FIG. 37. EFFECT OF PRONOUNCED HEATING UPON THE STRUCTURE OF ARC-FUSED IRON

Specimen AD_{10} was heated for 6 hr. in vacuo at 1,000 deg. C. The micrograph represents a section of the specimen at one corner. The oxide and "nitride plates" have been removed in the exposed tip of the thread. Etching, 2 per cent alcoholic solution of nitric acid. × 450.



FIGS. 31 TO 36. EFFECT OF 6-HR. HEATING AT 1,000 DEG. C. IN VACUO

All etched with 2 per cent alcoholic HNO_3. × 450.

Fig. 31. Initial structure of AD_2.
Fig. 32. AD_2 after heating.
Fig. 33. Initial structure of B_4.
Fig. 34. B_4 after heating.
Fig. 35. Initial structure of A_{10}.
Fig. 36. A_{10} after heating.

THERMAL ANALYSIS OF ARC-FUSED STEEL[13]

In order to throw further light on the nature of the plates (nitride) found in the metal after fusion in the arc, the thermal characteristics of the electrode material before and after fusion as revealed by heating and cooling curves were determined. Samples of a ⅛-in. electrode of type "A" and of the specimen A, which resulted from the fusion were used as material (composition in Tables III and VI, CHEMICAL & METALLURGICAL ENGINEERING, Oct. 6, 1920, vol. 23, pp. 677 and 678).

In Fig. 38 are given the curves obtained which show the characteristic behavior of the arc-fused metal upon heating. The commonly used inverse-rate method was employed in plotting the data; the details of manipulation and the precautions necessary for the thermal analysis have already been described.[14] In Table II are summarized the data shown graphically in Fig. 38.

TABLE II. THE THERMAL CHARACTERISTICS OF ARC-FUSED IRON

		Ac_3					Ar_3			Ar_2
Rate of Heating and Cooling, Deg. C., per Sec.	Ac_2, Maximum, Deg. C.	Beginning	Maximum, Deg. C.	End	Maximum Temp., Deg. C.	Time Above A_3, Min.	Beginning	Maximum, Deg. C.	End	Maximum, Deg. C.
Unfused Electrode										
*	768	892	910	918	960	..	896	893	879	766
0.15	765	897	911	916	960	.	895	891	879	766
Arc-Fused Metal †										
0 14	764	...	847	874	960	28	847	838	820	764
0 13	764	...	849	876	985	42	847	836	822	764
0 13	764	...	844	870	960	29	847	837	821	765
0.13	766	...	850	874	1,035	256	848	835	816	764

* Heated at rate of 0 16 deg. C. per sec., cooled 0.15 deg. C. per sec. For other specimens, the rate of cooling equaled the rate of heating.
† The same specimen was heated four times in succession, as shown in Fig 38.

The principal change to be noted which has resulted

[13]Credit is due to Howard Scott, assistant physicist, for the work described in this section.

[14]H. Scott and J. R. Freeman, Bureau of Standards Scientific Paper 348.

from the arc-fusion of the iron is in the A_3 transformation. This is now very similar to the corresponding change observed in a very mild steel (e.g., approximately 0.15 per cent carbon). That the difference in the A_3 transformation of the arc-fused metal as compared with that of the original electrode is not due to an increase in the carbon content is evident from the lack of the sharp inflection of the A_1 transformation ("pearlite point") which would, of necessity, be found in a low-carbon steel. No evidence of the A_1 change was observed for the arc-fused iron within the range of temperature from 150 to 950 deg. C. The change in the character of the A transformation is without doubt to be attributed to the influence of the increased nitrogen-content of the iron.

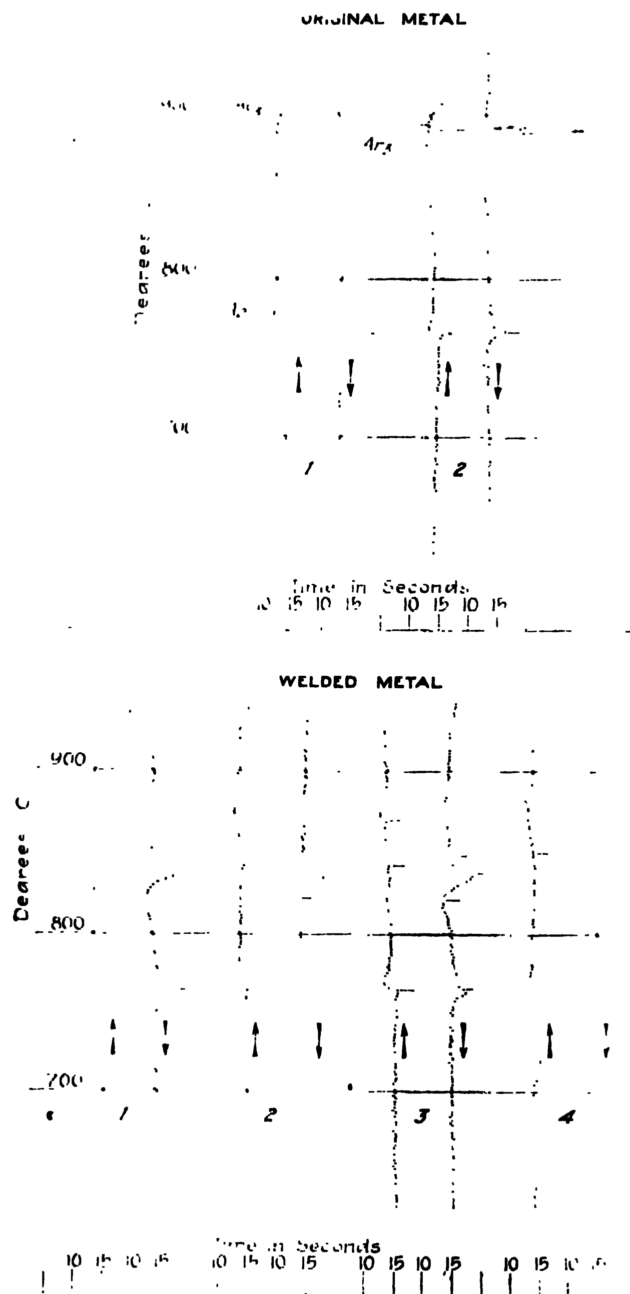


FIG. 38 CURVES SHOWING THE THERMAL CHARACTERISTICS OF ARC-FUSED IRON

The direction of the arrow indicates whether the curve is a heating or a cooling curve.

The specimen was maintained above the temperature of the A transformation for a total period (four heatings) of 6 hr., the maximum temperature being 1,035 deg. C. The transformation apparently is unaffected by the long-continued heating, thus confirming the results described in the preceding section.

In discussing the properties of steel nitrogenized by melting it in nitrogen under pressure, Andrews[15] states that it was found possible to extract almost entirely the small quantities of nitrogen by heating a specimen at 1,000 deg. C. *in vacuo* for periods of 1 to 6 hr. The metal used contained 0.16 per cent carbon and 0.3 per cent nitrogen. Thermal curves are given to show that there are no critical transformations in the material: the nitrogen suppresses them. They gradually reappear, however, as the nitrogen is removed by heating the material *in vacuo* at 1,000 deg. C. Several days' heating was required, however, to obtain an entirely degasified product, the carbon being removed also. A further statement is made that a steel of 0.6 per cent carbon content containing 0.25 per cent nitrogen can be brought back to the normal state of a pure steel only by several weeks' heating *in vacuo*.

The results of the thermal analysis add considerable confirmatory evidence to support the view that the plates existing in the arc-fused metal are due to the nitrogen rather than to carbon.

SUMMARY

Microscopic examination of bent pieces of arc-fused metal show that the metallic grains are inherently ductile, even to a high degree. Grosser imperfections, however, are entirely sufficient to mask this mark of excellence.

The view that the characteristic features observed in the structure of the arc-fused iron are due to the increased nitrogen content is supported by several different lines of evidence. These include the likeness of the structure of the material to that of pure iron which has been "nitrogenized," the similarity in the behavior of both arc-fused and nitrogenized iron upon heating, the evidence shown by thermal analysis of the arc-fused metal, together with the fact that, as shown by chemical analysis, the nitrogen content increases during fusion, while the other elements, aside from oxygen, decrease in amount. The characteristic form in which oxide occurs in iron, together with its behavior upon heating, renders the assumption that the oxide is responsible for the plates observed in the material a very improbable one.

Judged from the results obtained, neither type of electrode appears to have a marked advantage over the other. The use of a slight protective coating on the electrodes does not appear to affect the mechanical properties of the arc-fused metal materially in any way. The specimens were prepared in a manner quite different from that used ordinarily in electric-arc welding and the results do not justify any specific recommendations concerning methods of practice in welding.

In addition to the credit given throughout the text to those who have co-operated in various phases of the investigations, the authors wish to acknowledge the help of H. L. Whittemore and R. W. Woodward for the aid in the necessary mechanical testing and to F. H. Tucker for the general chemical analyses made during the progress of the work.

Bureau of Standards,
Washington, D. C.

[15] H. Andrews, "Iron and Nitrogen," *J. Iron and Steel Inst.*, vol. 86 (1912—II), p. 210.

The Disk, Plate and Cylinder Processes for the Production of Carbon Black

Description With Mechanical Details of Disk, Plate and Cylinder Process Carbon Black Plants — Driving Mechanism and Heat Variations—Comparison of Processes

By ROY O. NEAL

THE small rotating disk, ring or Blood process was invented by A. R. Blood in 1883 and is extensively used at the present time. The disk upon which the carbon black is deposited is shown in Fig. 1. It is made of cast iron, varies in diameter from 36 to 42 in. and has a 50-in. face. The lava tips are set in a circular piece of ¾-in. standard pipe, which is about 28 in. in diameter and contains from eighteen to twenty-four tips. The scraper for removing the carbon is in contact with the disk continuously and is set over a hopper radially with the disk.

A driving gear bolted on the disk, and a pinion meshing with the gear, are attached to the drive shaft by means of a setscrew. The teeth of the pinion are extraordinarly long to allow for expansion and contraction of the entire length of the driving shaft. A shaft base or cap sets in the axis upon which the disk rotates and acts as a guide and support for the driving shaft. It also makes the pipe, that sets on a concrete base and carries the weight of the disk, more rigid and stable. The gear and pinion actuate the disk, which makes one revolution in about 15 min. Details of a wheel, driving gear and pinion, and shaft base are given in Fig. 2. An assembly drawing of a gear and pinion, shaft base and accessories is shown in Fig. 3, although a disk is used of different design than that above described.

The disks are arranged in rows having twenty-one disks per row, with either two or four rows per building, although the latter is the more common practice. One unit plant has from sixteen to twenty buildings, so that there are eighty-four disks per building and 1,532 disks in an 18-building factory.

Each pair of rows has one conveyor and each row has a separate drive shaft extending the entire length of the building. The drive shafts are moved by a gear and pinion, power being transmitted by a 2-in. shaft located in the alley. Fig. 4 shows how the power is transmitted to a building having four rows of disks.

The carbon black is delivered from the buildings and proceeds the same as in the channel process. No gear-shifting machine is employed and the shafting is lighter than in the channel system, as the weight of the material in the condensing buildings of a typical plant using the rotating disk method is about 150 tons.

The quality and yield of the carbon black made by the disk process is approximately the same as that made by the channel method.[1]

The "Plate" or Cabot Process

The plate system was invented by Godfrey L. Cabot about thirty years ago and has two modifications, one consisting of stationary plates 24 ft. in diameter beneath which are revolving scrapers and burners that are supplied with gas, and the other, using revolving plates 24 ft. in diameter, having stationary scrapers and burners. The first arrangement is chiefly used and is employed at a plant in West Virginia which until recently had the largest output of any factory in the world. This plant had 113 plates and is shown in Fig. 5. This process is also used in Louisiana.

The plates are made of forty-eight segments, sixteen in the inner row and thirty-two in the outer row, the over-all diameter being 24 ft. The plates are perforated with ventilator holes to allow the products of combustion to escape and afford a means of maintaining a draft. The plate is supported by guys which are screwed into a cap having approximately the shape of a very broad truncated cone. This cap rests upon the top of a hollow mast, the joint between the cap and the mast being made gas-tight with asbestos.

The plates are surrounded by a circular building made of corrugated sheet iron and are 26 ft. in diameter. Above each plate is a roof made partly of triangular pieces of sheet iron and partly of four-sided sheets of corrugated iron that extends about two-thirds of the distance up the 16-ft. mast, leaving, therefore, in the center an open space having about one-third the diameter of the plate, through which the products of combustion can escape.

The mast stands in a bed-plate, the upper surface of which carries a groove in which run steel balls as a bearing. Upon these steel balls rests a casting having eight arms projecting outward and upward that fit into the lower ends of struts made of 2-in. pipe. On the outer end of these struts is an angle casting into which the pipe fits, and a horizontal hole which accommodates a horizontal guy rod. Each horizontal guy is connected at the inner end to an octagonal plate which rotates with the burners around the central mast.

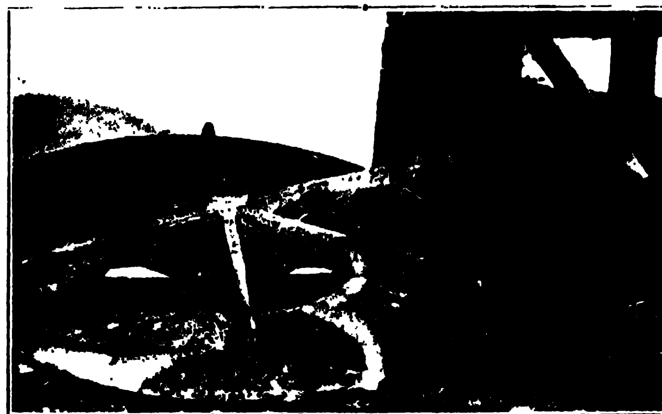


FIG. 1. DISK CARBON DEPOSITING SURFACE

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[1]See CHEM. & MET. ENG., vol. 23, No. 15, Oct. 13, 1920, p. 729.

The scrapers and burners revolve around the central mast and the burners fit in a gridiron of pipe lying on a circle of 4½ x ½-in. bar iron which is bolted to the vertical face of the angle castings. The lamp is fed by two ¾-in. holes in the central mast incased in a gas-box with stuffing boxes and glands above and below. This gas-box revolves around the mast supported on the

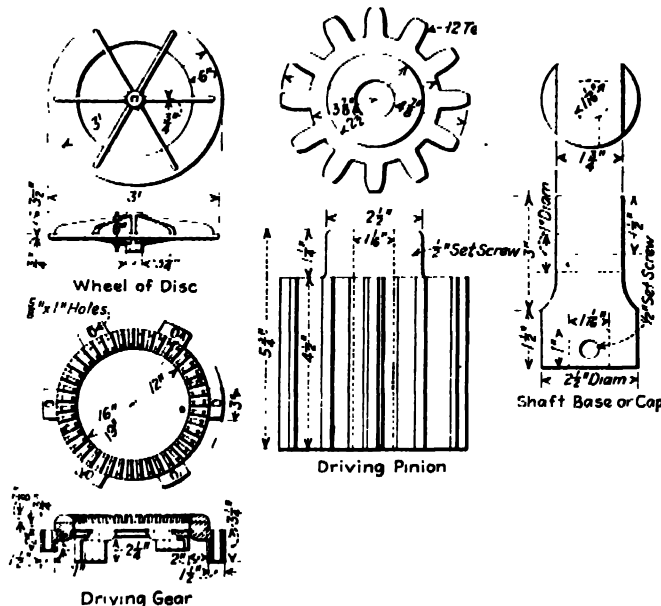


FIG. 2. DETAILS OF DISK AND DRIVING MECHANISM

eight-horn casting with the burner pipe, radial black box, etc.

The gas line from the regulators is connected to the bottom of the mast, this mast closed above by a cap from which depend the oblique guys. Slightly below the scraper box are the ¾-in. perforations that admit the gas into the gas-box. To the gas-box are connected two 1½-in. pipes feeding a 4-in. main in which are screwed the 1¼-in. burner pipe extending beneath the surface of the depositing plate. Each 4-in. pipe feeds over fifty 1¼-in. pipes, equidistant from one another and extending to the periphery, the circular depositing plate. The 1-in. pipes carry the lava tips, that are the same as those in the channel or disk process. The two center pipes have sixty lava tips each, and there are 1,265 tips under the entire plate. The burners make one revolution in 8 min.

The black is removed from the plates by scrapers placed radially to the mast. Below the scrapers is a collecting box that carries a screw conveyor, the shaft of which is actuated by a gear and pinion. The gear sits on the mast and the pinion on the end of the conveyor shaft. The carbon is carried to the inner end of the

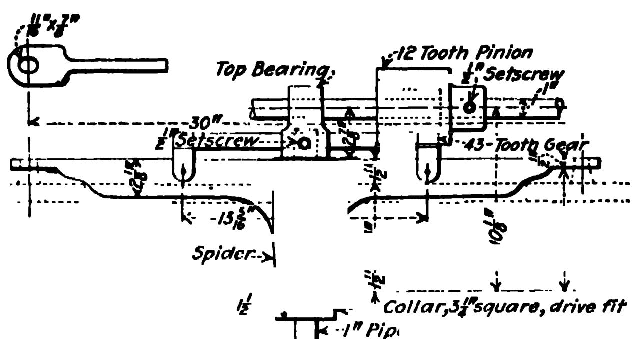


FIG. SPIDER, GEAR AND PINION

collecting box and descends through a vertical pipe into a circular box that discharges downward into a long conveyor which runs beneath the circular boxes and 2 ft. from the center of the ring. The black is carried from several plates by conveyors that bring it to the packing house, in which it is elevated to bins, from which it is dropped into the packing machines.

All the machinery at these plants moves very slowly so that a surprisingly small amount of power is used. Only one 35-hp. gas engine is necessary to operate twenty-two plates. This includes power for conveyors, packing and bolting machinery.

The writer is indebted to Godfrey L. Cabot for a great deal of the information concerning this system.

Roller or Rotating Cylinder Process

The roller process was first used by E. R. Blood in 1883, but at first was unprofitable owing to the small yield. Later, however, the operation details were improved and a market for this product, which possesses valuable properties notwithstanding its inferior color, has been created. At the present time this product sells for the highest price of any grade of carbon black and supplies a limited market, being utilized chiefly in making lithographic and embossing inks, and printing ink for half-tone prints.

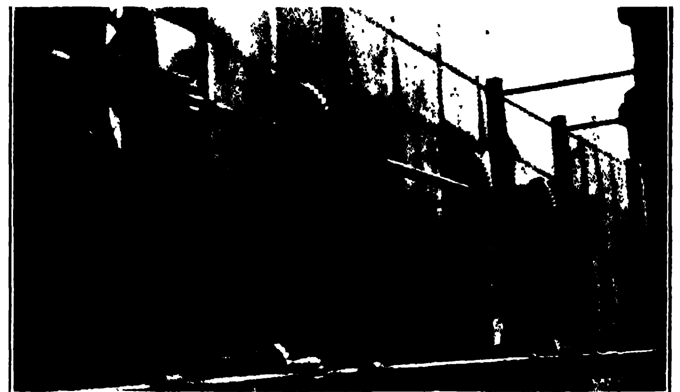


FIG. DRIVING MECHANISM IN DISK PROCESS

The buildings or benches in this method are from 65 to 100 ft. in length and from 25 to 35 ft. in width, being made of 24-gage straight or V-crimped sheet iron, and wired to a small angle-iron framework. From four to ten buildings are connected to the same driving shaft or source of power.

The gas is reduced in pressure as in other methods and led to each set of rollers or cylinders by means of a 1¾-in. pipe. Some manufacturers place a small disk in the screw union in each distributing pipe before it is connected to the pipe carrying the lava tips in order to regulate the flow of the gas uniformly under each roller. The burner pipe holding the lava tips is from 3 to 5 in. below the cylinders and in most cases is lower than in the channel system. The lava tips are round and have a round perforation instead of a fishtail opening. The flame issuing from the tips is cylindrical. The tips are separated by ¾ in. to 4 in., as is shown in Fig. 6.

The rollers are from 3 to 8 ft. in length, having a spider bearing for a 1½-in. shaft. If made of cast iron they are about ⅞ in. thick and 8½ in. (outside diamensions) in diameter, weighing approximately 100 lb. The outside of the rollers is machine faced. Some operators use ordinary extra heavy casing in 8- or 9-ft. lengths and place spider bearings by means of countersunk

rivets in each end in the center for the shafting. This arrangement is cheaper and makes the plant more independent of the local foundries, although there is a possibility of the cylinders warping, consequently throwing the driving mechanism out of alignment. At a plant using casing no difficulty was experienced due to warping, distortion or scaling by heat.

The scrapers for removing the deposited carbon black are located at the direct top of the rollers or near the top, and run longitudinally the entire length of the rollers. They are in direct contact with rollers and scrape continuously. On one design V-shaped blades



FIG. 5. PLATE PROCESS PLANT

are attached to the opposite ends of downwardly curved metal straps. One of the blades is positioned for contact with one of the rollers and one for another roller. The weight of the straps and blades is borne by the cylinders, and is sufficient to cause the blades to come into close contact with the rollers and perform their scraping function efficiently.

Over the cylinders is located a removable sheet iron hood, provided with apertures for controlling the ventilation within the roller chamber. This hood also protects the cylinders against drafts. Arranged below the cylinders is a trough-shaped hopper contracted at the bottom and designed to shut out the air from the cylinders and to collect the black which is scraped therefrom. A screw conveyor is mounted in the bottom of the hopper and carries the black to the bolting machines, thence to the storage bins, from which it is taken by the packing machines. The hood, hopper and conveyors are supported by an angle-iron frame. Under each hood are nine rollers, three rollers on each shaft. Where 4-ft. rollers are used there are only two rollers on each shaft, and in some designs there are only two sets of rollers to a hopper. There are two rows of hoods and hoppers to the building, with the shafting running the entire width of the building—that is, each shaft will actuate four or six rollers, depending upon the length of the cylinders. The draft is also regulated by slits or slide doors in the building itself. A typcial building, then, would have from 196 to 288 rollers, 10,000 lava tips and about twenty-four to thirty-two hoods and the same number of hoppers.

On each shaft, which is made of hollow pipe, a worm gear with about twenty-eight teeth and a pitch diameter of about 6 in. is attached by means of a setscrew. This gear is actuated by a worm 3 or 4 in. in diameter and having about five threads. This makes one revolution every 15 to 45 min., the grade of black determining the rate at which the cylinders revolve. The worm is mounted on a solid steel shaft moved by a chain and sprocket transmission from the main power line. The conveyors, elevators, bolting machines and packing machines are also connected from the main power shaft, that is actuated by the gas or expansion engine. The power requirements are about the same as with the channel method. Fig. 7 shows details of this system.

GEARS

A large number of gears are necessary in the machinery for making carbon black. Most of the gears used are bevel, since power is transmitted to the conveyors by this type, although spur gears are made use of in power transmission to bolters, scalpers, etc., and worm gears move the cylinders in the roller process and transmit power from reversing gear shift to main drive shaft, that actuates the rack and pinion in the channel system. Fig. 8 shows a typical spur gear and pinion. The letters refer to:

	Gear	Pinion		Gear	Pinion
Pitch* (circular)	= *C*	*c*	Diameter of hub	= *H*.....	*h*
Face	= *F* . . .	*f*	Outside diameter	= *D*.....	*d*
Bore	= *B*	*b*	Length of hub	= *L*......	*l*
Pitch diameter	= *D'*......	*d'*	Projection of hub	= *P*	*p*

* Diametral pitch is the number of teeth to each inch of pitch diameter. The word "diameter" when applied to gears is always understood to mean pitch diameter.

If the teeth are properly shaped and the linear velocities of the two wheels are equal, then the angular velocities or speeds of rotation are inversely proportional to the number of teeth and to the diameters. Thus a gear that has twice as many teeth as one mating with it will revolve just half as many times per minute.

In ordering standard gears and pinions it is only necessary to specify circular pitch, bore, face and ratio of number of teeth on gear to number of teeth on

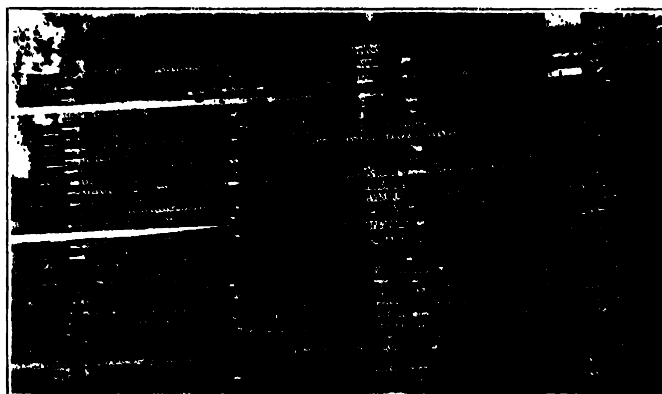


FIG. 6. GAS BURNERS USED IN ROLLER PROCESS

pinion. The width of the faces of teeth is generally made two or three times the circular pitch, although there is no standard rule.

A special gear problem characteristic of carbon black industry arises due to the heat changes. This difficulty is solved by using pinions whose facial dimensions are four or five times that of the gears so that should sudden expansion or contraction result in shaft the gear and pinions will still mesh. Should bevel gears be used, contraction might possibly prevent the intermeshing and upon expansion the teeth might break or force shafting out of alignment, causing a waste of power and undue wear upon gears and bearings—in fact, some bevel gears have worn away as much as ⅜ in. from this cause. Quite frequently a device is resorted to which is not strictly mechanical, but which, nevertheless, gives good results under the wholly peculiar conditions of this industry—namely, a bevel wheel is driven with a spur

gear. The bevel is very flat, perhaps five or six times the pitch diameter of the spur that drives it. Obviously the wear and tear on the cogs is uneven and greater than a true bevel properly adjusted would give, but this rough and ready contrivance has the great advantage that as the shaft, on which sit the spur gears, comes and goes with expansion and contraction the cogs on the spur wheels are so long that they always engage the teeth of the bevel gear, and as the power required is very small in proportion to the size of the gears and the motion very slow the extra wear and friction caused by this mathematically inaccurate method are of minor importance, far less injurious in actual practice than the evils that might otherwise result by the expansion and contraction of the driving shaft. Some of the gears installed in carbon black factories are not standard, but are "bastard" gears and are cast from special patterns.

In the disk process especially gears are exposed to an intense heat that practically eliminates the possibility of lubrication, so that wear and frictional losses are necessarily large, though maximum service is obtainable by:

1. Correct installation, which must take into account that old, badly worn gears will unduly wear new pinions and *vice versa*.
2. Proper maintenance, which means that gears must be kept in mesh on true centers in proper alignment. This necessitates proper maintenance of bearings.
3. Lubrication where possible.
4. Inspection at intervals.
5. Ample strength, ductility and wearing surface, hardness in gears and pinions.

FIG. 8. GEAR AND PINION

FIG. 7. DIAGRAM OF CYLINDER PROCESS

If the proper attention is not given, the gears soon fail to mesh accurately and serious evils result, such as:

(*a*) Power escapes in transmission.

(*b*) Bearings wear unevenly, throwing shafts out of line. This is turn causes gears, bearing and other parts to wear faster.

(*c*) Vibration is produced in the gears, resulting in increased wear and tear.

THERMAL DECOMPOSITION

Several patents have been granted on cracking or thermal decomposition methods of producing carbon black from natural gas, but at the present time only one company is operating on a commercial basis, and this concern is decomposing the gas for the hydrogen and is not even collecting the carbon formed.

The carbon black produced by this procedure contains adamantine or hard particles, is grayish in color and possesses a high apparent specific gravity. One sample that the writer examined contained 5.38 per cent matter that was soluble in chloroform and possessed only one-fifth the tinting strength of ordinary carbon black. Some of the product showed flakes of naphthalene, so that its utility in the rubber tire industry is very much impaired—in fact thus far the product made by thermal decomposition is almost unmerchantable and has been used successfully only in making cheap paints and has sold for from 1c. to 2c. per lb. In one process a large pipe with walls 1½ in. thick is erected in a vertical position. The gas is introduced in the lower portion of the pipe and ejected from a side connection located near the top. A temperature of 1,500 deg. F. is maintained by several circular rows of gas torches. The carbon, deposited upon the inner walls of the pipe, is released by a revolving mechanism. This mechanism consists of a shaft to which chains are attached running the entire length of the furnace. Upon revolving, the chains scrape the carbon from the inner wall of the pipe. The difficulty with this process is the rapid deterioration of pipe and the large content of iron scales in the carbon black. From 8 to 10 lb. has been obtained per 1,000 cu.ft. of gas, but the product is of no commercial value.

In another process the cracking chamber is lined with firebrick and is heated to 1,500 deg. F. by admitting at intervals a blast containing a mixture of air and gas. The carbon liberated is carried over by the blast of gas and collected in separators or bags.

The channel, rotating disk and large plate methods give approximately the same yield of black per 1,000 cu.ft. of gas. The roller system produces considerably less carbon than any of the other processes, but the resultant product is much more valuable and is utilized for highly specialized purposes. Table I shows the yield procured by various processes in different fields.

TABLE I YIELD OF CARBON BLACK IN DIFFERENT FIELDS

Plant No	State	Process	Lb. of Carbon Black per 1,000 cu.ft. Gas
1	Louisiana	Channel, 2-table	0.78
2	Louisiana	Channel, 1-table	0.95
3	Louisiana	Channel, 1-table	0.80
4	Louisiana	Large plate	0.80
5	West Virginia	Large plate	1.10
6	West Virginia	Rotary disk	0.95
7	West Virginia	Roller	0.80
8	West Virginia	Rotary disk	1.00
9	West Virginia	Channel, 2-table	1.12
10	West Virginia	Channel, 1-table	1.30
11	West Virginia	Rotary disk	1.40
12	Oklahoma	Channel	1.20
13	Wyoming	Channel	1.40

The channel system has the advantage that plants can be constructed almost entirely from standard forms, thus making the enlargement of this type of plant convenient. The cost of construction is less than any of the other types of factories.

The large plate method has the disadvantage of requiring special castings which are so large as to entail a greater initial cost of construction. However, they are advantageous when erecting a plant capable of producing a large output in that the power requirements are less than those of the other methods.

TABLE II. COMPARISON OF DIFFERENT METHODS

Plant No	Location	Method	Sq.ft. per Burner Tip	Sq.ft. per Lb. of Carbon Black	Sq.ft. per 100 cu.ft. of Gas Burned
1	Louisiana	Channel, 2-table	0.21	4.87	3.73
2	Louisiana	Channel, 1-table	0.26	4.23	4.04
3	West Virginia	Roller		9.10	7.33
4	West Virginia	Large plate		6.53	7.16
5	West Virginia	Channel, 2-table		5.05	6.75
6	West Virginia	Small disk		3.10	2.90
7	Oklahoma	Channel, 1-table		3.70	3.50

Sq. ft. of depositing surface

The rotating disk process requires a special casting, but has the preference over the channel method in that the plants are more elastic. Part of the disks in a condensing building may be out of order, still the remaining rings will operate and it is not necessary, as in the channel method, to eliminate an entire condensing building.

A plant using the roller system produces the smallest yield and requires the largest depositing surface per lb. of black made and per 1,000 cu.ft. of gas burned (see Table II) of any type of plant. The demand for the product made by this process is small and the present production is sufficient to supply the present demand.

Japanese Matches

The export of Japanese matches, which during the war monopolized many of the world's markets, is now steadily decreasing, says the *Japan Chronicle*. Most of the trade now goes to Hongkong and the southern part of China. Exports during July reached a value of $84,399, which was a decline of $25,693 below the previous month and of $41,126 below July, 1919. Enormous stocks have accumulated on the Kobe market, where the prices in August showed a slight increase over July.

Commercial Retorting of Oil Shales

By Louis Simpson

IT HAS been predicted that within two years gasoline will reach the record price of 75c. per gal.

It is known that there are many millions of tons of oil-yielding shales in the United States, distributed not over one or two, but probably over a majority of the states and that money to develop those properties and retort the shale should be readily obtainable.

These premises being admitted, it is natural to ask, Why should there be any scarcity of crude hydrocarbon oil or of gasoline—a fractionated product of crude oil? There can be no effect without a responsible cause or causes. It is therefore necessary to seek the cause or causes.

When the extent of the wealth of the oil-yielding shale deposits began to be appreciated by the officials of the United States Bureau of Mines, these officials widely recommended those interested in the utilization of these neglected natural deposits to use the style of retort that for many years had been successfully operated in Scotland. This unfortunate advice, given in all good faith, has proved to be a veritable stumbling block in the way of the development of the industry, for the following reason: It has been found (and after years of contention it is now generally admitted) that the Scotch style of retort, the result of development influenced by local conditions peculiar to Scotland, is not the most suitable or the most economical form of retort when used under conditions widely and essentially different from those existing in Scotland.

Claims of the Scotch

The Scotch, because they had made a success of the retorting of the Scotch oil shales, took every opportunity of making it known to the world that the Scotch oil-yielding shales were the only true oil shales, that the Scotch retort was the only possible retort and that the Scotch-trained shale engineer was the only engineer who knew anything about the oil-shale business. These claims, which have no foundation in anything but in the Scotch imagination, have so frightened the capitalist that the necessary capital in sufficiently large amounts has not been available, capitalists preferring to wait until the retort question was settled.

It is now known that Scotch experience, unmodified by other experience, has in the past proved detrimental instead of advantageous when operations had to be conducted under conditions greatly different from those existing in Scotland. It is now admitted that the chemical principles that underlie the process of retorting oil-yielding shales as carried out in the Scotch retort are correct, but it has had to be granted that, in the application of those principles, there is much that can be improved.

Moreover, even were the application of the principles the best when applied to retorts retorting Scotch shales under Scotch conditions, such application might not and probably would not be the best when the retort is required to retort shale of a different character and quality under conditions that are different.

The shale found in Scotland, needless to say, is not, as claimed, the only true oil shale. Any shale that contains "kerogen" is a true oil shale. The base of such shale may consist chiefly of silica, alumina or lime. The shale may contain a small or a large per-

centage of fixed carbon, it may contain nitrogen and potash in comparatively large or in very small quantities. Hence the variations in quality may be and are very wide.

Further, the oil obtained from the shale may be chiefly of a paraffine, or, on the other hand, of an asphalt base or it may be relatively free from sulphur or have a relatively high sulphur content, all factors affecting the value of the oil.

Differences Affecting Commercial Value of Oil-Yielding Shale

To summarize, differences that affect the commercial value of oil-yielding shale are:

1. Base of the sedimentary deposit, whether silica, alumina or lime.
2. Base of the recovered oil, whether paraffine or asphalt.
3. Relative percentage of sulphur in the oil.
4. Fixed carbon content of the shale, which may be less than 2 per cent or more than 20 per cent.
5. Quantity of oil recoverable, which may be less than 10 gal. or may exceed 75 gal. per ton.
6. Quantity of nitrogen recoverable as ammonium sulphate, which may be less than 20 lb. per ton and may exceed 100 lb. per ton.
7. Quantity of potash recoverable. In only a few cases will it be found profitable to recover the potash content.
8. Spent shale. This generally is of no value, but should the shale be of a lime base it may at times be profitably used in the manufacture of portland cement.

Location and Character of the Deposit

The location of the deposit may be favorable or otherwise. The deposit may be near a railway or may be at a considerable distance from any railway communication.

It may be necessary to undertake expensive pipe lines, also wharves, with all the attendant expenses of tanks, etc.

It may be necessary to invest much capital in tank cars, while in other cases one or more of these capital expenditures may not be necessary.

As the shale itself differs within wide limits, so also may the character of the deposit.

In Scotland shale has for some years past been recovered by deep mining, some having been mined at a depth of 2,000 ft., at a commensurately high cost for such mining.

The deposits as known to date may be divided:

1. Horizontally bedded deposits, being the top strata of hills, covered by an overburden that can be economically removed.
2. Horizontally bedded deposits, that can be mined from tunnels or adits driven into the hillside. These may be subdivided into those where the roof is good and those where the roof has been badly disturbed, also into those where the shale beds are from 3 to 8 ft. thick and those where the shale beds are thinner than 3 ft. or thicker than 8 ft.
3. Deposits more or less horizontally bedded, forming the bottom of a valley. These can be subdivided as follows: (*a*) Those covered by a slight overburden. (*b*) Those where the overburden is considerable, yet not too deep to be economically removed. (*c*) When it is more economical to bypass certain lean beds.
4. Deposits, now vertical in position, which are made available by the erosion of water, making it possible to remove the shale by quarrying or by modified shovel work. These can be subdivided into those that are covered with but slight overburden and those where the overburden is heavy.
5. Deposits, now vertical in position, appearing as bands of shale extending down the sides and the bottom of valleys, being the remains of synclinals, the anticlinal portions of the formation having been eroded.
6. Deposits such as are found in Scotland, that have to be recovered by deep mining, these being subdivided according to the depth that has to be mined.

Methods of Mining

Deposits 1, 3, 4 and 5 can all be excavated by the use of steam-operated, or better still, electrically-operated shovels. This method of mining costs considerably less than the method required in deposit 2 and immensely less than that called for in deposit 6. The difference is so great that it is possible that a deposit giving a low yield of oil, but which can be mined by shovels, will prove more remunerative to operate than a deposit which, although it is rich in oil, has to be mined as deposit 2, typical of the Colorado shales, or as 6, typical of the Scotch shales. The difference in the cost of mining and assembling at today's cost may exceed $2 per ton of shale, which is a profit in itself.

Unfortunately the shovel method of mining cannot economically be undertaken unless the daily tonnage mined is considerable, hence it is necessary that the industry should be undertaken by concerns prepared to expend the capital necessary to construct works of considerable throughput.

Expenditures and Returns

As stated by Martin J. Gavin in his article "Oil Shales and Their Economic Importance," published in Chemical & Metallurgical Engineering, Aug. 18, 1920: "The oil-shale industry will require the expenditure of many millions of dollars." Mr. Gavin, however, is not correct when he claims that an investor "will probably have to wait for a long time for a return on his investment and that returns will probably be conservative."

There is nothing to warrant such a statement. Given a property, well selected as to location, extent and quality, not only can the industry be put into operation in unusually quick time, but the profits will become available at once upon the retorts being put into commission and the profits may be expected to be very considerable.

It may be that Mr. Gavin may be able to point to instances where this has in the past been the case, but such conditions have resulted from the attempted operations of works that were ill planned and not well thought out. Plants constructed under such conditions were from the first doomed to disaster.

Plants of small throughput cannot be economically operated. A plant to be capable of being economically operated must be so designed that it can be kept in

commission twenty-four fours per day, seven days per week and 365 days per year, or as near this as may be possible. Such a plant must have a staff of experts, competent to at once attend to any difficulties that may arise. Only works with a large throughput can afford to pay the salaries of such a staff.

A plant of 2,000 tons shale per twenty-four hours throughput is the ideal size for most economical operations. Such a plant when properly designed and constructed can be operated at an absurdly low cost per ton as regards wages, as is evident from the following: Taking wages at the average of the high rate of $6 per man per eight hours, the cost of mining and assembling being excluded, but including crushing, retorting, condensing, attendance in boiler and power house and for spent shale and oil delivery, including also foremen, the total number of men employed per day is but fifty-three. This, at $6, gives an expenditure of $318 for 2,000 tons throughput, or about 16c. per ton. The cost of management, chemists and office will require 8c. per ton more, or a total of 24c. per ton. The cost of ammonium sulphate recovery is a varying charge dependent upon the cost of sulphuric acid and upon the yield of the manufactured chemical per ton shale. The cost may be less than 9c. per ton shale or might be more than 20c.

Repairs may be taken as costing 3c. per ton, loss on packages as 2c. per ton, depreciation as 10c. per ton, taxes (not including excess profits tax), insurance and sundries 5c. per ton, making a total of 44c. per ton plus the cost of ammonium sulphate recovery and the cost of mining and assembling.

As previously shown the cost of mining and assembling depends upon local conditions. It may be less than 20c. per ton and it may exceed $3 per ton. Speaking generally, the whole cost per ton, including mining and ammonium sulphate recovery, may be less than $1 per ton, while on the other hand, in extreme cases, the cost may exceed $3 per ton.

As has been already stated, the difference between the cost of operating an ideally located and developed works, retorting shale in an ideally planned and constructed works and one that is not ideally placed, planned or constructed is a handsome profit in itself, and one that would afford the payment of large dividends.

Lack of Experienced Oil-Shale Engineers

There is, however, another reason why capitalists have, in the past, looked with small favor upon oil-shale propositions. Capitalists who deal largely in mining properties are accustomed to employ certain chosen engineers who are called upon to report upon any proposition submitted to them. Until within a comparatively recent rate there have been no engineers on this continent who were capable of correctly making a report upon an oil-shale property. Even today their number is limited. An engineer with a reputation and experience in gold, silver, copper or iron mining is probably about the most unsuitable man to choose to make such a report. To ask a man who has, and justly has, a reputation gained in work he understands to risk that reputation by giving opinions on work he does not understand is not fair, and such men usually find it safer to turn the proposition down. In consequence of the lack of knowledge difficulties are magnified and reasonable possibilities are ignored. It is but human nature to listen to the old adage and "When in doubt, don't."

An oil journal lately published an account of a small retort plant which operated for sixteen hours per day only, "taking advantage of daylight hours," it was stated. The result was as follows:

	Cents per Ton
Mining (open pit) and delivering	73 00
Crushing	4 50
Power, wages and gasoline	12 00
Retorting	24 00
Lubricating oil	0 25
	113 75

It is to be noted that in the above-presumed cost many charges are omitted. The figures are quoted for the purpose of comparing the cost of a small plant with one operating upon an economical throughput.

	Small Plant, Cents per Ton	Plant of Econom Cents per T
Mining	73	20
Crushing	4½	2
Power	12	3
Retorting	24	4
	113½	29

It is certain that up to date the new business of retorting oil shales on the American continent has never had a fair chance. It is certain that it never will have a fair chance until some strong group of capitalists becomes prepared to risk capital in the construction of a plant large enough to retort 2,000 tons of shale in twenty-four hours. If such a plant be built from properly designed and thought out plans it will be proved that when operating upon medium- to high-grade shales, the return will be very much larger than "conservative" and with this additional advantage the return will be assured for many years to come.

Costs of the Industry

The costs of the industry should be made out somewhat as follows:

1. Removal of overburden or—in case of mining—preliminary work.
2. Drilling and explosives.
3. Excavating and assembling or loading and assembling.
4. Crushing.
5. Retorting and condensing.
6. Power plant, etc.
7. Removal of spent shale.
8. Byproducts recovery.
9. Warehouse and delivery.
10. Gasoline and lubricants.
11. Repairs.
12. Loss on packages.
13. Taxes, insurance and sundries.
14. Management.
15. Depreciation.
16. Amortization.

In a great many cases the cash returns from the sale of the manufactured byproducts will pay not alone the cost of such manufacture but also all the costs of mining and retorting, etc. In all cases it is necessary that the question of byproduct recovery should be examined carefully. This question has already been discussed at length in Chem. & Met. Eng., vol. 22, p. 20, Jan. 7, 1920.

When the whole cost of mining, of retorting and of recovering and manufacturing the byproducts can be paid for out of the sales of those byproducts, who is there that will dare maintain that the production of oil by retorting oil-yielding shales is not profitable or at the best will only yield "conservative" returns?

Ottawa, Canada.

Fuel Symposium at the Sixtieth A.C.S. Meeting, Chicago

TWELVE papers were presented in the form of Fuel Symposium which had been prepared by a committee of the Division of Industrial and Engineering Chemistry under the chairmanship of A. C. FIELDNER. Four major topics were discussed by the various speakers: (1) Carbonization of coal. (2) Liquid fuel problems, particularly gasoline. (3) The general problem of fuel conservation. (4) The problem of sulphur in fuels. This session aroused a great deal of interest because of the widespread attention being given to fuel matters and urgency of fuel supply in industry at the present time.

CARBONIZATION OF LIGNITE

A paper entitled "Carbonization of Canadian Lignites," by EDWARD STANSFIELD, was presented by Mr. FRENCH, the engineer who has been associated with this investigation, covering the work done jointly by the Department of Mines and the Lignite Utilization Board of Canada. This report described the early small-scale experiments and the later larger-scale tests which have led up to the design and construction in southern Saskatchewan of a plant which is expected to handle two hundred tons of raw lignite per day. The lignites used are available at about $1.75 per ton at the mine. A typical analysis of the material employed, on a moisture-free basis, is as follows: Water of constitution, 31.8 per cent, volatile, 28.9 per cent, fixed carbon, 34.1 per cent, ash, 5.2 per cent. The heating value is approximately 4,260 calories per gram. From this material the following results are reported:

	Percentage of Weight of Dry Coal	Per cent of Original Heating Value
Water	11.7	...
Gas	17.0	8.3
Crude tar	4.1	6.0
Residue (char)	66.7	78.1
Loss	0.5	7.6

These represent yields of about 3,150 cu.ft. of gas having a heating value of 385 B.t.u. per cu.ft., 5.3 gal. of tar, 910 lb. of residue, and 10.2 lb. of ammonium sulphate per ton of dry lignite treated. The process is developed to a point where the tar is distilled and the pitch from this used as a binder for briquetting the char. The principal object of this work is the development of a solid fuel, therefore less effort has been made upon gas and byproduct recovery thus far. The commercial plant is nearing completion, and it is hoped that operations will begin within a few months.

As a contribution to the discussion of this report, E. P. SCHOCH, professor of the department of chemistry of the University of Texas, presented a discussion upon the utilization of Texas lignites. The effort in this work was to obtain a supply of city gas, and the tendency was, therefore, along different lines than had been described in the Canadian work. Special attention was given to operation of the retorts under pressure. It was found that this gave a higher yield of gas, but at the expense of a lower yield of tar. This result was probably caused by the slower elimination of the vapors from the retort, causing a greater cracking and, therefore, larger gas yield from the otherwise liquid constituents.

The large percentage of carbon dioxide in the gas led to a special effort looking to the removal of this constituent. As a result liquid purification was adopted and very favorable results are reported. From 2,000 to 3,000 cu.ft. of gas per ton of raw lignite was thus obtained with a heating value in the gas approaching 600 B.t.u. per cu.ft. The yield of coke and tar were of the same order as those reported on the Canadian material.

The advantages claimed for the method of handling recommended were: Coke of a good heating value, gas immediately usable for city supply, maximum yield of tar, a cheap retort of large capacity operating under conditions that make for long life, and the production of coke easily handled in briquetting.

FUEL CONSERVATION

H. C. PORTER discussed the general subject of present and future conservation of fuel supplies. Among the means of increasing our fuel resources he suggested the following: Increased use of boiler plant accessories such as feed-water heaters, and other efficiency devices, use of gas instead of coal in steel plants; electrification of railways; development of superpower electric stations; carbonization of coal at the mine; increased carbonization with recovery of byproducts; alternate carbonization and steaming of coke in a single machine for production of a mixture of coal-gas and blue-gas; use of oxygen to enrich water-gas blast (the oxygen to be made with power used at off-peak hours); a lower heating value per foot for city gas supply; elimination of beehive ovens; and other well-recognized means of fuel economy.

The article by HENRY KREISINGER entitled "Byproduct Coke, Anthracite and Pittsburgh Coal as Fuel for House Heating" was presented by title only. Similarly the reports on "The Charcoal Methods for Gasoline Recovery" and the report on "Colloidal Fuels" were not presented in detail. The abstract of the paper on the latter subject by C. A. SHEPPARD included the following comments:

Colloidal fuels is a name given to a distinct class of liquid-to-semi-liquid blended fuels. They were developed in this country during and subsequent to the last two years of the great war. They are composites, in which finely divided carbonaceous solids or semi-solids—various kinds of coal—are so suspended in and blended with liquid fuel oils as to form readily stable and atomizing fuels. They have been developed for burning with the regular types of atomizing burners using ordinary fuel oils, but have also possibilities for use in internal combustion engines of the Diesel and semi-Diesel type.

The machinery for compounding these fuels is simple; it consists of a suitable mill for pulverizing coal, coke, etc., storage and blending tanks for the oil bases, and mixing kettles for compounding the composite fuel. Little modification in existing types of machinery is necessary, and the process is readily made continuous. The cost of manufacture may be reckoned at approximately $1.50 per ton, inclusive of the fixateur —a substance used in small quantity to stabilize the colloidal fuel.

The following is a brief summary of the properties of colloidal fuels:

1. They are liquid and handle and atomize for combustion like fuel oils.
2. They contain more heat units per gallon than fuel oils.
3. They contain very little moisture and ash.

4. The temperature at which they take fire (flash point) is above 200 deg. F. They are immune from spontaneous combustion.

5. Not only are they vaporless up to high temperatures, thus avoiding explosive mixtures with air, but they may be fireproofed by a "water seal" of an inch or more of water, owing to the fact that they are heavier than water.

6. Hence also they will sink if spilled blazing on the surface of water—i.e., they are self-quenching. Their fire risk is as low as anthracite coal, and far less than bituminous coal or ordinary fuel oil.

7. They are the most compact fuels known. The advantages of this are obvious: increased radius for ships, lessened storage space in crowded cities.

Byproduct Coking

F. W. Sperr, reviewing the byproduct coke situation, summarized the present status of work in this field. He emphasized particularly the trend toward byproduct gas manufacture and away from the production of water gas. The lesser labor requirement per ton of coal handled in byproduct ovens as compared with coal gas plants handling the coal at smaller units is also a factor at present tending to increase byproduct oven operations. The relative economy of beehive and byproduct oven operations was emphasized and the trend for many years past toward byproduct coke for blast-furnace use was pointed out. It was urged that further study should be given to additional applications of coke so that more of our bituminous coal could be handled with byproduct recovery. Utilization of coke breeze by stokers was pointed out as one important contributing factor to the success of coking at the present time. Other factors mentioned were producer gas firing of ovens, use of silica refractories in place of fireclay materials; the extensive application of tar as a metallurgical fuel, etc. It was pointed out that recent byproduct ovens provided for steaming of coke in the oven, thus arranging that almost complete gasification of the solid fuel may be accomplished in what is practically a single operation.

Low-Temperature Carbonization

S. W. Parr presented a discussion of low-temperature carbonization, by which he meant treatment of fuel at temperatures below 750 to 800 deg. C. He indicated that up to this temperature he considered essentially only primary products of distillation; secondary products of high-temperature decomposition do not enter materially until higher temperatures are reached. The usual method of rating coals as to cokability depending upon the ratio of oxygen content to hydrogen content is criticized by this author. He pointed out that conditions of treatment of the coal were of greater importance than this ratio, for if temperature is properly controlled the interaction of the oxygen compounds with those compounds which afford the binder for the coke is prevented. He presented one example of a coal badly weathered which was still suitable for coke production by proper temperature control. He advanced the theory that those constituents which are soluble in phenol react upon heating with oxygen compounds to give compounds of variable composition and prevent coking. He emphasized particularly that the sulphur, nitrogen, and oxygen compounds formed seemed to violate the laws of definite compounds as the percentage composition of these compounds varied by small steps, in a way inconsistent with our usual concept of definite composition.

Because of the low heat conductivity of the coke mass through which heat must be transferred by ordinary systems of coking, this author has undertaken to use the exothermic heat of reaction during coal carbonization to furnish the bulk of the heat required for coking. He refers to the reactions thus as proceeding "autogenously." He expresses two of his conclusions in this particular as follows:

"It is possible to utilize the exothermic reactions inherent in high oxygen coals in such a manner as to secure the autogenous transmission of heat to the center of an otherwise non-conducting mass and under conditions wherein the ultimate temperature attained at any point of the coal mass is not in excess of the prescribed limit.

"The time for autogenous transmission is governed by the speed of the exothermic reactions involved and is estimated to be approximately one-fourth of the time required for heat penetration as obtained under high-temperature conditions."

At the present time Dr. Parr has not proposed any definite industrial processes, but is working on a basis of a discontinuous operation with 35 lb. samples—i.e. on a commercial laboratory scale.

Gasoline Losses

A. C. Fieldner and associates reported upon extensive tests of motor vehicles for efficiency in gasoline use. These tests make clear the very large losses of gasoline which result from improper carburetor adjustment and careless driving. These tests were those carried out in connection with the investigation of poisonous gases from automobile exhaust which must be cared for in the proposed vehicle tunnel under the Hudson River.

Mixture of Natural and Manufactured Gas

J. B. Garner urged the use of natural gas for the enrichment of manufactured gas supplies, stating that in his opinion natural gas companies should no longer be permitted to sell natural gas as such but should conserve it for the city supply to supplement the manufactured gas production for these purposes.

Commercial Realization of Low-Temperature Carbonization

Dr. Harry A. Curtis, chief chemist of the International Coal Products Corporation, reported on the Carbocoal process, which has been developed to the point of the installation of a plant having a daily capacity of 350 tons of product, using 500 tons of coal per day. This process was described in Chem. & Met. Eng., vol. 23, No. 10, Sept. 8, 1920, p. 499.

Sulphur in Fuels

The report of Alfred R. Powell discussed the factors which affect the sulphur content of coke and of gas produced by the carbonization of bituminous coals. The significance of the different sulphur compounds in the coal upon the distribution of the sulphur in the products is pointed out.

A report on a similar subject was presented by H. F. Yancy and Thomas Fraser, entitled "The Distribution of the Forms of Sulphur in the Coal Bed." The relations between the relative quantities of pyrite sulphur and organic sulphur were discussed. This work represents a report on a large number of mine samples, particularly those collected in southern Illinois and western Kentucky.

Dr. Allen Rogers Receives the Grasselli Medal

AT THE joint meeting of the American Section of the Society of Chemical Industry and the New York Section of the Société de Chimie Industrielle, Friday evening, Oct. 8, the Grasselli Medal was presented to Dr. Allen Rogers of Pratt Institute.

Presentation Address

BY MARSTON TAYLOR BOGERT

The Grasselli Medal was established by the Grasselli Chemical Co. of Cleveland, Ohio, to be awarded annually for the paper presented before the New York Section of the Society of Chemical Industry which shall, in the opinion of the medal committee, offer the most useful suggestions in applied chemistry. The committee of award, at its meeting Sept. 17, 1920, voted unanimously to bestow the medal for this year upon the honorary secretary of the American Section, Dr. Allen Rogers, for his paper entitled "Industrial Uses for the Shark and Porpoise," printed in the *Journal* of this society for Jan. 31, 1920 (vol. 39, No. 2, pp. 9-10T).



DR. ALLEN ROGERS

As a personal friend both of the donors and of the recipient of the medal, it will be understood how pleasant I find my task this evening as the official to make the formal presentation.

Dr. Rogers was born in Hampden, Me., May 22, 1876, and was graduated from the University of Maine in 1897 with the degree of B.S. in the chemistry course.

In 1900 he received the degree of M.S. from his alma mater and in 1902 the degree of Ph.D. from the University of Pennsylvania, where he remained for two years as senior fellow and instructor in organic chemistry.

In June, 1904, he abandoned this temporarily, to enter the employ of the Oakes Manufacturing Co., Long Island City, N. Y., as research chemist, where his investigations on problems related to the leather industry led to several patents being taken out by the company.

In September, 1905, he withdrew from the Oakes Manufacturing Co. and returned to the ranks of the teachers, as professor in charge of industrial chemistry at Pratt Institute, Brooklyn, N. Y., the position he still occupies.

For many years Dr. Rogers has made a special study of leathers and tanning, until he is now widely recognized as one of our foremost experts in this important field. Patents have been granted to him for various processes of treating leather, and other patents are pending. His most interesting work in this direction is that recorded in the paper for which the medal is awarded.

In the time of our country's need he promptly and patriotically sacrificed all personal selfish interests and volunteered for military duty, being commissioned Major in the Chemical Warfare Service, where he was put in charge of the industrial relations branch.

Dr. Rogers is the author of a Manual of Industrial Chemistry, in preparation of which he was aided by over forty distinguished collaborators.

It therefore gives your host of friends particular pleasure, Major, to see this medal awarded to one who has for so many years labored so unselfishly for others and who has devoted himself so assiduously and so successfully to the development of that branch of chemical industry to which the paper relates. May it bring to you much happiness, and may it prove an inspiration to yet further achievement!

Acceptance of the Grasselli Medal

BY ALLEN ROGERS

My dear Colonel Bogert: I certainly appreciate your kind words and hope that I may be worthy of all the good things you have said. It was a great surprise to me, I assure you, when I received the information that my paper on "Industrial Uses for the Shark and Porpoise" had been deemed of sufficient merit to warrant recognition for the award of the Grasselli Medal. The commercial utilization of the shark is a matter that has interested me for several years, and if I have done anything to interest others in my friends of the deep, it is of course very gratifying. Sharks have always been considered as scavengers and of no benefit to man. My work, however, has shown me that they have some good points in their favor, and if we take advantage of them I feel confident that a great industry may eventually be established. Already much has been accomplished in this direction. A fairly large plant is in operation at Morehead City, N. C., where the fish are caught, the skins removed, the livers rendered for oil and the flesh converted into fertilizer stock. Another plant is located at Sanibal Island, Fla., and at the tannery in Newark, N. J., about one thousand skins are being treated each week. Plans are now under way for establishing other stations at various points along the Atlantic and Pacific coasts, while the existing plants will be greatly enlarged.

As time goes on and we learn more about these despised creatures we will no doubt discover new uses for the various parts of their anatomy, and who can tell what benefit may then be derived?

I am sorry not to have been able to show some new motion pictures recently taken at the various plants, but hope to do so in the near future. At that time I may have some results of investigation to present. I have, however, a few samples of leather and oil and will be glad to answer any questions after the meeting.

In accepting this medal I wish to thank the Grasselli Chemical Co., through whose generosity the award is made possible. I desire to express my appreciation to the members of the medal committee for their consideration, and I want to thank you personally for the friendship you have manifested and the inspiration you have given to me in making the presentation of this beautiful medal.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacturing Pig Iron From Pyrites Cinders in Electric Furnaces.—In the manufacture of sulphuric acid from pyrites a byproduct rich in iron is obtained which up to now is of very little use due to its high content of sulphur, making it unfit for use in the blast furnace as an iron ore. MARCEL GUÉDRAS gives a description of manufacturing pig iron from pyrite cinders in electric furnaces in the July, 1920, issue of *Technique Moderne*, pp. 301-304, of which the following is an abstract:

The average composition of the pyrites cinders is:

	Per Cent
SiO_2 ..	3
Fe_3O_4 .. (66 per cent iron)	94
S ..	2.75 to 3.5

This is evidently a very rich ore if it could be used. In collaboration with M. Duina, the author has devised a process for the manufacture of pig iron from cinder in the electric furnace.

In the blast furnace the use of pyrites is limited to a maximum of 10 per cent of the charge. It has been possible to increase this percentage after scorifying by a German process which consumes a relatively great amount of fine coke or coal, but the porous cinders obtained still contain 0.5 to 0.45 per cent sulphur.

A more rational process for treatment is by reduction in the electric furnace, a practical and advantageous process when considering the richness of the cinders in iron and the small content of silica.

A very important point, which formerly has not been duly considered by metallurgists, is the physical state of the roasted pyrite. This pulverulent material is spongy and by this fact absorbs great quantities of water. Quite often pyrite cinders after standing some time contain as high as 20 to 22 per cent of moisture.

To obtain a normal and regular treatment of pyrite cinders it is absolutely necessary first to dehydrate them completely, combining this operation with a partial desulphuration; to be later completed by chemical reactions in the reduction furnace. This point constitutes one of the principal specifications of the Guédras-Duina process.

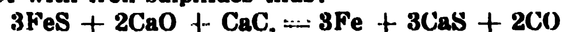
Desulphuration and dehydration is to be followed by agglomeration, since it is necessary that the cinders shall not be charged into the electric furnace in a pulverulent state, as the fine material would sift through the other constituents of the charge, partially escape reduction and, therefore, be lost with the slag. The combined operations of dehydration, desulphuration and agglomeration take place in a gas heated rotary Breuillé kiln. Temperature required is from 1,000 to 1,200 deg. C.

Pyrite cinders with a sulphur content of 2 to 3 per cent when charged into the furnace leave the furnace with a sulphur content of 0.1 to 0.2 per cent; the nodules are strong, but highly permeable to gases, a very useful quality for the subsequent reducing operation.

Reduction takes place in an open top electric furnace, but can also be done in an electric blast furnace when the gases are to be used.

The desulphurating reactions which take place during reduction are:

(*a*) A reaction which is proper to all electric furnaces—namely, the action of lime carbon with the formation of calcium carbide. Carbide and lime then react with iron sulphides thus:



(*b*) Calcium chloride is also added to the charge, and it intensifies the desulphuration of the molten bath as given by the equation



When the formed carbonyl chloride comes in contact with moisture in the furnace atmosphere or after escaping to the air it is rapidly destroyed according to the equation



(*c*) Adding manganiferous minerals or manganiferous slag to the charge for the introduction of manganese into the pig iron is also of help in desulphurization.

The technique of this process is based upon two distinct ideas:

(1) Absolute necessity to eliminate the moisture completely in a preliminary roast.

(2) Utilization of the desulphurizing action of the electric furnace, which action is increased by the presence of a calculated amount of calcium chloride in the molten bath.

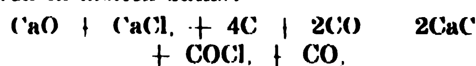
Due to the high content of sulphur in the original material it is practically impossible to have a complete desulphuration by chemical processes only and it is therefore necessary to have a preliminary desulphuration in conjunction with the dehydration.

Calcium sulphide formed in the furnace is very unstable. This instability is correlated to the question of molecular equilibrium between the constituents of the slag.

The miscibility of sulphur in the metal depends upon the concentration of sulphide in the slag and on the tension of the sulphur.

Very little research has been done upon the vapor pressure of sulphur in hot sulphides, and the data reported usually present great discrepancies. A fact well determined is that when a certain quantity of sulphur has passed into the state of calcium sulphide the equilibrium ratio between iron sulphide in the slag and that in the metallic bath is changed and a certain quantity of sulphur passes into the slag. This action is much more pronounced in continuous pig-iron furnaces than in electric-steel furnaces, due to the continuous addition of the slag-forming lime.

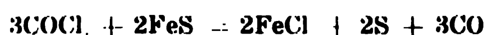
The rôle of carbon oxychloride is of great importance. This is best shown by Michalske's reaction, which takes place even in molten baths:



Chlorine in the $COCl_2$ thus formed displaces sulphur in iron sulphide



or



The advantages of elimination of sulphur by substitution are that the limit of CaS saturation in the slag cannot be exceeded and complete desulphurization of the metallic bath can be realized.

A desirable slag would be calculated to correspond to the formula $SiO_2.2CaO$—i.e., a basic silicate, in which

will be found a certain quantity of CaC_2, considered in itself a very basic substance. However, to lower the melting point of the slag it is advisable to incorporate a certain proportion of alumina and thus figure to an alumino-calcic silicate of the formula $SiO_2 . Al_2O_3 . 2CaO$.

The reducing agent used may be coke, charcoal or a mixture of charcoal and anthracite.

To produce a ton of pig iron 380 to 400 kg. of coke is required, which corresponds to 218 kg. of carbon, plus what is needed for carburation.

The consumption of energy may be tabulated as follows:

			Calories
Reduction of	930 kg. iron	1,887	1,754,910
Reduction of	10 kg. Si	7,830	78,300
Reduction of	5 kg. Mn	1,730	8,650
Vaporization of	165 kg H_2O	1 549	255,585
Fusion of	1,000 kg. pig iro	300	300,000
Fusion of	400 kg. slag	500	200,000
Total heat spent..			2,597,445
Heat received:			
Combustion of 212 kg. of carbon × 8,133			1,724,196
			873,249
Losses by cooling and radiation			259,744
Heat to be furnished by the current			1,132,993

That is to say, 1,322 kw.-hr. The actual consumption is on the average 2,200 kw.-hr.; the furnace has, therefore, a power factor of 0.6, which is low.

Pig iron obtained by this process analyzes 0.001 to 0.03 per cent sulphur, which of course is excellent. The consumption of electrodes is 14 kg. per ton of pig iron produced. An industrial plant of 3,000 kw. can produce 11,000 tons of pig iron per year and requires 16,060 tons of pyrite cinders.

Recent Chemical & Metallurgical Patents

British Patents

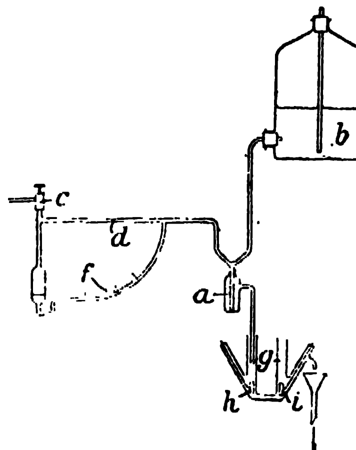
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Hardening Iron and Steel.—An aniline dyestuff such as auramine and methyl violet is used in hardening wrought iron and steel. The material in powdered form may be mixed with rock salt, saltpeter and carbon, etc., and spread over the article to be hardened; or a solution in ammonia water may be used for quenching. (Br. Pat. 143,510—1919. W. KAISER, Frankfurt-on-Main, July 21, 1920.)

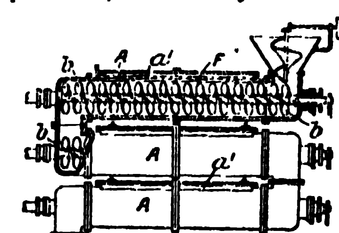
Sulphonic Esters.—Resinous compounds are prepared by the reaction of phenolalcohols with aromatic sulphochlorides containing hydroxy or carboxylic groups or both these groups; mixtures of two or more such sulphochlorides may be used; the reaction is effected in presence of alkali, preferably in slight excess. The products can be converted into soap-like products which can be used as emulsifying agents, or in the manufacture of lubricants from tar oils. Br. Pat. 143,185—1919. See also 143,187—1919. B. MELAMID, Breslau, Germany, July 21, 1920.)

Transformer Oils.—Tar oils dissolved or not in an inactive solvent are oxidized as by bichromate or permanganate mixtures at low temperatures to obtain fluid oils capable of use as transformer oils. In an example 100 kilos tar oil is stirred for about an hour with bichromate mixture, and allowed to stand until atmospheric temperature is reached. The supernatant oil is separated from the resin deposited, refined with 2 to 3 per cent of 66 per cent sulphuric acid, washed, and distilled *in vacuo*. In a second example, 100 kilos tar oil is dissolved in 100 kilos benzine and treated at 0 to 5 deg. C.; the solvent is distilled off, and the oil treated as in the first example. (Br. Pat. 143,198—1919. M. MELAMID, Breslau, Germany, July 21, 1920.)

Synthetic Ammonia Analysis.—In the synthetic production of ammonia, the gases circulating in the system are, for determining their ammonia content, passed through an absorbent of ammonia and the electrical conductivity of the resulting solution measured. In a suitable apparatus, the gases pass through a regulating-valve *c* and a flow-meter *d*, *f* to an absorber *a* supplied with water at a predetermined rate from a vessel *b*; the solution then passes into an electrolytic cell *g* having electrodes *h*, *i* of platinum, etc., and in circuit with suitable apparatus for measuring the conductivity. (Br. Pat. 143,341—1919. E. K. RIDEAL and A. G. TARRANT, University College, London, July 21, 1920.)



Glucose.—One part of wood is first dried, treated with 1 to 2 parts of 35 per cent hydrochloric acid, and supersaturated with gaseous hydrochloric acid until the acid concentration reaches 41 per cent, the temperature being maintained between 0 and 25 deg. C. It is then allowed to digest at a slightly higher temperature, and finally the surplus acid is removed and the glucose purified by washing and filtration. The acid treatment is conducted in a series of externally-cooled connected tubes *A*, each provided with a mixer and conveyor *b*, liquid acid being introduced into the upper vessel and gaseous acid into the lower vessels through pipes *F*. The mash is digested for two to eight hours in drums adapted to turn on hollow axes, through which water is circulated so that the temperature is maintained between 3 and 30 deg. C. Excess hydrochloric acid is then withdrawn from the mass, which contains a mixture of glucose and dextrin, by placing the drum in communication with a vacuum vessel containing dilute acid kept at 10 to 15 deg. C. Sufficient water is added to the mash to allow it to be filtered, and the filtrate is concentrated *in vacuo* to free it entirely from hydrochloric acid, which is collected in



the usual manner. The dextrin may be converted into glucose by boiling for about an hour with diluted hydrochloric acid. Specification 107,219 is referred to. (Br. Pat. 143,212—1919. L. TERRISSE and M. LEVY, Geneva, July 21, 1920.)

Treating Hides and Skins, Electric Endosmose.—In tanning or impregnating materials, they are first impregnated with the tanning, etc., liquor by electric endosmose, and are then treated with preferably stronger liquor without electric current, to complete the tanning, etc. The electric treatment may be carried out as described in Specification 19,849—1914, with liquor of density 2 to 3 Bé., and may last 2 to 3 hours. The non-electric treatment may be effected with liquor of density 10 deg. Bé., and its duration may be two days. Suitable tanning material is extract of pine bark, oak, or chestnut. The invention is applicable to the impregnation, with chromium or other metal salts or colloids, of fabrics which have been treated with glue or gelatine. (Br. Pat. 143,921—1919. ELEKTRO-OSMOSE AKT. GES., Berlin, Aug. 5, 1920.)

Copper Sulphate.—Copper sulphate is obtained from raw copper carbonate ore by treating with dilute sulphuric acid until the solution becomes sufficiently rich in copper, and then neutralizing the solution by some untreated copper carbonate ore, and heating to boiling point until its density is about 52 deg. Tw., it being meanwhile maintained in basic or neutral condition, for which purpose copper oxide may be added and air or steam may be forced through the solution to facilitate separation of the precipitated impurities on cooling. The precipitated matter is separated, and, if any impurities remain, the solution may be again boiled and cooled. (Br. Pat. 143,973—1919. J. S. ROSS, Westminster, Aug. 5, 1920.)

Purifying Rock Salt.—Rock salt is purified for table use by first comminuting it into grains of about 1 mm. in size and sifting, and then grading the grains in saturated salt solution according to their specific gravity. By the process of comminution, the more brittle impurities, such as anhydrite, are broken down into fine powder, which is sifted away; while in the grading treatment, the heavier particles, such as the sulphates of calcium and magnesium, collect in the lower part of the grading device and the pure salt in the upper part. The grading devices are of the kind in which an inclined sieve is agitated in salt solution, or in which the comminuted salt is moved against the flow of strong brine. (Br. Pat. 144,022—1919. L. W. DAMMAN, Zwolle, Holland, Aug. 5, 1920.)

Treating Yarns and Fabrics.—Cotton yarn or cloth is treated for rendering the surface thereof smooth, lustrous, soft, suitable for dyeing and incombustible. The material is immersed for from one to fifty minutes in sulphuric acid of 52 to 60 deg. Bé., washed in water, shaken, beaten or stretched to remove adhering or projecting fibers, and immersed for ten to fifteen minutes in caustic soda having a specific gravity of from 8 to 15 deg. Bé. It is then treated with a 3 per cent solution of borax to render the material incombustible, and afterward with a 5 per cent solution of glycerine or with a solution of calcium chloride, glucose or soap. (Br. Pat. 144,083—1920. S. KASHITANI, Osaka-fu, Japan, Aug. 5, 1920.)

Purifying Oils and Fats.—Animal and vegetable oils and fats, such as whale oil and maize oil, are freed from fatty acids so as to give directly and quantitatively a neutral oil or fat free from soap and a dry alkali soap ready for use, by treatment with dry caustic alkali or calcined alkali carbonate and removal of the water produced by the reaction, as by heat and agitation under reduced pressure or by the addition of calcined sodium sulphate, and taking up the oil in dry solvents such as methylal, ether, methyl acetate, acetone and carbon disulphide, that dissolve only the oil. The solvent may be added at the start or after removal of the water formed. Thorough bleaching of the oil or fat and the soap may be effected by using peroxide or percarbonate in place of caustic alkali or carbonate. (Br. Pat. 144,-176—1919. A. G. BLOXAM, London, Aug. 5, 1920.)

Obtaining Textile Fibers From Papyrus.—In the preparation of textile fibers, which may be used as a substitute for hair, from papyrus, the material, after soaking or retting, is subjected to slight mechanical pressure and to an alternating simultaneous right and left hand torsional or twisting movement, in pairs of rollers so arranged that adjacent pairs move axially in opposite directions. The fibers are dried and the loosened incrusting material is removed and may be used as a carrier for the exciters in the fermentation process. To obtain a cleaner fiber, the fibrous material, either before or after the mechanical treatment, may be subjected to a short fermentation. (Br. Pat. 144,249—1919. J. J. GAHLER HERISAU, Appenzell, Switzerland, Aug. 5, 1920.

Triphenylmethane Dyes. — Triphenylmethane dyes are obtained either by condensing sulphonated aromatic aldehydes with *o*-nitraniline or derivatives thereof having a free *p*-position, or by condensing unsulphonated aromatic aldehydes with *o*-nitraniline or derivatives thereof having a free *p*-position and sulphonating the product. In the second case, the condensation product is a mixture of the product from one molecular part of aldehyde and two molecular parts of *o*-nitraniline with other products which probably result from further reaction of the aldehyde; the crude mixture can be sulphonated or can be separated into its constituents—e.g., by means of hydrochloric acid—before sulphonation. According to examples: benzaldehyde is condensed with *o*-nitraniline and the product is sulphonated, or the product is separated into its constituents by hydrochloric acid, and the separated constituents sulphonated; benzaldehyde *m*-sulphonic acid is condensed with 3-chlor-6-nitraniline. The products dye wool yellow shades. (Br. Pat. 144,658—1919. BADISCHE ANILIN UND SODA-FABRIK, Ludwigshafen-on-Rhine, Aug. 11, 1920.)

Ammonium Chloride; Alkali Manufacture. — Synthetic ammonia is used in the ammonia-soda process, and the ammonium chloride liquor produced is not treated for the production of ammonia, but is evaporated to obtain a separation of sodium chloride at a high temperature, such as 100 deg. C., and then cooled to obtain a separation of ammonium chloride at a low temperature, the heating and cooling to obtain these salts being repeated if desired. The final mother-liquor, which is a cold solution saturated with ammonium and sodium chlorides, may be added to the liquor to be treated for the production of ammonium and sodium chlorides as above described. It is stated that it is advantageous to oxidize a portion of the synthetic ammonia to nitric acid and to use some of the bicarbonate of soda obtained from it to absorb the acid. (Br. Pat. 144,659—1919. BADISCHE ANILIN UND SODA-FABRIC, Ludwigshafen-on-Rhine, Aug. 11, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Treating Complex Zinc Ores.—The treatment of complex ores containing both volatile and non-volatile constituents, such as lead-zinc ores with which are associated copper and precious metals, is a difficult metallurgical problem. Both wet methods of treatment and smelting methods have been proposed. When smelting lead ores containing zinc in a blast furnace it has been necessary to keep the zinc content of the slag below 8 per cent as a maximum and this, together with the building up of zinc oxide accretions in the cooler portions of the furnace shaft when treating ores high in zinc, has limited the zinc content of the charge to about 7 per cent.

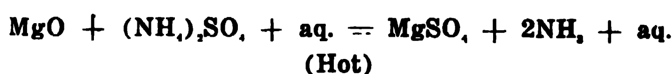
L. B. SKINNER of Denver, Col., proposes to treat this type of ore in a reverberatory furnace in such a way that a greater portion of the zinc is volatilized from the charge and subsequently recovered as fume. Ores high in zinc can thus be treated without difficulty. The method consists in preparing a mixture of an oxidized siliceous ore containing iron and sulphur to form a matte from the non-volatile constituents of the ore with an excess of solid carbonaceous material over that necessary to effect the possible reductions of the charge and treating this mixture on the hearth of a reverberatory furnace by the combustion of fuel with a moderate excess of preheated air. The volatile constituents of the ore are reduced *in situ* by the reducing agent and the gaseous products are passed through a regenerative stove to preheat the air used for the combustion of the fuel and the fume recovered in a bag house. (1,350,286; Aug. 17, 1920.)

Process for the Extraction of Lead From Its Ores.—Several methods have been suggested for the hydrometallurgical treatment of ores for the recovery of lead and silver, and that more generally termed the "brine process," or "acid brine process," has been used on ores, concentrates and for the recovery of lead and silver from electrolytic zinc plant residues.

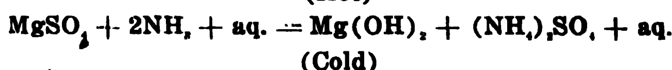
F. E. ELMORE of Boxmore, England, has been granted a patent on a modification of the "brine process" which has for its object the economical use of reagents. In some ores lead occurs as a sulphate or can be converted into a sulphate by roasting and in this form can be separated from gangue material by leaching with a hot brine solution. If the lead occurs as sulphide a hot brine acidulated with sulphuric acid will produce a solution containing the lead. Under either condition a certain amount of sodium sulphate and sodium acid sulphate is produced, and the solution becomes, on repeated use, less efficient due to the accumulation of sodium sulphate and to the depletion of the sodium chloride. Further, lead salts are produced containing varying proportions of the sulphate and chloride which under certain conditions is a disadvantage. The proposed process consists in the crystallization and separation of the lead salts from the leach solution and then crystallizing sodium sulphate from the lead-free solution by further cooling to about zero deg. C. The sodium sulphate is separated from the brine and dissolved in hot water. This sodium sulphate solution is used at about 100 deg. C. to treat the lead salts obtained from the first crystallization and thus change the lead chloride to sulphate with the regeneration of sodium chloride. The lead sulphate is separated from this solution also by crystallization. It is possible to obtain a lead sulphate practically free from chlorides by control of the operation. In case the lead salts contain silver, these after separation from the brine are boiled with sufficient water to dissolve the lead chloride; an insoluble residue remains containing practically the whole of the silver. The lead chloride solution is separated from the residue and treated with hot sodium sulphate solution for conversion into lead sulphate. (1,350,959; Aug. 24, 1920.)

Ammonium Sulphate.—A simplified procedure for the recovery of ammonia from coke-oven gas has been devised by BATES TORREY, Jr., of Syracuse, N. Y. The hot gases are sprayed with water in the hydraulic main and the hot water thus obtained is separated from the tar in settling tanks. The gases are further cooled in a scrubber and the residual tar is removed in a tar extractor. The gases now pass through another scrubber which is sprayed with the hot water recovered from the hydraulic main. During this treatment the gases take up the free ammonia in the wash water and carry it along to the saturators. The unvaporized water from the scrubber is pumped back to the hydraulic main to be used in spraying the raw gas. After a time, due to the repeated circulation of the water, the concentration of fixed ammonium salts in the solution approaches saturation. Provision is therefore made for the periodical removal of a portion of the concentrated solution. This is treated with lime in an ammonia still. The liberated ammonia passes to the saturators. (1,349,393; assigned to the Semet-Solvay Co.; Aug. 10, 1920.)

Purifying Magnesium Compounds.—Magnesium oxide may be separated from many impurities by treating with a boiling solution of ammonium sulphate. Magnesium sulphate is formed, with the liberation of ammonia, which, when passed into a cold solution of $MgSO_4$, precipitates an equivalent amount of magnesium hydroxide. The reaction is thus cyclic.



$$MgO + (NH_4)_2SO_4 + aq. = MgSO_4 + 2NH_3 + aq. \quad \text{(Hot)}$$



$$MgSO_4 + 2NH_3 + aq. = Mg(OH)_2 + (NH_4)_2SO_4 + aq. \quad \text{(Cold)}$$

The reaction may also be applied to magnesium carbonate, in which case ammonium carbonate is liberated and the final precipitate is a basic carbonate of magnesium. (1,348,933; CLINTON E. DOLBEAR of San Francisco, Cal.; Aug. 10, 1920.)

Treating Waste Pickling Solutions.—Waste pickle liquor (from sheet, plate or wire mills) is forced through spray nozzles into a furnace so heated that the temperature at the top is about 1,200 deg. F., while at the bottom it is about 1,500 deg. F. The vapors, which result from the evaporation of the solution and the decomposition of the ferrous sulphate, pass over a catalyzer which converts any SO_2 to SO_3. They are then condensed in the form of sulphuric. The iron oxide deposited in the furnace is in an extremely fine state of subdivision and hence is of unusual value as a pigment or filler. (1,348,462; ALBERT T. WEAVER of Joliet, ERNEST W. D. LAUFER of Arlington Heights, and EBERHARD VON WINTZINGERODE of Chicago, Ill., assignors to the American Steel & Wire Co.; Aug. 3, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Meeting of the Rochester Section, A. C. S.

Saturday afternoon, Oct. 2, the Rochester Section of the A. C. S. held its first meeting of the year. The event was celebrated by a visit to the New York State Agricultural Experiment Station at Geneva. Here about one hundred chemists from Rochester, together with those of Geneva, listened to a very interesting address by Dr. L. L. Van Slyke, head of the chemistry department of the station.

Dr. Van Slyke gave a résumé of the work of the station, which consisted largely in its early days of routine analysis, but which has since been enlarged in its scope to cover investigation in milk and milk products, animal nutrition, plant foods, soils, fertilizers, insecticides, etc. Special inspection and research work on milk and its products has resulted in bringing this industry to a very much more efficient and higher plane. The first work in chemistry at the Geneva experiment station was carried on by Dr. Stephen M. Babcock, who is now director emeritus of the Wisconsin Experiment Station. The name Babcock is familiar to agricultural chemists the world over. The name Van Slyke is equally well known.

After Dr. Van Slyke's address Richard F. Keeler presented an outline of a method proposed by Dr. Hobart H. Willard and himself for the determination of aluminum in the presence of a relatively large amount of magnesium by measuring the hydrogen ion concentration. He gave a description and demonstration of an apparatus designed for a plant control laboratory by the use of which the amount of aluminum in from four to six samples of magnesium aluminum alloy can be determined definitely by one operator in less than an hour.

An inspection of the laboratories and farms, followed by a dinner at Hotel Seneca, at which there were talks by Dr. L. L. Van Slyke, Dr. R. J. Anderson, Dr. C. E. Kenneth and Byron Grimes completed the day's program.

Industrial Cost Association Meets in New York

The Industrial Cost Association, the object of which is "the standardization of accounting and cost terminology; . . . interchange of average experience between representatives of manufacturers and dealers engaged in similar activities; . . . to act as a clearing house in distributing to all members the development in cost practices to the end that uniformity, once established, may be maintained," held a meeting in New York City, Sept. 27. This organization is one of industrial executives rather than of professional cost accountants. Membership is held by representatives of a wide range of industries; including many which may be classified as chemical and metallurgical. The officers of the organization are M. F. Simmons, of the General Electric Co., president; C. H. Smith, of the Westinghouse Air Brake Co., first vice-president; Roland H. Zinn, of the Tanners' Council, second vice-president, and A. A. Alles, Jr., of the Fawcus Machine Co., secretary-treasurer. These officers, with the following, comprise the directors: Walter Rantenstrauch, Spencer M. Duty, W. H. Moore, W. E. Hundley and G. K. Wilson.

Evaporation Losses in Gasoline

While engineers, chemists and automobile men throughout the country have been bending their best efforts toward developing some liquid fuel as a substitute for gasoline to meet the ever-increasing demands of the fast-growing automotive industry, the United States Bureau of Mines comes forward with the declaration that the entirely preventable losses in the evaporation of gasoline from crude petroleum from the time the petroleum leaves the wells until it arrives at the refineries reaches a total of more than 300,000,000 gal. each year.

These are merely the preventive losses from evaporation alone and do not take into consideration other losses, many of which in part may be avoided. The total loss from evaporation amounts to more than 600,000,000 gal. of gasoline for the country, one-half of which, or 300,000,000 gal. of gasoline, may be saved.

The worst feature of this loss is the fact that the gasoline wasted is the most volatile and consequently the best quality. It follows that the prevention of this loss, which is economically possible, would not only increase the gasoline supply materially but would also increase the general standard of the gasoline.

The bureau shortly will issue careful directions to the oil men as to how this situation may be remedied.

It is estimated that the 600,000,000 gal. of gasoline lost through evaporation each year is worth as a national asset about $150,000,000.

Bureau of Standards Loses Many Scientists

The Bureau of Standards during September lost sixty-three members of its scientific staff through resignations. These resignations included such men as Mayo D. Hersey, physicist, in charge of the aviation instrument section; Christian Nusbaum, associate physicist of the magnetic measurement section; A. H. Taylor, associate physicist, in charge of the photometry and illuminating engineering section; Samuel R. Parsons, associate physicist, of the aëronautic power plant section; Victor R. Gage, mechanical engineer, of the aëronautic power plant section; G. M. Williams, associate engineer, of the cement, sand and stone section; William B. Brown, associate physicist, of the aëronautic power plant section; Herbert M. Freeman, associate physicist of the radio section; and Albert B. Peck, associate physicist of the cement, stone and sand section.

Citations by the Federal Trade Commission

The Federal Trade Commission has recently cited the following firms for unfair competition: The United States Color & Chemical Co., Inc., Boston, Mass., for giving cash commissions to employees of its customers to induce their employers to purchase respondent's products; the Seymour Chemical Co., Providence, R. I., for giving to boss finishers in textile mills cash commissions to influence such finishers to induce their employers to purchase the products of the respondent and refuse to buy competitors' goods.

Industry and the Tariff Commission

Need for careful study of industries and commerce before tariff rates are fixed was pointed out with unusual clearness in an address before the Southern Tariff Congress at New Orleans on Oct. 12 by William S. Culbertson, a member of the U. S. States Tariff Commission. "In our complex industrial system," said Mr. Culbertson in his address, "literally thousands of products, many of which are unknown to the average man, are affected by tariff legislation. Unless the data regarding them are gathered by specialists working day after day away from the stress of tariff hearings there can be no adequate understanding of the problems which they raise, either in detail or in their larger bearings on our national welfare."

Since the chemical industries are very vitally concerned with the tariff, a considerable portion of Mr. Culbertson's address dealt with chemical matters. Extracts from his remarks are as follows:

The elimination of Germany from the world's markets by blockade, the diversion of the productive capacity of the Allies to war needs, and the interruption of shipping—each had its constructive effect on our industries.

You may read in the reports of the Commission the records of this progress—of the production of surgical instruments, optical glass, laboratory glassware, scientific instruments, knitting-machine needles, potash, war metals such as tungsten and manganese, and thorium nitrate and incandescent gas mantles. You will find that while some crude barytes was produced in Missouri before the war, the Eastern manufacturers of lithopone—an important paint pigment—imported at that time this raw material from Germany. High prices opened additional barytes deposits in Georgia, Tennesee and Kentucky, which are now supplying not only the Eastern lithopone plants, but also the new barium chemical industry—another child of war conditions. You will learn of the rapid development of the ferroalloy industries in the United States and of the competition which they are now facing from British sources. You—at least some of you—will no doubt be more interested in the story of vegetable oil production. The increase in the production of peanut oil is most striking. Domestic production increased from 60,533 gal. in 1912 to 12,791,200 gal. in 1918. Most of the imports since 1915 have come from the Orient. Peanut oil, however, is properly considered as a part of the larger problem of vegetable oils, of which there are, as you know, many. Cottonseed oil, coconut oil, soya bean oil and corn oil are only a few of the products that come in more or less close competition with peanut oil. We have attempted to analyze the whole situation in a survey as yet unpublished.

The coal-tar chemical industry may be discussed at greater length as an example of these new developments, partly because it is the most striking and also because of its vital relation to our industrial and military security.

In the meantime the American dye industry was beginning to grow. It was given a stimulus by the tariff act of Sept. 8, 1916, and from that time on until we entered the war the American consumers' needs of the simpler dyes were gradually met. The tariff law of Sept. 8, 1916, served its purpose in encouraging capital to enter the industry. The entrance of the United States into the war brought far-reaching changes in the dye business. On the one hand it restricted the supply of certain raw materials which were commandeered for munition purposes, and on the other hand it forced the dye industry to supply an unusual amount of dyes for the khaki uniforms and thereby decreased the supply of the ordinary colors used by civilians. The industry, however, continued to develop. The production of dyes had increased from about 7,000,000 lb. in 1914 to a total output in 1918 of 58,464,446 lb., valued at $62,026,390. The growth of this industry reads like a fairy tale.

The signing of the armistice brought new problems for this new industry. During the war the German industry continued partial production and with its productive capacity intact was ready to attempt to regain its lost markets. The industry had grown in Japan, Great Britain, France and Switzerland. Competition of a serious character threatened the American industry from abroad. Congress has been urged to grant the industry additional protection, not merely because the industry is desirable in a diversified industrial nation, but also because it is vitally connected with the progress of medical science and with the problems of national defense.

The foreign coal-tar dye industry is obviously only one phase of the larger question of the competitive status of foreign industries which we are trying to define. The chief competition with our industries will come in the future, as it has in the past, from Great Britain and continental Europe, but in many lines it will be some time before competition will reach its maximum strength. Speaking generally, wages in Europe, while still lower per man than in the United States, have increased relatively more. The difficulty of obtaining adequate fuel and essential raw materials also contributes to the abnormal cost of production. Transportation is demoralized. The advantage which depreciated currency gives the European producer in selling his goods abroad is very largely offset by the necessity of paying an exchange premium on imported products—coal, raw materials and semi-finished products.

Non-Metals Experiment Work

A limited amount of non-metals work is to be done at the new Bureau of Mines experiment station at Tuscaloosa, Ala. The principal work of the station is to be on byproduct and ferrous problems. The hope is expressed at the bureau that this station will be the nucleus of a much larger station which can give really comprehensive attention to byproducts.

The fear has been expressed that if any non-metals work were done at the Tuscaloosa station it would militate against the chance of securing a non-metals station next year. There was great disappointment among the chemical industries, which are large consumers of the non-metals, that they did not secure one of the experiment stations established this year. They are pointing out that the very limited amount of non-metals work being done at Tuscaloosa is not commensurate with the needs. Attention is being called to the fact that Tuscaloosa is just on the fringe of non-metals territory and is not the logical location for a non-metals station. The idea seems to be very generally held that Knoxville is a well-situated point for a full-fledged non-metals station.

A.S.M.E. Organizes Materials Handling Section

Four hundred members of the American Society of Mechanical Engineers have organized themselves into a Professional Section on Materials Handling and will provide primarily a common channel of intercourse among all the technical and industrial organizations co-operating in the solution of engineering problems connected with the handling and distribution of materials and products.

Probably the greatest economic need of civilization today is the devising of means and a more intelligent application of proper and co-ordinated methods whereby materials of one kind or another may be handled more swiftly and to better advantage.

This Section will aim to be a bureau of information—complete in its scope, specific in its knowledge of the physical and economic conditions and unbiased in its conclusions. This will be done by having special meetings on particular subjects, meetings jointly with other sections, other organizations or associations, and by taking part in all local and national problems relating to the purpose of this Section.

Imports and Exports of Chemicals

Exports of chemicals during August were practically in the same volume as the exports in August, 1919. On the other hand, imports of chemicals were nearly three times as great in August of 1920 as they were in August of 1919. Figures just compiled by the Bureau of Foreign and Domestic Commerce show that chemicals to the value of $21,189,777 were imported in August of this year. The imports in August, 1919, were valued at $7,964,651. The value of chemicals exported in August was $11,296,042. This compares with $11,121,531, the value of exports in August of 1919. For the first eight months of 1920 chemicals were exported to the value of $117,929,208. This is materially in excess of the value of chemicals exported during the first eight months of 1919, when they amounted to $86,350,599. The imports during the first eight months of 1920 reached the large total of $147,634,259. This compares with $73,112,471 in the first eight months of 1919.

The total imports of coal-tar products during August, 1920, were valued at $1,608,672. Switzerland continues to be the heaviest exporter. During August the colors and dyes imported from Germany were valued at only $54,115. The imports of gums were high in August, amounting to 12,182,391 lb., as compared to 5,513,559 lb. in August of 1919. The same is true of potash. The imports in August of 1920 amounted to 3,389,114 lb. In August of 1919 the imports totaled only 757,102 lb.

The exports of acids were much lower in August of 1920 than they were in the preceding August. The value of the acids exported in August of 1920 was $365,639. In August the year before the exports of acids were valued at $519,871. There was a marked increase in the amount of dyes and dyestuffs exported in August, 1920. The total was $2,111,095. In August, 1919, the total was $1,172,087. In this particular China was our best customer, with the United Kingdom and Canada in second and third places respectively. The exports of soda in August, 1920, were valued at $2,156,643. This compares with $1,771,283 in August, 1919.

Imports and exports of certain chemicals which do not move in large volume are shown by the following table:

EXPORTS CHEMICALS

	Aug., 1919	Aug., 1920
Copper, sulphate of (blue vitriol), lb	904,110	58,429
Formaldehyde (formalin), value	$122,978	$329,146
Glycerin, lb	391,154	257,057
Sal soda, lb	1,196,758	643,121

IMPORTS CHEMICALS

	Aug., 1919	Aug., 1920
Ammonia, muriate of, lb. (duty)	213,076	734,361
Fusel oil, or amylic alcohol and butylalcohol, lb. (duty)	461,443	355,133
Iodine, crude, or resublimed, lb. (free)	72,555	96,528
Lime, citrate of, lb. (duty)	262,483	444,692

Disabled Ex-Service Men Take Up Chemical Engineering

Disabled ex-service men to the number of 107 are pursuing courses in chemical engineering under the vocational education statute. At the end of August there were 1,949 disabled ex-service men taking engineering courses. This instruction is being given under the direction of the Federal Board for Vocational Education.

The work in chemical engineering is divided among forty-six schools, of which four are in New England, thirteen in the East, six in the South, fifteen in the Middle West, and eight in the West.

Apparatus Standards and Reagent Packages

Gas analysis apparatus standards and uniform packages for guaranteed reagents were discussed by two important conferences held in New York during the week of the Chemical Exposition. The committee on guaranteed reagents and standard apparatus appointed by the American Chemical Society is working actively under the chairmanship of W. D. Collins, and just now is giving particular attention to these subjects.

The appropriate size of units for purchase of reagent chemicals was discussed at a conference attended by representatives of manufacturers of guaranteed reagents and members of the committee. A plan was outlined by which the committee will take steps toward greater uniformity in ordering reagents. A tentative list of suggestions along this line will be drafted in the near future and submitted by publication for the criticism and comment of all interested parties.

The committee also called a special conference on gas analysis apparatus which was attended particularly by representatives of laboratory groups which make many gas analyses, both research and routine in nature. A program was adopted tentatively for preparing a set of uniform specifications for certain much used types of gas analysis apparatus. Tentative specifications will be adopted by this sub-committee and submitted to the main committee, which, it is expected, will publish them for comment and criticism before they are recommended for adoption.

Leather Waste for Heels in Germany

Commercial men who are interested in the leather trade are bringing out of Germany samples of a sole leather made from waste leather which is suitable for the manufacture of heels for shoes of all kinds, reports Consul-General Anderson of Rotterdam. The samples produced show a very firm, hard sole leather at first appearance suitable for any purpose for which sole leather is required. It is found upon close examination, however, that the leather is made up of pieces of waste leather which are likely to come apart when wet. The leather is manufactured from waste and scrap leather from old shoes or any other kind of leather waste, and is cleaned and soaked in water and then rolled into sheets and subjected to high pressure. The product has the appearance of a hard, dry, closely pressed sole leather, and for all purposes in shoe-making, when it can be protected to some extent from soaking or can be fastened together as in the nailing of a heel, it gives promise of being useful and economical. The leather can be had at the present time at 17 German marks per kilo, which at present exchange figures out roughly at about 12½c. gold per lb.

Manufacture of Superphosphates in Uruguay

The Administrative Council in Uruguay is considering a project for the establishment of a factory for the manufacture of superphosphates for use as fertilizers. A cheap supply of acid is guaranteed, and there is a great abundance of bones which are being exported at present at a low price. The project would prohibit the exportation of bones, but this is strongly objected to by the majority of the council, who are in favor of placing a high export duty on bones rather than prohibiting their exportation.

Swedish Market for Soda Sulphate

There is at this time a demand in Sweden for soda sulphate, the paper manufacturers generally being in need of supplies, reports Consul-General Murphy of Stockholm. If American manufacturers of chemicals can promptly satisfy the present demand at reasonable prices a steady market will be assured. The Swedish Paper Mills Association of Stockholm uses on an average 40,000 tons of soda sulphate a year, and the managing director states that orders will undoubtedly be forthcoming as soon as sure sources of supplies are located.

The manufacture of paper in Sweden dates back to the year 1573, when the first mill was established at Klippan. There are at this time eighty mills making all kinds of paper and pasteboard and 171 allied industries. The export of paper from Sweden in 1919 was 139,449 tons, as compared with 128,119 tons in 1918 and 189,612 in 1913.

Wood pulp for paper manufacture is likewise an important and flourishing Swedish industry, its future being assured by the vast timber supply of the country. In 1919 there was 807,761 tons of wood pulp exported from Sweden, the value of which was $13,-649,000. The wood-pulp industry is likewise in need of a steady supply of soda sulphate, the home manufacture being by no means sufficient to supply the demand.

Fertilizer Imports Large

More fertilizer materials were imported in August of 1920 than were brought into the country during the first eight months of 1918 and nearly as much was brought in in that single month as was imported during the first eight months of 1919. The following figures are those of the Bureau of Foreign and Domestic Commerce. They show the value of fertilizer materials imported in August of 1920 to have been $3,953,893. In the preceding August these imports amounted to only $934,493. These imports were made up largely of bone dust, calcium cyanamide, guano, kainit, manure salts, and muriate and sulphate of potash.

There was some increase in the exports of fertilizer materials. The value of these materials exported in August, 1920, was $2,967,610. In August, 1919, these exports were valued at $2,318,420. Phosphate rock led the list of exports, with sulphate of ammonia in second place.

Shale-Oil Prospects in New Brunswick

As the demand for mineral oil is increasing, the visible supply diminishing and the oil companies scouring the world for new sources of supply, interest in oil shales has been revived, reports Consul Rasmusen of New Brunswick, Canada. The oil-shale areas of Albert County, New Brunswick, have recently been inspected by representatives of both British and American interests. According to the Dominion Department of Mines, samples taken from Albert County have yielded 60 imperial gal. to the ton. The concession for the development of natural gas in this same area is held by the New Brunswick Gas & Oil Fields (Ltd.), of Moncton, whose activities are confined to the development of natural gas, but it is possible that shale-oil production will be attempted in the near future either by this company or by other interests.

Decree Modifying the Price of Alcohol in France

The French Ministry of Industry, Labor and Provisions, in accord with the excise administration and the Minister of Finance, has just issued a decree modifying the prices of alcohol. The new prices, as from Sept. 1, are:

For motive power, manufacture of artificial silk and other use in which alcohol is entirely denatured, 100 deg., 3 fr. the liter (1 liter = 1.057 qt.).

For anatomical or scientific preparation, antiseptic and medical use, manufacture of pharmaceutical products, antiseptic and medicated cotton, felt and hats, manufacture of peptone, fulminate of mercury, collodion, artificial flowers, transparent soap, imitation leather, tannin, pyrotechnical products, smokeless powder and aniline colors, 100 deg., 5 fr. 20 centimes the liter.

For the manufacture of vinegar, to Oct. 31, 1920, 7 fr. 60 centimes; from November, 1920, 5 fr. 60 centimes the liter; manufacture of varnish, 5 fr. 72 centimes; perfumery, 13 fr.; university laboratories and official establishments, 21 fr. 80 centimes. For laboratories other than official, medical and pharmaceutical use, use in hospitals and clinics, and for fruits and confectionery and other uses, 21 fr. 85 centimes.

British Firm Makes Grant for Scientific Education

At a recent general meeting of the firm of Brunner Mond & Co. (Ltd.), chemical manufacturers, held in Liverpool there was passed a resolution "that the directors be and they are hereby authorized to distribute to such universities or other scientific institutions in the United Kingdom as they may select for the furtherance of scientific education and research the sum of £100,000 ($486,650) out of investment surplus reserve account."

Personal

W. M. BITTLE has accepted the position of chief chemist of the Duratex Co., Newark, N. J. He was formerly in charge of pyroxylin investigations.

HARRY A. DEUEL, assistant to the manager of the Minnequa Steel Works and for nineteen years in the employ of the company at Pueblo, has resigned to become chief engineer of the Atlantic Steel Co., Atlanta, Ga.

E. H. FRANTZ, who for the past two years has been plant chemist with the Combination Rubber Co., Bloomfield, N. J. has joined the chemical laboratory force of the Duratex Co., Newark, N. J.

BENJAMIN RICHARD JACOBS has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to become director of the National Cereal Products Labs., with offices in Washington, D. C.

DYKE V. KEEDY has returned from a six months' trip to Europe, visiting Italy, Dalmatia, Bosnia, France, Holland, Belgium and England.

Dr. ARTHUR I. KENDALL, dean of the Northwestern University Medical School, spoke recently before the Chicago Section of the American Chemical Society on "Bacteria as Chemical Reagents."

Dr. VERNON K. KRIEBLE, assistant professor of chemistry at McGill University, succeeds Dr. R. C. Riggs as Scoville professor of chemistry at Trinity College, Hartford, Conn.

WILSON H. LOW, formerly head chemist for the Cudahy Packing Co., Omaha, Neb., has removed to Los Angeles, where his address is 532 South Lorraine Blvd. Mr. Low and his former head assistant, John H. Show, who was a pioneer in the Nebraska potash industry, have opened an industrial laboratory in Los Angeles.

C. W. NEUSBAUM has resigned as chemist at the Holland plant of the American Radiator Co. to accept a position as assistant chemist for the Beech Nut Packing Co., Rochester, N. Y.

WALTER DILL SCOTT has been unanimously elected president of Northwestern University. Prof. Scott has previously held the chair of psychology at Northwestern since 1905. He served as Colonel on the General Staff during the war, being director of the committee on classification of army personnel. He was awarded the Distinguished Service Medal for this work.

Dr. F. W. TRAPHAGEN, professor of metallurgy in the Dakota School of Mines, has returned to Rapid City, S. D., after spending the summer in metallurgical research work for the Denver Metals Co. at its plant at Utah Junction, Col.

Dr. G. S. WHITBY and Dr. R. M. MCLEAN have been appointed joint professors of chemistry in the faculty of applied science, McGill University, Montreal.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Pa., October 15, 1920.

It is now universally admitted that the iron and steel market is marked for a general readjustment. The prospect is accepted with much satisfaction by the majority of consumers, and with philosophic resignation by the producers, most of whom probably feel that they have had artificially high prices for a longer time than could reasonably have been expected.

While "readjustment" is universally admitted as being in prospect, or rather as actually begun, there are some divergences of opinion as to the character or course of the readjustment. A greatly decreased demand is admitted, but there is a difference of opinion as to what will follow in the matter of prices. It is all a question of prices of the independent steel producers, since no one suggests that the Steel Corporation's prices, which have been held to the Industrial Board schedule of March 21, 1919, will decline. Some steel producers insist that the independents will pursue the policy of filling the orders they now have, not seeking additional orders at cut prices, whereby the independent output is predicted to drop for the winter to a relatively low rate, possibly 60 per cent of capacity. Those who take what has already occurred in the market as indicative hold the opinion that independent prices will continue to sag, whereby in a few weeks or a very few months at the outside they will be down practically to the Steel Corporation level.

Illustrative of declines that have occurred and of the gaps between Steel Corporation and independent prices, it may be noted that plates, until recently held by independents at 3.25c. as minimum, have lately sold in small lots at 3.10c. and in at least one case at 3c., while the Steel Corporation's price is 2.65c. Structural shapes were held rather uniformly by independents at 3.10c. as minimum, but have recently sold first at 3c. and then at 2.90c., the Steel Corporation price being 2.45c. Merchant steel bars present a different case. Until lately there were some sellers at 3c., but 3.25c. seems to be the regular independent quotation now, mills having advanced their asking prices to protect contracts. The Steel Corporation price is 2.35c. In the past three or four weeks sheets have declined about half a cent a pound, the independent market being now approximately as follows: Blue annealed, 5c. to 5.25c.; black, 6.75c. to 7.25c.; galvanized, 8.50c. to 8.75c. The Steel Corporation's prices are 3.55c., 4.35c. and 5.70c. respectively, so that while sheets have declined very considerably they would still have a long distance to travel to meet the corporation level. In pipe there is a divergence of only about $7 a ton, the Steel Corporation having a 57½ per cent basing discount and the independents a 54 per cent basing discount.

Production Decreasing

The September report of steel ingot production, presented by the American Iron and Steel Institute, shows a rate for the month of about 42,700,000 tons per annum, or precisely the rate shown for August, that rate having represented an increase of 7 per cent over the July rate. The increase then was due to improved transportation and other physical conditions, and there was a similar improvement in physical conditions for September. The failure of the statistics to reflect increased production in September confirms reports circulated in the month that some works were already curtailing output on account of lessened demand on the part of contract customers. This trend is more decided now, and it is regarded improbable that October will show as high a rate of production as September. Such a showing would be impressive, because normally October is a particularly good month for tonnage outputs on account of weather conditions.

Pig Iron Weak

Pig iron has just given a remarkable exhibition of weakness after a display of strength in August that was plainly seen at the time to be largely artificial. In all districts except Chicago and Birmingham pig iron prices advanced in August, but there was nothing like the usual amount of buying and it was clear that prices were being pushed up by what might almost be called a mere whim of the furnacemen, consumers making purchases only for immediate requirements. September was a dull month in the market, and since the end of September it has been almost impossible to sell pig iron at all. A steel works that had been particularly provident in not buying ahead has been in the market for basic iron, which was firmly established by the August advances at $48.50 valley, or $50.46 delivered Pittsburgh. Its first purchase was at $46 valley, from a middle interest, and since then it has bought 1,500 tons, also from a middle interest, at $41.96 delivered, equal to $40 valley, while three producing interests had quoted on the basis of $42. In determining what is "the market price" the trade is usually disposed to ignore "resales" and from that viewpoint the market has not declined to $40, though the middle interest that sold 1,500 tons at $40 had 3,500 tons it was willing to sell at the figure. Certainly the market cannot be quoted at over $42 valley, when producers quote that price to a prospective buyer and do not effect sales. It was as late as last January that basic, on its upward movement, reached $40 valley, and thus there has been the abnormal experience of pig iron declining more rapidly than it had previously advanced. Bessemer iron remains nominally quotable at $48.50 valley, though a recent resale, of iron bought at $47, was at $46. Foundry is nominally quotable at $47 valley.

Declines in pig iron are susceptible of different interpretations. Pig iron had advanced more, relatively, than steel products, and thus a decline in pig iron might be regarded merely as a step towards equalization. The pig iron decline is notable on the other hand in that it occurs while Connellsville furnace coke for spot shipment is still $17. Such a price would justify a very high price for pig iron, and while it is eleven times the average price in May, 1915, and twenty times the price in 1894, it shows no definite signs of being about to recede, and it is, indeed, supported by the coal market, since coke at $17 represents little more than the market price of the coal involved plus a charge for conversion.

The Steel Corporation's unfilled obligations decreased during September by 430,234 tons to 10,374,804 tons, equivalent to about nine months of production at 90 per cent of capacity. The August decrease had been 313,430 tons.

The Chemical and Allied Industrial Markets

New York, October 16, 1920.

The dullness which has become almost habitual in this market continues uninterrupted, despite the unloading of small lots on the market that have been held in reserve. Buying interests, as in every other industry, are marking time and the period of this waiting having extended into weeks it seems as if steadiness is looked for rather than an advancement of price. The 1921 contract prices being put in effect by producers verify the opinion that there cannot very well be a general price recession for two reasons —(1) the cost of production has increased so much that an increase is inevitable; (2) in the two years of peace production has not even approached consuming demand, which will prevent the flooding of the market in the event of a surplus. The small amount of business transacted is mostly on odd lots for which concessions are being granted by second hands in order to clear their stocks.

Heavy Chemicals

All grades of *alum* remain firm, as very few offerings are being made. *Ammonia lump*, 5@6c., *potash lump*, 8¾@9¼c., and *chrome lump*, 16@18c. per lb., are all producers' prices and have not changed for some time. One of the items receiving a sharp increase over 1920 contract prices is *soda ash*, which will be sold on a basis of 2c. per lb. f.o.b. works, compared with former manufacturer's price of 1¾@1¼c. per lb. The spot market on the other hand declined sharply and the demand is not as keen as it was during the previous week, the new level being around \$2.25@\$2.50 per cwt. The new price on *caustic soda* for 1921 delivery is \$4 per cwt. Inquiry has also fallen off on the spot material, which is available at \$4.25@\$4.50 per cwt., with no anxiety evidenced on the part of buyers to take advantage of these unusually low prices when compared with the recent \$5.60@\$6 price. The pressure being relieved, *sodium nitrite* is being offered around 12@14c. per lb. with enough material in the hands of producers to meet the rather low demand, which is especially felt in the spot market.

Coal-Tar Products

The crudes are the one sustaining branch of this market and the firmness which is noticeable in these items is caused by a shortage of material. The market in general remained quiet; among those to recede was *aniline oil*, now listed at 28@33c. per lb. The *salts* also dropped off 1c. to a low figure of 33c. per lb. Both grades of *beta naphthol* underwent a change during the period. *Sublimed*, which has been scarce, was hard to find under 90c., while the *technical*, with little or no interest displayed, fell off 5c. to 60@70c. per lb. The crudes have all remained firm, *phenol* being still available at Government price of 12c., while producers are quoting 1c. per lb. higher. Considerable quantities of *naphthalene, flake* and *balls*, having arrived from abroad, the recent high levels have dropped to 10½c. for flake and 12½c. for balls, with a very slow demand for both grades.

Crude Rubber

The consistent dullness of this market is occasionally broken by spasmodic activity which arises from the small demand for immediate requirements—but even these short interludes are not sufficient to make a favorable impression. The basic cause of this is the absolute lack of demand from tire manufacturers, who have been kept out of the market for the past few months by the acute conditions in their own industry. London reports some buying but also, as here, it is confined to small lots. The revival of the tire industry would certainly check the steady drop of all grades of rubber from a 54c. level for *plantation* to the present 25c. per lb.—but this is not expected for some time, and as a result the recession is nominal, as it is difficult to obtain figures on actual transactions.

Naval Stores

No improvement over last week's decidedly dull market has been noticed. In fact still lower prices are being heard, and despite this condition the local market has shown no tendency to buy. *Turpentine* fell off 10c., to \$1.20 per gal., which practically amounts to a nominal figure, as there is so little material being sold. *Rosins* also fell off slightly, the cheaper grades being listed at \$12.90 and WW at \$13.25. This condition cannot go on much longer, as the supplies are not too plentiful and a general rise throughout the naval stores is looked for soon.

Oils

Linseed oil is the item of particular interest on the list, since it seems that it cannot be disposed of at any price. The new level of \$1 per gal. is attracting as little interest among buyers as did the less favorable prices of recent dates. *Chinawood* held firm during the period and an increase in demand would help greatly to raise the current quotations of 17½@18c. per lb.

The Chicago Market

Chicago, Ill., October 13, 1920.

The long-continued period of weak prices shows no sign of an end, although frequent mention is made of the opinion that things will be better after election. In view of the fact that the present depression in all lines is the effect of powerful economic forces rather than political manipulation the correctness of this opinion is questionable. Steadily increasing imports to the extent that America's favorable trade balance was only \$65,000,000 for the month of August indicate measurably reduced industrial activity for some time to come. It seems that the chemical industry can reasonably expect to share in this reduction of activity.

Purchasing is on a hand-to-mouth basis. The consensus among the members of the Purchasing Agents' Association, now in session here in Chicago, indorses this plan, on the ground that a general price reduction of from 25 to 50 per cent is in sight. Consideration must be given to the fact that the chemical industry has already had its shrinkage in most lines, and that but little further drop is economically possible.

Heavy Chemicals

The long-awaited announcement of contract prices on *caustic soda* and *soda ash* was forthcoming this week, the future of *sal soda* and *bleaching powder* being still in the dark. Spot offerings of *soda ash* range from \$2 to \$2.25 per cwt. with the few holders of second hands being forced to make offerings at a low figure by the reluctance of buyers. Contracts for 1921 are offered on a basis of \$2.42 per cwt. for 58 per cent. *Caustic soda* contracts are announced at \$5.06 per cwt. on 76 per cent. This is almost a dollar above current price, recent transactions in a dull market being reported at \$4.15@\$4.25. Some of the returned goods from Japan are going at \$3.85 or lower. The scarcity of *bleaching powder* has been materially relieved and the price has abruptly declined to 6½@6¾c. per lb. *Sal soda*, unchanged at \$2 per cwt., is in reasonable supply.

The market on *alcohol* begins to feel the effect of heightened production in that supplies are easier. Prices are unchanged, *ethyl* grade, 190 proof, being quoted at \$5.65 per gal., *methyl*, 97 per cent, at \$3.40 per gal., and *denatured* at \$1.12. *Iron sulphate* (copperas) is easy in the hands of dealers at about \$2.25 per cwt. for spot. Makers report a heavy volume of advance business at 2c. per lb. *Sodium bicarbonate*, under materially reduced demand, is going for \$2.80 per cwt. or less, transactions being limited to small lots. *Chlorine* in liquid form is firmly held by spot traders at 9½c. per lb. Some contracts are being closed for 1921 at figures ranging around \$8.75 per cwt.

Coal-Tar Products

Quiet prevails and, in general, a weak tone is felt in prices. *Aniline oil*, which felt a temporary strengthening a short time back, is again off, 27c. per lb. or less being the prevailing price. *Aniline salt* has also receded 2c. in the past three weeks, 34c. being today's price. *Phosgene*, for no apparent reason, has recently fluctuated sharply, the range being \$1@\$1.25 per lb.

Vegetable Oils

Linseed oil shows the effect of the constantly increasing visible supply of flaxseed by steady declines, the much-talked-of bogey of $1 having been reached. Spot carloads are offered at $1.05 and jobbers are selling small lots to the trade at $1.25, in barrels, 20c. lower than a fortnight ago. The resumption of production by some of the *corn oil* producers was immediately reflected by reductions in the market, offerings at 10c. per lb. for crude f.o.b. works going begging. Some business was closed at ¼@⅜c. less. The general condition of the corn products market is shown by recent reductions in the price of *corn sirup*, now being offered at $4.65 per cwt., against $4.90 at the opening of the season. *Peanut oil* slumped further to 11c. for Oriental, in tanks f.o.b. coast, and 16c. for edible, out of Chicago warehouses. Low market on competitive oils has driven the *soya bean* product to cover, coast quotation in sellers' tanks being only 9c. and small lot spots 13c.

Fertilizer Materials

Lower prices on live stock have materially reduced stockyards receipts, thereby decreasing production of fertilizer products. This is fortunate, as unusually warm October weather has forced demand to a low level. Few price recessions have been permitted by producers, and buyers are content to await developments. It seems probable that some further cuts must be made to induce trading. High-grade *ground blood* is quoted at $7.15 per unit, high-grade *ground tankage* at $6.85 and *renderer's unground tankage* at $5.50. *Ground steamed bone* is $35@$38 per ton, and *raw bone meal* about $50

The St. Louis Market

St. Louis, Mo., October 12, 1920.

The last two weeks have seen several fluctuations in the St. Louis market, some items advancing and other items declining slightly. Producers say that these changes have been brought about merely by the normal course of business and that they do not presage much of a change in the general tone of the market.

The market continues in good shape all around. Production is normal, demand continues satisfactory and stocks are such that practically all orders can be taken care of on normal deliveries. Contract business is moving along satisfactorily, numbers of contracts having been renewed since Oct. 1. Spot business is fairly strong. Producers are confident that the heavy chemical market is well under their control.

There has been a slight slackening of the demand for the 66-deg. *sulphuric acid*, but prices remain firm and producers look for an improvement shortly. This has been caused by closer buying on the part of the oil refineries. The 60-deg. grade is stronger and some lots have been quoted at as high as $16.50 per ton and 1½c. per lb. in carboys. The average price ran between $16 and $16.50 per ton. The 66-deg. is quoted at $24 per ton and 1⅝c. per lb. in carboys in carload lots. The 98 per cent acid remains firm at $25 per ton, f.o.b. works, with the market for it quiet. Oleum has registered an advance to $28.50 per ton from $27.50 and is in good demand.

Demand for *muriatic acid* continues very good, but due to liberal stocks the quotation on carload lots in carboys has dropped to 2@2¼c. per lb., a decline of about ¼c. The price on lots in bulk remains at $25 per ton.

Sodium bisulphate is in good supply, prices remaining unchanged. The demand continues, at from $5 to $6 per ton. Steel plants are said to be buying in this market freely and large orders have been received also from makers of animal foods.

Producers report a steadily increasing demand for *nitric acid*, but no increase in price has been registered. The quotations are $7 per cwt. on the 36-deg. and $10 on the 42-deg. Standard mixed acid, consisting of 36-deg. nitric and 61-deg. sulphuric, is firm at 1½c. per lb. of each acid.

Zinc chloride remains at $4 per cwt. Phenol is still quoted at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.......-.......	$0.65 - $0.75
Acetone	lb.	$0.15 -$0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4 50
Acetic, 56 per cent	cwt.	6.50 - 7.50	8.50 - 9 50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 -16.00	16.25 - . .
Boric, crystals	lb.	.15½- .16	.16½- .19
Boric, powder	lb.	.15½- .16½	.17 - .20
Citric	lb.	.78 - .80	.82 - .84
Hydrochloric (nominal)	cwt.	2.00 - 2.50	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	.16½- .18
Lactic, 44 per cent tech	lb.	10 - .11½	.12 - 16
Lactic, 22 per cent tech	lb.	.04½- .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).		.......-.......	....
Nitric, 40 deg	lb.	.06 - .07	.07½ .08½
Nitric, 42 deg	lb.	.07½- .08	.08½- 09½
Oxalic, crystals	lb.	.45 - .50	.52 - 55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg, tank cars	ton	12.00 -16.00	.......-.......
Sulphuric, 60 deg, drums	ton	.......-.......	.......-.......
Sulphuric, 66 deg, tank cars	ton	16.00 -17.00	18.00 - 20.00
Sulphuric, 66 deg, drums	ton	26.00 -28.00	... - ...
Sulphuric, 66 deg, carboys	ton	-. ..	.... - . .
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 -30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28 00 -30.00	38.00 42 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32 00 -35 00	40.00 ....
Tannic, U. S. P	lb.	1 45 1 50	1.55 1 65
Tannic (tech.)	lb.	.60 - .70	.80 90
Tartaric, crystals	lb	... -......	.74 .77
Tungstic, per lb. of WO	lb.	..... .-.....	1 20 - 1 40
Alcohol, Ethyl (nominal)	gal.	5.50 - 5.75	6.00 7.00
Alcohol, Methyl (see methanol)		-.	
Alcohol, denatured, 188 proof (nominal)	gal.	.. . - ...	1.12 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	. - ..	1.05 - 1.10
Alum, ammonia lump	lb.	.05 - .05½	05½ .06
Alum, potash lump	lb.	- .08½	09 .09½
Alum, chrome lump	lb.	16 - 17	.18 - .19
Aluminum sulphate, commercial	lb.	.04½	. - .
Aluminum sulphate, iron free	lb.	06	- . .
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ .10½	.11 .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 .35½	.36 - .38
Ammonium carbonate, powder	lb.	.16 - 16½	.17 - .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½- .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - 13½	.13½ .14½
Ammonium nitrate	lb.	.. .- .10	11 - .14
Ammonium sulphate	lb	.07 - 07½	.08½ . ....
Amylacetate	gal.	. -	5 00
Amylacetate tech	gal.		4 75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	13 - .14	.15 .16
Arsenic, sulphide, powdered (red arsenic)	lb.	16 - .17	.18 - .19
Barium chloride	ton	120 00 130 00	- ...
Barium dioxide (peroxide)	lb	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .12	.12½- .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½- .05	.05½- .06
Bleaching powder (see calcium hypochlorite)		-	.......-..... .
Blue vitriol (see copper sulphate)		-......	..... -......
Borax (see sodium borate)		-	..... -......
Brimstone (see sulphur, roll)		. ...	......-......
Bromine	lb.	.70 - 90	1.00 - 1.05
Calcium acetate	cwt.	3 50 - 3 55	- . .
Calcium carbide	lb	.04½- 04½	04½- .05½
Calcium chloride, fused, lump	ton	33 00 -34.00	35 00 45 00
Calcium chloride, granulated	lb	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	7 25 - 7 50	8.00 - 8 50
Calcium peroxide	lb.	.	1 50 - 1.70
Calcium phosphate, monobasic	lb.		.75 - .80
Calcium sulphate, pure	lb.	. - .	.25 .30
Carbon bisulphide	lb.	.08 - .09	10 .11
Carbon tetrachloride, drums	lb	.14 - .15	.16 - .17
Carbonyl chloride (phosgene)	lb.		1 25 - 1 50
Caustic potash (see potassium hydroxide)			-..... .
Caustic soda (see sodium hydroxide)		-....	. -.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	- ..	2 00 - 2 05
Copperas (see iron sulphate)		-....	. . .
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - 31
Copper cyanide	lb.	-....	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		-..	..... - . . .
Epsom salt (see magnesium sulphate)		-	.....- . ...
Ethyl Acetate Com. 85%	gal.	1 10 1 30	1.40 -
Ethy Acetate pure (acetic ether 98% to 100%)		. .	1 75 -. ..
Formaldehyde, 40 per cent (nominal)	lb	48 50	-. .
Fusel oil, ref.	gal.		5.25 6 00
Fusel oil, crude (nominal)	gal.	. ...	.. . .
Glauber's salt (see sodium sulphate)		-	...-......
Glycerine, C. P. drums extra	lb.	..... -.....	.26½- .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4 45
Iron oxide, red	lb.	..... -.....	.03 - .20
Iron sulphate (copperas)	cwt.	2 00 - 2 25	2.35 - 2.75
Lead acetate, normal	lb.	...-	13½ .16
Lead arsenate (paste)	lb.	11 - 12	.13 - 17
Lead nitrate, crystals	lb.	. . -. .	.90 - 1 00
Litharge	lb.	.14 - 15	.15½ - .16
Lithium carbonate	lb.	. . - . .	1 50
Magnesium carbonate, technical	lb.	.12½- .13½	15 - 16
Magnesium sulphate, U. S. P.	100 lb.	3.50 - 3 90	4.00 4 50
Magnesium sulphate, commercial	100 lb.	..... -....	3 50 3 60
Methanol, 95%	gal.	.. -	3 25 3 30
Methanol, pure	gal	. . .	3 50 4 50
Nickel salt, double	lb.	.....-....	.14 - .16
Nickel salt, single	lb.	..... -.....	.13 - .14
Phosgene (see carbonyl chloride)		..... -.	.. .
Phosphorus, red	lb.	50 - 55	.60 - . .65
Phosphorus, yellow	lb.	... -. ...	.35 - .37
Potassium bichromate	lb.	.34 - .36	.39 - .40

		Carlots		Less Carlots	
Potassium bitartrate (cream of Tartar)	lb	$0 52	$0 56	$0.57 -	$0 58
Potassium bromide, granular	lb.			.70 -	73
Potassium carbonate, U. S. P	lb.	.50 -	55	56	60
Potassium carbonate, crude	lb.	20	21	.23	25
Potassium chlorate, crystals	lb	.18 -	18½	19	20
Potassium hydroxide (caustic potash)	lb.	27 -	28	.29	33
Potassium iodide	lb	-.	....	3.35 -	3 60
Potassium nitrate	lb.	17 -	17½	.19 -	.21
Potassium permanganate	lb	75 -	80	.85 -	.95
Potassium prussiate, red	lb.	.85	.95	1.00 -	1 05
Potassium prussiate, yellow	lb.	.32	.36	.35 -	.40
Potassium sulphate (powdered)	ton	$240.00	255 00	....-....	
Rochelle salts (see sodium potas. tartrate)			....	....-....	
Salammoniac (see ammonium chloride)		. -.....		....-....	
Sal soda (see sodium carbonate)		..-.....		....	
Salt cake	ton	. -.		48.00 -	50.00
Silver cyanide (nominal)	oz	-.....		1.25 -.	....
Silver nitrate (nominal)	oz	-....		.60 -	62
Soda ash, light	100 lb.	-.....		2.25 -	2.50
Soda ash, dense	100 lb.	-		3.25 -	3.50
Sodium acetate	lb.	10 -	15	20	25
Sodium bicarbonate	100 lb.	2.85 -	2 95	3.00 -	3 50
Sodium bichromate	lb.	.22 -	.24	26	.27
Sodium bisulphate (nitre cake)	ton	7.00 -	8.00	9.00 -	11.00
Sodium bisulphite Powered, U.S.P	lb.	.08¾-	.	10 -	11
Sodium borate (borax)	lb.	09 -	.10	.11 -	12
Sodium carbonate (sal soda)	100 lb.	2 00	2.10	2.15	2.25
Sodium chlorate	lb.	11	12	.12½	.14
Sodium cyanide, 96-98 per cent	lb.	25	.30	.32 -	.35
Sodium fluoride	lb.	.18 -.	...	.19 -	20
Sodium hydroxide (caustic soda)	100 lb.	4 25 -	4 50	-	.
Sodium hyposulphite	lb.	.....	.....	.03	.04
Sodium molybdate	lb.	2.50 -.	....	3.25½-	...
Sodium nitrate	100 lb.	3.00 -	3.25	3.75 -	4.00
Sodium nitrite	lb.	13 -	.14	.15 -	16
Sodium peroxide, powdered	lb.	.32 -	.35	.35 -	.40
Sodium phosphate, dibasic	lb.	.03¾-	.04½	.04½-	.05
Sodium potassium tartrate (Rochelle salts)	lb.	-		.39 -	.40
Sodium prussiate, yellow	lb.	.25 -	.27	.31 -	.32
Sodium silicate, solution (40 deg.)	lb.	.01½-	.01¾	.02 -	.02½
Sodium silicate, solution (60 deg.)	lb.	.02½-	.03	.04 -	.05
Sodium sulphate, crystals (Glauber's salt)	cwt.	2.25 -	2.50	2.60 -	2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	09½-	.10	10½-	.11
Sodium sulphite, crystals	lb.	04 -	0.4½	04½-	.05
Strontium nitrate, powdered	lb.	15 -	.18½	.19 -	.20
Sulphur chloride red	lb.	.08 -	09	.10 -	.10½
Sulphur, crude	ton	16.00 -	20.00	......-......	
Sulphur dioxide, liquid, cylinders	lb.	.09 -.	.....	.10 -	.12
Sulphur (sublimed), flour	100 lb.	..-.....		3.80 -	4.35
Sulphur, roll (brimstone)	100 lb.	..-.....		3.40 -	3.90
Tin bichloride (stannous)	lb.	.42½-	44	.45 -	.46
Tin oxide	lb.	......-.	...	.55 -	.65
Zinc carbonate, precipitate	lb.	.16 -	.18	.19 -	.20
Zinc chloride, gran	lb.	.13	13½	.13½-	.17
Zinc cyanide	lb.	.45	.49	.50 -	.60
Zinc dust	lb.	.12 -	.13	.13 -	.14
Zinc oxide, U. S. P	lb.	.17	.25	...-	
Zinc sulphate	lb.	.03½ -	.03¾	.04 -	.06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities.

Alpha-naphthol, crude	lb	$1.25	—	$1.35
Alpha-naphthol, refined	lb.	1 50	—	1.60
Alpha-naphthylamine	lb.	.45	—	.50
Aniline oil, drums extra	lb.	28		.33
Aniline salts	lb.	.33		.36
Anthracene, 80% in drums (100 lb.)	lb.	.90		1.00
Benzaldehyde (f.f.c.)	lb.	2.00	-	2.10
Benzidine, base	lb	1.35	—	1.40
Benzidine sulphate	lb	1.15	—	1 25
Benzoic acid, U S.P	lb.	.85	—	.90
Benzoate of soda, U.S.P	lb	.80	—	90
Benzene, pure, water-white, in drums (100 gal)	gal	35	—	.40½
Benzene, 90%, in drums (100 gal)	gal	.33		.38½
Benzyl chloride, 95-97%, refined	lb	35		.40
Benzyl chloride, tech	lb	.25	-	.35
Beta-naphthol benzoate (nominal)	lb.	3 50		4.00
Beta-naphthol, sublimed (nominal)	lb.	90	--	95
Beta-naphthol, tech (nominal)	lb	60		.70
Beta-naphthylamine, sublimed	lb	2.25	-	2.40
Cresol, U. S. P., in drums (100 lb)	lb	.18	-	19
Ortho-cresol, in drums (100 lb)	lb	.23		.25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10		1.15
Cresylic acid, 95-97%, dark, in drums	gal	1 05		1 10
Cresylic acid, 50%, first quality, drums	gal	.65		75
Dichlorbenzene	lb	.07		10
Diethylaniline	lb	1 50		1.60
Dimethylaniline	lb.	.90	--	1 00
Dinitrobenzene	lb.	.30	-	37
Dinitroclorbenzene	lb	.32		35
Dinitronaphthalene	lb	45		55
Dinitrophenol	lb	40		.45
Dinitrotoluene	lb	38		.40
Dip oil, 25%, tar acids, car lots, in drums	gal	38		40
Diphenylamine (nominal)	lb	80	-	85
H-acid (nominal)	lb.	1 90		2.05
Meta-phenylenediamine	lb	1.25		1.30
Monochlorbenzene	lb	18		.20
Monoethylaniline	lb.	2.00		2.40
Naphthalene crushed, in bbls. (250 lb)	lb	.12	-	14
Naphthalene, flake	lb.	.10½	-	.11
Naphthalene, balls	lb	12½		13
Naphthionic acid, crude	lb.	75	-	.85
Nitrobenzene	lb.	14	--	.19
Nitro-naphthalene	lb.	40	--	.50
Nitro-toluene	lb.	.18	-	.25
Ortho-amidophenol	lb.	3.25	--	4 25
Ortho-dichlor-benzene	lb.	.15	-	.20
Ortho-nitro-phenol	lb.	80	.	.85
Ortho-nitro-toluene	lb.	.25	—	.40
Ortho-toluidine	lb.	.35	—	.38
Para-amidophenol, base	lb.	2.50	--	3.00
Para-amidophenol, HCl	lb.	2.50	--	3.00
Para-dichlorbenzene	lb.	.08	--	.12
Paranitroaniline	lb.	1 10	-	1.15
Para-nitrotoluene	lb.	1.25	—	1.40
Para-phenylenediamine	lb.	2.50	—	2.65
Para-toluidine	lb.	2.00	--	2.25
Phthalic anhydride	lb	.60	--	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12		20
Pyridine	gal	2.00	--	3.50
Resorcinol, technical	lb	4.25		4.50
Resorcinol, pure	lb	6 25	—	6.75
Salicylic acid, tech., in bbls (110 lb.)	lb	.45		.50
Salicylic acid, U. S. P.	lb	.45	—	.50
Salol	lb	.90	--	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal	30	—	.35
Solvent naphtha, crude, heavy, in drums, 100 gal	gal	.20	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Tolidine	lb	1.70	—	2.50
Toluidine, mixed	lb	.45	—	.55
Toluene, in tank cars	gal	.35	—	....
Toluene, in drums	gal	38½	—	.40½
Xylidines, drums, 100 gal.	lb	.50	—	.65
Xylene, pure, in drums	gal.	.47½	—	.50½
Xylene, pure, in tank cars	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal	gal	.32½	—	.35½
Xylene, commercial, in tank cars	gal	.30	-	

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.33	--	$0.38
Beeswax, refined, light	lb.	.34	—	.37
Beeswax, white pure	lb.	.60	—	.65
Carnauba, No. 1. (nominal)	lb.	.90	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	--	.86
Carnauba, No. 3, North Country	lb.	.35	-	.36
Japan	lb.	.18	-	.20
Montan, crude	lb.	14	—	.15
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	--	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	--	.11½
Paraffine waxes, refined, 125 m p	lb.	.12½	—	
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	--	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	--	.17
Paraffine waxes, refined, 135-137 m p.	lb.	.17½	—	18½
Stearic acid, single pressed	lb.	.20	—	.21
Stearic acid, double pressed	lb.	.22	--	.23
Stearic acid, triple pressed	lb.	.24	--	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal	$2.15
Pine oil, pure, dest. dist	gal	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f o.b., New York, for carload lots

Rosin B-D, bbl	280 lb.	$12.90	--	
Rosin E-I	280 lb.	12.90	—	13.25
Rosin K-N	280 lb.	13.15	—	.....
Rosin W G.-W. W	280 lb.	13.25	—	. .
Wood rosin, bbl	280 lb.	12.50	—	.
Spirits of turpentine	gal.	1.20	—	. .
Wood turpentine, steam dist	gal.		—	..
Wood turpentine, dest. dist	gal.	.	—	.....
Pine tar pitch, bbl.	200 lb.	...	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.72	—	...
Rosin oil, second run	gal.	.75	—	.
Rosin oil, third run	gal.	.92	--	....

Solvents

73-76 deg, steel bbls (85 lb.)	gal	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb)	gal.	.37
V. M. and P naphtha, steel bbls. (85 lb)	gal	.29

Crude Rubber

Para—Upriver fine	lb.	$0.26	—	$0.26½
Upriver coarse	lb.	17	—	.18
Upriver caucho ball	lb.	.17½	--	.18
Plantation—First latex crepe	lb.	25	—	...
Ribbed smoked sheets	lb.	.24½	—	
Brown crepe, thin, clean	lb.	.22½	—	
Amber crepe No 1	lb.	.22	—	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.16½	--	$0.18
Castor oil, AA, in bbls	lb.	.17	—	.17
China wood oil, in bbls. (f.o.b. Pac coast)	lb.	.17½	—	.18
Cocoanut oil, Ceylon grade, in bbls	lb.	.16½	—	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17½	—	.17
Corn oil, crude, in bbls	lb.	.12	—	.13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½	—	.11
Cottonseed oil, summer yellow	lb.	.13	—	.14
Cottonseed oil, winter yellow	lb.	..	—	
Linseed oil, raw, car lots (domestic)	gal.	1.07	—	....
Linseed oil, raw, tank cars (domestic)	gal.	1.00	—	
Linseed oil, boiled, car lots (domestic)	gal.	1.09	--	

Olive oil, commercial	gal.	3.00 —	3.50
Palm, Lagos	lb.	.10½ —	.10¾
Palm, bright red	lb.	..... —	...
Palm, Niger	lb.	.09½ —	.10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10½ —	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.30 —	1.45
Rapeseed oil, blown, in bbls	gal.	1.60 —	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14 —	14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	.11

FISH

Winter pressed Menhaden	gal.	$0.85 —	$0 90
Yellow bleached Menhaden	gal.	.87 —	.90
White bleached Menhaden	gal.	.90 —	.92
Blown Menhaden	gal.	1.05 —	.

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 -	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 -	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19 00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00 —	
Barytes, floated, f.o.b. St. Louis	net ton	26.50	28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	11 25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60 00 —	80.00
Casein	lb.	15 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½	05½
Chalk, domestic, heavy	lb.	.04 —	05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00 —	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 -	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00 -	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50 —	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	10 00
Feldspar, ground, f.o.b. Maine	net ton	21.00 -	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 -	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00	35.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	
Fuller's earth, powdered, f.o.b. Fla	net ton	18.00 —	
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	—	.02
Graphite, crucible, 80% carbon Ashland, Ala	lb.	...... —	.05
Graphite, crucible, 90% carbon Ashland, Ala	lb.	.... —	.10
Graphite, crucible, 85% carbon	lb.	. —	.08
Graphite, crucible, 88% carbon	lb.	... —	09½
Graphite, crucible, 90% carbon	lb.	... —	.10½
Pumice stone, imported, lump	lb.	.04 —	50
Pumice stone, domestic, lump	lb.	06 —	.
Pumice stone, ground	lb.	04	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.. —	10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	. —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17 00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	1 15 —	1.30
Shellac, orange superfine	lb.	1 10	1 20
Shellac, A. C. garnet	lb.	.90	95
Shellac, T. N.	lb.	.85 —	95
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 -	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 -	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 -	15.00
Talc, imported	ton	60.00 -	70.00
Talc, California Talcum Powder grade	ton	20.00	35 00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55–60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60–65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55–60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45–50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	18 —	19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	20	21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00 —	180.00
Ferro-manganese, 76-80% Mn, English	gross ton	170.00 —	175 00
Spiegeleisen, 18-22% Mn	gross ton	82.50 —	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00 —	2.50
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90 —	1.05
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	...
Ferro-vanadium, 30-40% per lb. of contained V	lb	6.50 —	8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20½% silica, not more than 11% moisture	gross ton	$10.00	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70	75
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	75 -	.85
*Coke, foundry, f.o.b. ovens	net ton	... -	18.00
*Coke, furnace, f.o.b. ovens	net ton	16.50 -	17 00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 -	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	80.00 -	100.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½–	85 02
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	60 -	70
Manganese ore, chemical (MnO_2)	gross ton	80.00	100 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.70 -	75
Monazite, per unit of ThO_2	unit	42.00 -	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 –	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	16½–	
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12	14
Pyrites, domestic, fines	unit	.12 –	14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 –	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50	5 00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb	2.75	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb	2.75 –	3.00
Vanadium pentoxide, 99%	lb.	12.00 –	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 –	
Zircon, washed, iron free	lb.	.05	

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	16.50
Aluminum, 98 to 99 per cent	34.80
Antimony, wholesale lots, Chinese and Japanese	7 12½@7 25
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45 00
Tin, 5-ton lots	39.50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	8 00
Zinc, spot, New York	8.50
Zinc, spot, E. St Louis	7.70@8.05

OTHER METALS

Silver (Commercial)	oz.	$0.91½
Cadmium	lb.	1 40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6 00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	110 00
Iridium	oz.	400 00@450 00
Palladium	oz.	100.00
Mercury	75 lb.	77 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper bottoms	37.25
Copper rods	38.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	14 00	17 00	13 00	14 00
Copper, heavy and wire	13 50	16 00	12 50	13 50
Copper, light and bottoms	12 00	14 00	11.00	12 00
Lead, heavy	6 75	4 75	6.00	6 50
Lead, tea	4 50	3 75	4.00	5.50
Brass, heavy	7 00	10 50	9 00	14 00
Brass, light	6 00	7 50	6 00	7 50
No. 1 yellow brass turnings	7 00	10 00	7.00	7 50
Zinc	4 50	5 00	4 00	5 50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named.

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4 58	$4 47	$3 47	$5 00	$3 37	$4 08	$3 47
Soft steel bars	4 73	4.62	3 37	4 50	3 27	3.98	3 37
Soft steel bar shapes	4 73	4.62	3 37		3 27	3.98	3 37
Soft steel bands	6 43	6 32	4 07	6 25		..	
Plates, ¼ to 1 in. thick	4 78	4 67	3.67	4 50	3 57	4 28	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

ANSONIA — The Amer. Brass Co., 58 Liberty St., will build a 1-story, 340x400-ft. copper wire mill. Estimated cost, $725,000. Work will be done by day labor. Noted Oct. 15.

NEW HAVEN—The New Haven Pulp & Board Co., Green and East Sts., plans to build a 2-story factory addition. Estimated cost, $50,000. Fletcher Thompson, Inc., 1087 Broad St., Bridgeport, engr.

Illinois

CHICAGO—The By-Products Coke Corp. plans to build several buildings between 110th and 111th Sts. and Baltimore Ave.

Iowa

CEDAR RAPIDS—The Concrete Products Co. has awarded the contract for the construction of a 2-story factory and office building to the John Klepach Constr. Co., 1128 South 3d St. Estimated cost, $60,000.

Maine

GREAT WORKS—The Penobscot Chemical Fibre Co., 49 Federal St., Boston, has awarded the contract for the construction of a 34x45x109-ft. addition to its pulp and paper plant to the Aberthaw Constr. Co., 27 School St., Boston. Estimated cost, $125,000.

Massachusetts

FITCHBURG—The Falulah Paper Co., Falulah Rd., has awarded the contract for the construction of a 1-story, 40x100-ft. paper factory addition to Samuel M. Green Co., 293 Bridge St., Springfield, Mass. Estimated cost, $25,000.

WESTFIELD—The Vitrified Wheel Co. Emery St., will soon award the contract for the construction of a 2-story, 60x102-ft kiln building. Estimated cost, $30,000. Frost E. Chamberlain, 390 Main St., Worcester, archt.

Michigan

HAMTRAMCK (Detroit P. O.)—The Jeffrey Dewitt Co., Butler Ave. along the tracks of the Grand Trunk R.R., plans to build a 5-story factory for the manufacture of porcelain ware on Butler Ave. Estimated cost, $200,000.

Minnesota

CHISHOLM — The Bd. Educ. has purchased a site on 3d Ave. and Chestnut St. and plans to build a 3-story, 150x225-ft. vocational school on same. A chemical laboratory will be installed. Estimated cost, $250,000. Joseph Austin, pres.

New Jersey

GARFIELD—The De Mattia Bros. plan to build a 90x200-ft. rubber mill here. Estimated cost, $200,000. B. De Mattia, secy. J. F. Kelley, P. O. Bldg., Passaic, engr.

TRENTON—The New Jersey Tile Co., Muirheid Ave., plans to build a 60x200-ft. plant, to include 3 kilns, press room, slip house, etc., on Brunswick St. Estimated cost, $30,000. Karno Smith Co., Broad St. Bank, engr.

New York

BROOKLYN—The Amer. Marine Paint Co., Inc., 175 Dwight St., will build a 2-story factory on Richards St. Estimated cost, $75,000.

SYRACUSE — The Crown Oil Co., 310 West Jefferson St., is building a 1-story, 30x110-ft. gasoline and oil building on Van Rensselaer St. Estimated cost, $30,000.

Ohio

CLEVELAND—The Brass Co., c/o Allan Sogg, archt., 319 Hippodrome Bldg., plans to build a 1-story, 75x160-ft. foundry and machine shop. Estimated cost, $100,000.

Pennsylvania

BETHLEHEM—The Traveler Rubber Co. plans to build a 1-story, 25x35-ft. pumping station and a 1-story, 20x30-ft. cement house. Estimated cost, $10,000. J. O. Hunt, 114 North Montgomery St., Trenton, N. J., archt.

PHILADELPHIA—The Staybestos Mfg. Co., Linn and Armat Sts., has awarded the contract for the construction of a 2-story, 60x120-ft. factory for the manufacture of asbestos products on Berkley St. and Germantown Ave., to R. M. Peterson & Son, 5114 Germantown Ave. Estimated cost, $75,000.

Rhode Island

PROVIDENCE—The Revere Rubber Co., 355 Valley St., has awarded the contract for the construction of a 3-story addition to its rubber factory on Valley and Hemlock Sts., to the Cruise & Smiley Constr. Co., East Ave., Pawtucket. Estimated cost, $50,000.

Texas

TERRELL—The Chairman of the City Comn. will receive bids until Oct. 25 for the construction of a filtration plant capable of purifying 1,000,000 gal. of water every 24 hours.

Wisconsin

MILWAUKEE — Peter Bogenski, 1139 Grove St., plans to build a 1-story, 70x172-ft. factory for the manufacture of waterproof cement brick.

MILWAUKEE—The Red Star Yeast & Products Co., 27th and St. Paul Sts., will soon award the contract for the construction of a 2-story, 30x96-ft. yeast house. Estimated cost, $25,000. E. R. Liebert, University Bldg., archt. and engr. Noted Oct. 6.

PORT WASHINGTON—The Turner Mfg. Co. will soon receive bids for the construction of a 1-story, 60x180-ft. foundry, machine shop, etc., on Main St. Estimated cost, $150,000. W. A. Englehardt, mgr. F. D. Chase, Michigan Ave., Chicago, archt. and engr.

WAUWATOSA—The Milwaukee Co. Bd. of Administration received bid for rebuilding the sewage disposal plant from the Lippmann Stone Co., 449 Clinton St., Milwaukee. $27,904. Noted Oct. 6.

Wyoming

CASPER—The city plans to install a manual-controlled chlorination system in the pumping house here. Estimated cost $1,500. F. S. Knittle, City Hall, engr.

New Brunswick

GRAND FALLS—The International Paper Co., Three Rivers, will receive bids in November for the construction of a pulp and paper plant here. Estimated cost, $1,000,000.

Nova Scotia

SYDNEY—The Dominion Iron & Steel Co. will soon award the contract for the construction of a brick-making plant.

Ontario

PORT ARTHUR—The Provincial Paper Mills, Ltd., has purchased the Port Arthur Pulp & Paper Co. and plans to expend $1,000,000 to improve and build additions to same for its own use. Noted Sept. 15.

TORONTO—The Anthes Fdry Co., Ltd., 64 Jefferson Ave., has awarded the contract for the construction of a 1-story foundry on Jefferson Ave., to the Ramsay Contg. Co., 39 Indian Rd. Estimated cost, $20,000.

Quebec

MONTREAL—The Sherwin-Williams Co., Ltd., Centre St., has awarded the contract for the construction of a 3-story addition to its plant to Angil Norcress, Ltd., 65 Victoria St. Estimated cost, $62,000.

THREE RIVERS—The city will submit a bylaw to the ratepayers for the construction of a filtration plant and aqueduct. Estimated cost, $325,000. Z. Lambert, engr.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

THE JEFFREY MANUFACTURING CO., Columbus, O., has opened an office at 1108 Marine Trust Bldg., Buffalo, in charge of H. W. Scott, formerly of the Columbus, O., office, in order to render more efficient service to western New York customers.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces that its first electrically heated core and mold drying oven has been put into operation at the Emery Steel Castings Co., Baltimore, Md. It is also announced that orders were received for the following Greaves-Etchells electric furnaces: Joliette Castings & Forgings, Ltd., Joliette, P. Q., 1 ton; Brennen Steel Castings Co., Cleveland, O., ½ ton. The furnace for the Bird-Archer Co., Cohoes, N. Y., for making special steel castings, has also been successfully started up.

MONSANTO CHEMICAL WORKS announces the establishment of a Chicago branch in the Marine Bldg., 209 North LaSalle St. This branch is opened with a view of serving its customers and friends in Chicago and surrounding territory more efficiently than could be done from St. Louis. A complete stock of the products manufactured by Monsanto Chemical Works will be carried at this branch, which will be managed by W. L. Filmer, who previously had charge of the flavors and condiments division of the St. Louis sales department.

A group of prominent steel foundries comprising: Electric Steel Co., Chicago, Ill.; Fort Pitt Steel Castings Co., McKeesport, Pa.; Isaac G. Johnson Co., Spuyten Duyvil, N. Y.; Lebanon Steel Foundry Co., Lebanon, Pa.; Michigan Steel Castings Co., Detroit, Mich., and the Sivyer Steel Castings Co., Milwaukee, Wis., have organized for the purpose of developing and perfecting higher standards in the production of steel castings. R. A. Bull, formerly vice-president of the Duquesne Steel Foundry Co., resigned from that position and has been appointed consulting metallurgist for the group mentioned. He will devote his entire time to preliminary research. His connection with the foundry industry covers a period of over twenty years, during which he has held important positions in foundries in St. Louis, Chicago, New York and Pittsburgh. The new organization will undoubtedly be a vital factor in the further improvement of the strength and quality of steel castings.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Shall the Government Patent and Develop The Inventions of Its Employees?

UNIQUE in the cordial relations existing between Government officials and industrial scientists and engineers was the meeting held at the Chemists' Club in New York on the evening of Oct. 15 to discuss certain plans for patenting and developing the inventions of Government employees. Under the auspices of the American Institute of Chemical Engineers, the New York sections of the American Chemical and American Electrochemical societies, and the American Section of the Society of Chemical Industry, Dr. FREDERICK G. COTTRELL, Director of the Bureau of Mines, and Dr. CARL L. ALSBERG, Chief of the Bureau of Chemistry, explained their problems in disposing of inventions of Government employees, made in the course of official duties, and advocated legislation for dealing with these "byproducts" of regular work. A full report of the meeting, prepared from stenographic notes, is published elsewhere in this issue.

We regard the subject as of the utmost importance to industry, because it involves the question of the encroachment of Government on private business. It involves also a new departure in developing patentable inventions made by Government employees, .and thus vitally affects the future relations of Government and industry. For these and other evident reasons we commend to the chemically-controlled industries a careful study of the plan outlined by Dr. COTTRELL, as all of them may be concerned in the course of time.

Briefly stated, the thesis of Dr. COTTRELL is this: In the course of their official work in fundamental research, industrial investigations or for the purpose of law enforcement, Government employees inevitably make discoveries and inventions which have actual or potential commercial value, provided they are developed and brought to the point of industrial application. Lacking any suitable machinery for this purpose, these inventions are lost to industry and a valuable byproduct of Government research is neglected. Dedication of the patent to the public is claimed to be futile as far as further development of the idea is concerned, because private industry will not take up and develop an invention on which it has not the protection afforded by a patent or by a license from the patentee.

The remedy proposed is to authorize the Federal Trade Commission to accept assignment of such patents, license their use and collect royalties which are to be paid to the Treasurer of the United States, excepting a part which is to be paid to the inventors whose patents are thus handled. Legislation to this effect has already passed both houses of Congress, in slightly different form in each, and is now in conference committee pending action at the forthcoming session.

It may be surmised that industrial scientists are not pleased with the prospect of thus injecting a new and unknown element into the already highly competitive state of private business—and for a variety of reasons which we believe will increase as knowledge of the plan becomes more widespread. For ourselves we see in the proposal an experiment in economics and patent administration which is not justified in the light of present industrial conditions, and one which is almost certain to lead to friction between Government and business and in many cases an abrupt termination of the cordial relations now existing between certain industries and Government bureaus. While the plan admittedly has not had wide circulation in business and industrial circles, we have failed to find an advocate outside of Government or quasi-public institutions. Is it not a significant fact that the industries which are to be affected in a practical way by this legislation will have none of it, being quite willing to take chances with competitors in developing business but viewing with apprehension the entrance of a third party into the field on a basis which, in the nature of the case, can scarcely be impartial? The whole subject is one that needs more counsel between Government and business before it is finally settled by legislation.

Examination of the bill suggests to us the following objections to its passage: In the first place, rightly or wrongly, business has no confidence in the Federal Trade Commission; and any proposal which places in the hands of that body the power which the present bill confers will be regarded with suspicion. Power once acquired by a governmental agency is not lightly abandoned. More than that, it is likely to be extended as time passes, until the original purport and intention of even an acceptable measure are lost and forgotten. In the present case the success of the plan depends on its administration, and there is no certainty that that would be in accordance with the good intentions of its promoters. Although the latter argue that the bill is an enabling act and not mandatory, and that therefore it will fail if not wisely administered, it would still appear that under its terms the President has the power to direct that all patentable matter resulting from research work in any Government department be patented and administered by the Federal Trade Commission. Thus the United States could become a vast holding company, owning patents affecting practically every branch of private industry.

But granting that the act is wisely administered, we still have the necessity of partiality in its administration, for unless licenses are restricted in number there is no gain over dedication of the patent to the public in the first instance. Thus we will be confronted with the delicate decision as to how many licenses shall

be issued, and still more important, to whom. If such a situation can be handled by the Federal Trade Commission with satisfaction to all concerned an unexpected measure of success will have been achieved. No one believes it is possible. By the terms of this bill the Government is committed in advance to the principle of participation in private business on a selectively competitive basis. Its patented discoveries and inventions will not flow to industry as a whole, but to such units thereof as may be selected. Its non-patented, and presumably inconsequential, discoveries will be open to all as heretofore. It is quite conceivable that the Federal Trade Commission, in order to protect its favored licensees, will have to conduct a lively legal business in suits for infringement against concerns which see fit to ignore the discriminative policy.

In the meantime what about the effect of the bill on the employee in whose interest, in part, the measure has been drawn? Dr. COTTRELL rightly minimizes the reward to the employee as a feature of the bill, and lays principal stress on the benefit to the public by bringing inventions into practical use. But the employee is to profit nevertheless, and we may well inquire into his attitude if the bill becomes law. Will it be humanly possible for him to forget that then there will be some incentive for him to produce patentable inventions? Will there not be the temptation, which may even become an established tendency, to pursue those lines of industrial investigation that will lead to immediate reward, and neglect more fundamental research that could benefit the whole industry without profit to the individual? Putting these questions to a man recently resigned from Government service, he admitted that the existence of such a law would be bound to affect his attitude somewhat. How shall we commercialize the inventions without at the same time and in some degree commercializing the inventors? And how will the scheme be regarded by that employee of the Government whose work is outside the field of patentable invention? Ability and meritorious service are not confined to the scientific bureaus alone; and yet the bill would discriminate between those employees who, as a class, may make and receive reward for patentable inventions and those who, from the very nature of their work, may not. Certainly no private industry would deliberately inject so disquieting and disturbing a factor into its organization, and there is no reason to believe that its effects will be less baneful inside the Government than without.

The measure is admittedly an experiment in economics in order to solve a problem arising in certain Government bureaus. We doubt if the experiment is called for either on account of an accumulation of valuable inventions in those bureaus or for the benefit of the public. Government inventions probably are no better or worse than the average run emanating from industries having research laboratories, and we know that most of them are inconsequential as far as practical development is concerned. If anyone thinks that valuable and practical patents are numerous let him study the patents expiring, say in 1920, which are pertinent to his industry, and see how many he will be inclined to adopt. Those on which he would spend much money will be a surprisingly small, if not fractional, percentage of the whole.

As for the argument that patents dedicated to the public will not be accepted by industry on account of lack of protection during the development period, there may be another way to make such inventions effective—viz., by promulgating such industrial regulations as will call for the patented article or process. This could be done consistently in the interest of the public, and more impartially than the Federal Trade Commission could grant licenses.

In addition to the foregoing there are many other objections to the legislation, which will be found in our report of the meeting. The subject is a large one and no attempt has been made to exhaust it. We believe that one of the parties at interest—industry—has not been fully advised of the purport of the legislation and consequently has not fully conceived its effects. The printed hearings on the bill reveal no witnesses from industry or from any other source appearing against the measure. Immediate steps should be taken by industrial organizations to inform themselves fully in the matter and to urge rehearings if such are possible. No emergency exists which could be met by immediate passage of the bill, and surely it would be better to have all elements harmonious if such a thing were possible. If industry does not take advantage of this opportunity to make itself heard and felt, then it will have no fault to find with those who, from altruistic and sincere motives and as a result of long study and deep thought, propose experiments in patent administration in the interest of the public. The matter has now received more publicity than all that has gone before and those who will be adversely affected will proceed with their eyes open. They should not only marshal facts in opposition to the plan, but should if possible suggest alternative methods of solving the problem encountered by Government officials. Immediate action is necessary if anything is to be accomplished.

Thoughtless Legislation

IT WILL BE recalled that one of the aims of the national prohibition act as set forth in its title was "to insure an ample supply of alcohol and promote its use in scientific research and in the development of fuel, dye and other lawful industries." In spite of this, the regulations issued by the Bureau of Internal Revenue have tended somewhat to hamper the legitimate use of non-beverage alcohol. When, therefore, additional burdens are imposed upon the user and distributor of non-beverage alcohol through state legislation, the industry cannot be expected to thrive.

Such is the condition in New York State at the present time. The liquor tax law (Chap. 911, Laws of New York) imposes a tax of thirty cents upon each gallon of non-beverage alcohol manufactured or sold within the State of New York. Alcohol manufactured outside of the state is not subject to tax unless resold within the state. The result is that the legitimate consumer of non-beverage alcohol is forced to pay a premium of thirty cents a gallon unless he is in a position to buy directly from a producer outside of New York State.

Were this a new measure, we could indicate only the possible consequences. As it is, the law has been in effect since May 24, 1920, and we have only to point to the actual results. Those manufacturers who have been producing alcohol within the state have closed their plants and some of them have moved to other states. Large dealers and distributors of alcohol have refused

to do business within the state and their premises have been closed to such an extent that it is almost impossible to buy alcohol in the State of New York. Some of the larger dealers have been incorporated in other states and even though the law be repealed their business will be lost to the State of New York for many years.

Surely a little intelligent forethought would have prevented the drafting of a measure which discriminates against legitimate business interests of the state wherein the legislative body convenes. As the situation stands, it is clearly the duty of the New York Legislature to repeal or amend the offending sections of the liquor tax law.

Education by Myth And Verbal Subtleties

ONE of the most distinguished of British scientists, FREDERICK SODDY, attacked the old-time classical education in a recent number of *Nature*. He charged that the classical or arts college educates by "myth and verbal subtleties," arguing, as HUXLEY did before him, that science is slighted for "mediæval and drawing-room studies." Continuing, he said that "the traditional education given to the ruling classes trains them to be impervious to new knowledge and able only to find in the old and dead past ideals for imitation and reverence." Science has produced most of our material wealth and has "demolished the cobwebs of traditional economics and finance," giving laws based on fundamentals and truth. According to Professor SODDY, who has had excellent opportunity to observe classical education at Oxford, where he has studied and lectured, much of the world's trouble today from war and industrial discontent is the consequence of the wrong education of the ruling class.

This is a striking indictment of classical education, all the more so because of Professor SODDY'S concise way of stating it: "myths and verbal subtleties." He is objecting to the emphasis that arts colleges place upon the vast literature of old customs and traditions, upon seemingly aimless folk-lore, and upon elaborate myths such as those told by HOMER and VIRGIL. Such studies make attractive the circuitous and wasteful methods by which man has drifted from one thing to another, the inexplicable obsessions under which he has labored, the blind ignorance that has made progress so difficult and the obstinacies and loyalties that blend so curiously in human nature. Professor SODDY in speaking of verbal subtleties is objecting to the hair-splitting and the mechanical trifling that have characterized universities since their founding, and that still persist—strange mediæval relics in our modern times.

In H. G. WELLS' "Outline of History" he points out the development of the pedant among the philosophers of the Alexandrian period, after that Egyptian city ceased to draw men like EUCLID, ARCHIMEDES and HERON. Says Mr. WELLS, speaking of Alexandria's famous museum (or university) as it existed about the time of CHRIST: "Wisdom passed away from Alexandria and left pedantry behind. For the use of books was substituted the worship of books. Very speedily the learned became a specialized queer class with unpleasant characteristics of its own. The museum had not existed for half a dozen generations before Alexandria was familiar with a new type of human being; shy, eccentric, unpractical, incapable of essentials, strangely fierce upon trivialities of literary detail, as bitterly jealous of the colleague within as of the unlearned without, the bent scholarly man. He was as intolerant as a priest, though he had no altar; as obscurantist as a magician, though he had no cave. For him no method of copying was sufficiently tedious and no rare book sufficiently inaccessible. He was a sort of byproduct of the intellectual process of mankind . . . We have still to discover how to preserve our centers of philosophy and research from the caking and darkening accumulations of narrow and dingy-spirited specialists. We have still to insure that a man of learning shall be none the less a man of affairs."

This habit of strange devotion to "trivialities of literary detail," as Mr. WELLS puts it, is the fault that Professor SODDY condemns as "verbal subtleties." Hair-splitting of this sort was one of the principal activities of the mediæval universities, and undoubtedly, as Professor SODDY says, education of this kind for the ruling class of any country unfits them to appreciate the value of modern science for solving the world's problems.

However, though the arts-educated man is out of date in his thinking and painfully exasperating in his inability to understand the possibilities of the science-educated man, the lessons of the past should not be disparaged so much as Professor SODDY apparently would have us. Education by myth seems the wrong method for young men who must cope with the insistent realities of modern times, but there is much of tolerance and understanding to be gained by an acquaintance with the ancient world. When myths were the only literature of man, the human mind was being impressed in indelible ways that remain unconscious but potent factors in our nature. Habits of thinking that were formed in the childhood of the race determine our decisions today. If, as KANT said, the human mind is like a jelly-mold which transmits our experiences, much of its shaping was done in that prehistoric period when myths were current. It is not a knowledge of myths that is harmful to our ruling classes, but over-emphasis of the purely literary part of the myths and under-emphasis of the history of science in those early times. A study of the historical development of the human intelligence, with suitable stress upon the growth of knowledge in natural science, would teach a ruling class to be open to new knowledge of all kinds. The reading and discussion of man's early struggles with nature from the point of view of modern science would lead students to respect scientific enlightenment as nothing else can. The history of mediæval times—when science was so much hindered by superstition and narrow prejudice—if taught to show how science gradually lighted the way in spite of all opposition, would induce college-trained men to give every opportunity to science as an alleviator of man's burden—which is how so distinguished a philosopher as A. J. BALFOUR regards it.

The proper combination of modern science and the old humanities in education was suggested by the late Sir WILLIAM OSLER, himself a great scientist and classicist. He pointed out that the old philosophers, who are usually studied with no idea of the growth of natural science, were themselves keenly interested in physics, chemistry, mathematics, biology, geology, etc. ARISTOTLE, for instance, was primarily a biologist; PLATO was deeply interested and impressed with geometry; the old Hindus mixed up mathematics and mysticism, but were able to grasp the idea of negative numbers before the Greeks did; such a historical personage as PYTHAGORAS was

convinced that the science of numbers explains the secrets of nature—an idea to which the atomic theory of chemistry gives some credence today.

The point then is that myths and a general classical grounding are not in themselves bad influences, as perhaps Professor SODDY'S address would suggest, but that a study of the ancient world should include the history of science, and should indicate how man's blind fumblings for fundamental truths were cleared up by such scientists as DEMOCRITUS, ROGER BACON, COPERNICUS, GALILEO, DALTON, etc. The man who has been educated merely in the conventional studies of the old-time arts college is as narrow as the engineer who knows nothing of the old humanities. As Sir WILLIAM OSLER advocated, the improved education of the future should combine the old and the new, the humanities and the sciences.

Iron and Steel Conditions in Germany

THAT the chief difficulty in the re-establishment of the German iron and steel industry is not a shortage of raw materials is made evident by the course of market prices in Germany. Scrap, which can be used very largely in lieu of iron ore or pig iron, has had a sensational decline, from a high point of 2,100 marks last March to a price of 500 marks in August, as just reported by our correspondent in Berlin. On account of the inflation in Germany and the very low rates in international exchange ordinary price comparisons are difficult, but there is a separate way to obtain information, that being to compare prices. The August price of billets is quoted at 2,365 marks, and thus we have scrap quoted at 21 per cent of the price of billets. That is an absurdly low relation, for if it obtained in the United States we should have scrap at $8 a ton on the basis of the Steel Corporation's billet price, or at about $12 on the basis of the billet price of the independent mills.

Making a comparison along another line, we have it that prices of semi-finished steel and finished rolled-steel products reached a high point last May and have since greatly declined, the declines running between 20 and 25 per cent. This seems to suggest that the iron- and steel-producing industry is finding itself able to function better than its customers.

Viewing the matter from still another angle, with the further decline in exchange, German iron and steel prices are attractive to outside buyers. At this writing we do not have available exchange rates between Germany and foreign countries, but a comparison by way of the New York rate will suffice. With the mark at 1.46 cents, the billet price just quoted is equal to about $35 per gross ton, while the plate price of August is equal to 2.38c. per pound, these being far below any prices in our own domestic market, yet we have been able to do a good export trade at prices well above our domestic prices.

Thus the internal position of the German iron and steel industry is not wholly bad. There is opportunity for exports, while there seems to be more need of the domestic demand being increased than of the ability to produce being increased.

The great shortage of coal in Germany is usually stressed, and it is quite true that the shortage is acute. We are so easy-going here that we are apt to lose sight of the fact that our own conditions are very far from reasonable. For several months past the price of Connellsville furnace coke for spot shipment has averaged eleven times its price in May, 1915, and twenty times its price in 1894. In the past fortnight there has been a tremendous decline, from $17 to $15 per net ton at ovens, so that the price now is only ten times the price in May, 1915. Coal has been selling at about ten times the price to which it occasionally declined at times within a few years before the war, or at twenty times the price some mines accepted in the late years of the last century. We have seemed to think nothing of this, but really Germany has no monopoly of having affairs out of joint. Germany has plenty of chances to recover, and there is no occasion to waste any sympathy. It behooves us rather to set our own house in order, welcoming all readjustments that may tend to produce a stable basis upon which we can conduct safe and sane business.

Cottonseed Investigations Urgently Required

SOME months ago certain representatives of the cottonseed industries discussed with Dr. C. L. ALSBERG of the Bureau of Chemistry the problems of steaming cottonseed. Strange as it may seem, apparently no one has ever studied the effect of time and temperature of steaming cottonseed upon the yield and quality of oil and cake obtained. The industry is beginning to realize that there may possibly be some need for sound fundamental information on this important part of the plant process. As a result of the early conferences, it was decided that a co-operative arrangement could probably be made whereby the Bureau of Chemistry would work on these problems, advising in some of the investigations which are necessary upon a semi-commercial scale. The design of cottonseed machinery is involved and the co-operation of manufacturers of this equipment was fully assured. It seemed that the problem could be undertaken at an early date and valuable results could be expected almost from the start. However, there now comes a hitch. It is the old problem of the want of a few dollars, resulting in neglect and delay of the invesigation.

It seems that this industry can ill afford to permit even a month to pass without starting these studies on so promising a basis as has been proposed. Fundamental research, such as this, if guided and assisted by an experienced research organization, is almost certain to succeed. The expense would be nominal. One may properly ask why does not the industry get busy and at once provide the funds to engage a well-qualified man to take charge. If the industry as a whole cannot arrange for this work it would doubtless be profitable enough to warrant a single company in undertaking the problem.

The plant facilities required for the tests, the laboratory work for control purposes, and all the rest can easily be provided if adequate supervision is assured through the designation of the proper individual in immediate charge of the work. The industry cannot afford to let another season pass without starting these studies. The action of steam on both the cell structure of the seed and the glycerides is of the fundamental importance and is known only in a general empirical way at present. Solution of the problem will benefit the cotton planter, oil refiner and consumer.

Readers' Views and Comments

A Plea for Education of Promoters

To the Editor of Chemical & Metallurgical Engineering

SIR:—The extremely rapid development during the last few years of the industries in which chemistry plays an important part has brought into our field a type of citizen long known to us in other lines—namely, the promoter. Oil shale and platinum from "any old sands" come in for their full share of attention from this fellow, who formerly flourished in the mining game. Even the clay-working business is "honored" by his attention. I recently received an invitation to invest "with a chosen few" in a clay-working plant.

Excerpts from the prospectus as follows may be worthy of note at least from an illiterary angle:

"Are you willing to provide some of the $200,000, or more, with others in this plant?" One is intrigued by the "or more."

"My developments carry the saving in bad places farther than anyone else in the world, making it a safe business for Americans to go into—under my methods." There is some satisfaction in knowing that one's saving or savings would go far even in bad places with the methods guaranteed.

And here is another economist who settles our industrial problem, for he says: "The Government reports the immigration is landing at the rate of over 10,000 per week—this settles the whole industrial trouble—with a provision made for returning the Radicals and others." Will Emma Goldman be here soon?

And further on he advises: "The selling to retailer is the same here as everywhere, which shows a difference of there [*sic*] price from my cost of over 200 per cent while these people in this country that have grown, who have the better quality, show a difference of 100 per cent to 140 per cent and they all, here, and in Germany, sell wares that have these defects and losses . . . " But why continue? If the Dorr Company or others who have equipment for clarifying sludge on a large scale want to get in touch with this chap, I will gladly furnish his address.

Mr. Editor, I call this to your attention with the thought that you may see fit through your columns to implore the more highly educated type of promoter to give some thought to the possibilities for gain in the chemically controlled industries. Do you not know a college president or two who may be interested? As long as we have "little saving to carry in bad places" we may gain much enjoyment from the post of observation. F. GISTON.

Future Rubber Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the suggestive article on Future Rubber Research on pages 449-450 of your journal for Sept. 8, I wish to point out that although the adjectival description of the manager of the British Rubber Research Laboratory is correct, the writer has by mischance given my name instead of that of B. D. Porritt, who holds the responsible appointment in question. D. F. TWISS.

Dunlop Rubber Co., Ltd.,
Fort Dunlop, Birmingham.

The Oil-Shale Industry and the Necessity for Common Sense

To the Editor of Chemical & Metallurgical Engineering

SIR:—The issue of CHEMICAL & METALLURGICAL ENGINEERING of September 8 contained two valuable articles, both treating upon Hydrocarbon Oils and Oil-Yielding Shales. William A. Hamor's writings upon hydrocarbon oils are always worth reading, but at times, when he refers to the nascent oil-shale industry, he is liable to become pessimistic. Effects often follow very closely after the cause, so it may be claimed that so long as petroleum experts thus continue to "knock" the new industry, it will be found difficult to secure the funds without which a really commercial plant cannot be constructed. But despite the knocker such plants will be constructed. The plants that up to date and upon this continent have been constructed and operated do not even begin to give the industry a fair show. The industry is one that, to be operated economically, has to be operated upon a large scale, with every process well planned.

Martin J. Gavin, who wrote upon "The Necessity for Research in the Oil-Shale Industry," has evidently lately visited Scotland and has returned so filled with Scotch methods that it would almost appear from his article that the "necessity for research" no longer existed. It is to be feared that any research undertaken by a mind so full of Scotch practice will not yield economic results. It may reasonably be advanced, from reading Mr. Gavin's article, that his visit to Scotland has, to some extent, impaired his reasoning and observation powers. Mr. Gavin states: "The Scotch retort, when carefully examined, is found to be admirably suited for its tasks." If this be so, where then is the need of research? It would be regrettable were Mr. Gavin to be taken off the research lately placed under his direction because of Mr. Gavin having already ascertained that "when carefully examined, the Scotch retort is found to be admirably suited for its task." It may, however, reasonably be asked, What can any reasonable man expect from the operations of any machine than that it should be found to be admirably suited for its task? Fortunately for Mr. Gavin and for his research, his opinion, so given, of the Scotch retort will not be accepted as correct by those interested in the oil-shale industry.

In the consideration of this most important subject, a question that probably is the most important that will come up for solution at the hands of industrial chemists and engineers during the nineteen hundred and twenties, let common sense be exercised from the commencement.

It is admitted that the oil-shale industry has for many years been very prosperous in Scotland. It is admitted that the Scotch retort, when operating in Scotland under the local conditions there existent during the last thirty years, has given the Scotch investor satisfaction as an excellent money gainer, but is it not a matter of history that the Scotch retort and process, used in other countries, where other and dissimilar conditions existed, have proved to be a failure, in one well-known case a most disastrous failure? It is advanced

that it would have been more worth while, more sensible, to have visited the scene of that failure and to have "carefully examined" into the causes of that failure than to have visited Scotland to witness the successful operation of the retort process, *working under conditions known to be very different to those that exist on this continent.* Many years' experience in planning, construction and management of large industries has satisfied the writer that it is the failures that call for the closest examination, not the apparent successes.

Should it be impossible for Mr. Gavin to visit the works of the defunct Commonwealth Oil Shale Co. in Australia, let Mr. Gavin set down and collect all the information he can concerning the most disastrous failure of the *Scotch retort and process, operating under Scotch management, constructed under Scotch direction from Scotch plans,* and then let him reason the whys and wherefores of the failure. If Mr. Gavin will do this, he will arrive at the conclusion arrived at by the writer—viz., that there are certain serious defects in the Scotch retort and process which, although not seriously operative when working under the conditions that exist in Scotland, yet under other conditions become active and dangerous.

It is admitted that the chemical principles that underlie the method of educing the oil contents of the shale (and which are employed in Scotland for that purpose) are substantially correct. It is, however, advanced that the applications of these correct principles have been in the past and are today made most uneconomically, not only in the actual applications but also as to the operation, and that under certain conditions that are known to exist the applications are unworkable. To illustrate, the following statement shows the quantity of coal used in eight Scotch oil-shale retorting works prior to the war. These works are numbered by the writer as from 1 to 8, as the management of the several works might resent having these particulars made public were the names of the works or of the firm operating also made public. In certain cases full particulars are not available, but such particulars as are available are sufficient to prove the contention that the Scotch retort is uneconomic in its operations.

COAL CONSUMPTION PER DAY IN SCOTCH RETORT WORKS

Works	1	2	3	4	5	6	7	8	Total
Shale daily retorted, long tons	500	500	1,000	720	1,008	850	764	590	5,932
Long tons of coal used:									
In gas producers	18.55	4.50	8.57	10.07	*	*	*	11	...
Under steam boilers	66.40	30.60	57.0	*	80.0	72.0	†	*	..
Total coal used	85	35	65½	*	80.0	72.0	*	†	..
Tons of coal used per day for throughput of 1,000 tons shale	170	70	65½	*	80†	72†	*	*	...

* The quantity of coal used was not given.
† Quantity of coal used under steam boilers only

Therefore in Scotland from 65½ up to 170 long tons of coal was used per day for each 1,000 tons of shale retorted. This, at $10 per ton, means that these perfect retorts burned up not less than $655 worth and up to $1,700 worth of coal per day for each 1,000 tons of shale per day, or, reckoning 300 working days, from $196,500 to $510,000 per year for fuel. Most, if not all, of this fuel, if the retorts had been properly constructed or had been the wonderful machines claimed by Mr. Gavin, would not have been required. But to these very large annual totals must be added the cost of firing the coal, consisting of wages and repairs, the total being amply sufficient to pay a large dividend upon a good capitalization.

Mr. Gavin seems to have been filled up with claims as to the superiority of the crude oil obtained from the Scotch retort. The writer has no knowledge of the oils educed from American shale, which were compared by Mr. Gavin with the Scotch crude, but he is convinced that crude oil of as good a quality can be produced on this continent without using the Scotch retort as can be produced in Scotland when using the Scotch retort. However, capitalists do not invest their money in the oil-shale business for the honor of besting old Scotch operators, but for the purpose of securing a return from their investment, and if it is found to be more profitable to produce an oil somewhat inferior in quality, it is very certain that investors will desire that quality of oil to be produced. Research work should be directed, at first, toward the economical production of such a quality of oil as is salable at the greatest profit.

It is to be deplored that Mr. Gavin should have permitted his mind to be thus influenced before he commenced upon his research work, because it will take just so much longer to convince him of the incorrectness of the Scotch claims.

The principles that underlie the eduction of oil-yielding shales are simple, though the economic application of those principles is difficult. Oil-yielding shales, broken into pieces as small as the requirements of the circulation and of the exhaustion of the educed gases will permit, are heated in a closed chamber and the gases educed are drawn off and are passed through condensers to recover the oil. The gases are then washed in scrubbers to recover the naphtha and the ammonia contents.

Temperatures that are higher than the maximum absolutely necessary for eduction *must not be used* if the maximum recovery of oil is desired, and the educed gases should not be exposed to a temperature higher than that at which they are educed.

These governing principles are very simple, but their economic application to retorts is a matter that requires much engineering knowledge and experience. This economic application is encompassed by many difficulties and too often we escape from one only to be met by another of even more importance. These difficulties are not only scientific in their character, but they are also economic, hence there should be associated with the research chemist an engineer.

The writer claims that under American conditions the Scotch retort and process are unduly costly to construct and to keep in repair, that they are immensely wasteful of heat units, that they cannot be operated without the use of large quantities of steam and that there are localities where the necessary water is not available. In such localities, were the Scotch retort to be used without steam, the resultant yield of oil would be comparatively small and the quality poor. In fact the Scotch retort is unworkable without the employment of large quantities of steam. The retort, as it is now operated, seeks to recover, in one operation, a full yield of oil and also of ammonia and it is a well-known and admitted fact that dual purpose machines are never noted for maximum yields. Maximum yields require the employment of two specially designed machines.

Let the deadly parallel speak. Let it be seen how far the Scotch retort that is claimed to be "so admirably suited for its task" conforms to the standard of perfection.

THE PARALLEL

	Standard of Perfection	Scotch Retort
Construction	Should be so designed that it is capable of being quickly constructed. The material required for construction should be readily procurable on the American continent. It should be capable of being constructed by such labor as is available at or near the locality where the retort is to be erected.	Requires very considerable time for construction. Much of the material required is special and may have to be imported, at great cost, from Europe. The labor also will, to a certain extent, have to be imported and is hard to secure even in Scotland.
Cost of Construction	Should cost *per ton throughput* as little as possible.	Exceeds many times, per ton throughput, the cost of several of other designs of retorts.
Production or Throughput	To secure economy in the cost of the construction of the retort it is imperative that the shale should not require to remain in the retort too long a time. It has been demonstrated that the oil can be educed when the shale is exposed to heat for only one hour.	Very slow throughput. The Scotch retort requires the shale to remain in the retort from twelve to eighteen hours.
Feed Into Retort	Constant	Intermittent
Discharge From Retort	Constant	Intermittent
Application of Heat	Should be arranged so that each and every particle of shale being retorted shall receive identically the like heat treatment.	Shale located next to the walls of the retort is subjected to much higher temperatures and for a much longer time than is the shale located in the center of the retort. To subject the shale in the center of the retort to the required temperatures, the shale located at the sides of the retort must be overheated and burned.
Removal of the Educed Gases	The educed gases should be removed from the retort as soon as educed and in no case should they be subjected to high temperatures.	The educed gases before removal have to be exhausted through the whole length of the retort. It is because of this that steam is required to be used so that the removal of the gases may be accelerated.
Yield of Oil	Should be the economic maximum. It is seldom commercial to secure the maximum.	Claims to recover the economic maximum, but no proofs have ever been advanced that it does so.
Quality of Oil Yield	Should be as high as possible without interference with economic results.	Claims to recover oil of high quality, but no justification has yet been advanced which warrants the presumption that oils of as high quality cannot be educed from the same shales when using other makes of retorts.
Condensation	The condensation of the gases exhausted from the retort should be so arranged that the conditions under which condensation takes place are the same during the night as they are during the day and the same during the coldest day in the winter as they are during the hottest day in the summer. In Canada the difference between minimum winter temperature (that is, more than 32 deg. F. below zero) and the maximum summer temperature (that is, over 95 deg. F.) is over 127 deg. F. While the differences of the temperature in Colorado may not be as great as that experienced in Canada, yet they are much greater than in Scotland.	In Scotland the educed gases are condensed in condensers using atmospheric air condensing. In Scotland the variation of the temperature of this atmosphere is probably within 80 deg. F. Condensers using atmospheric air condensing are also very irregular in their operations, through the constant variations in the strength, humidity and direction of the air currents. With such variation of temperature and of air currents, how is it possible to secure satisfactory condensation?

THE PARALLEL—Continued

	Standard of Perfection	Scotch Retort
Heat Conservation	Should be most carefully considered. The retort should be designed and operated so that perfect heat efficiency and heat conservation can be secured. The retort should be so operated that the forced gases produced will be sufficient to provide the heat required to heat the retorts and also required to produce the power to operate the works. The efficiency possible from the combustion of washed gases is so much higher than the possible efficiency from the combustion of coal that there is no economy in most cases in purchasing coal to use in place of fixed gases.	Heat conservation is almost entirely ignored. The losses—avoidable losses—of heat are very great. The heat efficiency of the gases burned in the combustion chambers of the retort is very low, as is also that of the coal burned under the steam boilers. All the heat contained in the educed gases is lost. As an example of wasting heat, nothing more wasteful can be instanced than the Scotch retort and process.
Area Covered by Works—Cost of Wages	It is an axiom with industrial works planners that the works shall cover as little ground as may be possible providing fire and transportation requirements are considered.	The Scotch works, etc., cover several times the ground area necessary, thereby *increasing the labor and overseeing* charges and increasing largely the cost of pipes.
Durability	The works should be so designed that the cost of repairs, and the loss of operating time consequent to such repairs, shall be reduced to a minimum.	The Scotch works are generally not good examples of works planned so as to require a minimum of repairs, but as each works would require to be criticized separately, it is not possible to particularize.
Regulation and Flexibility	The retort and other machinery should be so constructed that the application of meters, thermometers and pyrometers (plain and recording) and of pressure gages and gas recorders may be possible. Nothing should be left to the personal factor or other "rule-of-thumb" method, as is largely the case in Scotch practice. From first to last the process should be precise and yet capable of variations, as required to retort economically the variations in the quality of shale that from time to time have to be retorted.	In the Scotch retort and process the success of operations is left to the judgment of one or more men who have to rely upon their eyesight, their judgment and their experience. Such a system of operating may be possible but never desirable in locations where operations have been carried on for a long term of years, but such a system would not be economic when operating a new industry located in a new country, nor would it be possible.
Topping	Although topping is not a process that is a part of retorting, yet as topping may be a process that may be required under certain local conditions to be added to retorting, it cannot be ignored. With improved methods of retorting and condensing it is possible to make alterations in the present method and for topping that not only save expense but will produce better fuel oil and a larger yield of gasoline and kerosene.	The Scotch process is governed by their methods of condensing which prevent the employment of certain economical methods of "topping."

To illustrate the objection made to the Scotch retort because its operations are regulated by the human factor, the following anecdote current in dairy farming circles is given.

A certain dairy farm manager, who rightly had a reputation of being a good judge of milking cows (he was Scotch) resented being obliged to weigh the milk given by his herd of cows every night and every morning.

After three months' experience of the proper recording of the milk given by each cow, the expert voluntarily owned up that he had been wrong. He was frank to acknowledge that he had believed he could judge a milch cow and that he knew for certain which of his cows yielded the most milk, but that since the milk had been weighed night and morning he had found out that certain cows he had judged to be his best were not his best and that certain other cows he had esteemed but lightly had shown up to be among his best cows. So much for the human factor. Personal observation and experience are valuable, but the results obtained by the use of the personal factor cannot be compared, for accuracy, with the results of regulation by exact measurements.

In concluding, it is to be hoped that Mr. Gavin will, at first, confine his research work to the determination of essentials and will leave the "frills" for investigation when the difficulties that concern the essentials have been elucidated. His program is a large one, so large that it is important that today's practical problems should first be investigated.

LOUIS SIMPSON.

Ottawa, Ont.

What Shall the Government Do With Its Employees' Inventions?

An Explanation by Dr. Alsberg and Dr. Cottrell of the Conditions in Government Laboratories Which Led to the Drafting of Senate Bill 3,223 Authorizing the Federal Trade Commission to License Patents Granted to Government Employees—Objections Brought Out in Open Discussion

THE following report is a selection of the salient statements made at the meeting at the Chemists' Club, New York, called on Friday evening, Oct. 15, to discuss H.R. 11,984 and S. 3,223, bills for granting the Federal Trade Commission the power to receive assignment, administer and license patents on inventions made by Government employees. The original bill has passed the Senate, and can be brought up in the House on the call for the report of the committee at any time, placed on the calendar, and acted on—passed or turned down entirely or amended; it can be amended in exactly the form it stands as having passed the Senate the second time, and then if it is passed just as it stood in the original measure, it will go to the President, having passed both houses. The Federal Trade Commission was chosen because it was felt that this body was already in a position to handle such matters, while the creation of a new agency would involve duplication of effort.

David Wesson presided and opened the meeting with one of his characteristic bearing-on-the-subject stories. He then drew an analogy between the Government and a corporation, which he noted could not handle its business like the former and survive. He continued:

"Attention has been called to two plans for improving the financial conditions of Government scientists. Perhaps we have not been correctly informed about the details of these plans, but as stockholders in our great United States Government corporation we are very much interested in them. As the matter has been put to your chairman, it would appear there is a proposal on foot to allow scientists in the employ of the Government to have the opportunity of working with the Government's resources and on the Government's time to develop inventions at the expense of the stockholders of this great corporation about which we have just been speaking. It also seems to have been understood that the Government proposes to take out and control patents for the benefit of the employees of this big corporation in which we are all stockholders. If these are the facts, they are certainly very objectionable for various reasons. In the first place, it is well established by decision and precedent under the U. S. patent law that inventions by an employee using information and facilities of the employer belong to the latter. This, of course, would put employees of our great United States corporation in a separate and privileged class.

"Again, the Government employees who are scientists would naturally have privileges which those who are not scientists cannot possess.

"There is no doubt that a law permitting individualization of Government-made inventions would make Government service very attractive and it is possible to conceive that the old saying 'a public office is a private snap' would become truer than ever."

The Problem of Dealing With Government Inventions

BY CARL L. ALSBERG

It has always seemed to me a great pity that so many of the things that are done in the Bureau of Chemistry and in the Government services generally incidental to other work lie unused in the archives of the scientific press or in Government bulletins, and I cast around for a way to make such work really useful to the people of the country. Analyzing the situation from day to day, in the course of years I began to realize that the average research man, in the Government service at any rate—it may be different in the industries—is a rather impractical sort of person.

THE OFFICE OF DEVELOPMENT WORK

It seemed to me that the only thing to do was what was being done very largely in industry, to separate to a certain extent the development and practical application from the research, and for that purpose I grouped together a few young engineers who had been in the service of the bureau for quite a while and who have made good in a great variety of ways during the war, and called them the Office of Development Work. Their job is to take anything that happens to turn up in connection with the research work or other work of the bureau that looks like a useful discovery and that might have some practical application, and in the language of our present secretary, who is an advertising man, sell it to somebody.

It is not proposed, as the press has stated, to take up anybody's invention and develop it, nor is it proposed to do any work for anybody excepting the Bureau of Chemistry's technologists, and possibly for certain other scientists in the Department of Agriculture.

SHOULD CHEMICAL WORK BE CENTRALIZED?

Now, any organization by fundamental sciences—and I take it that Dr. Wesson's suggestion that all the chemical work be grouped together in one organization is a suggestion in that direction—in the Government service, in my judgment, is just as wrong and impossible as the organization of research in a large industrial corporation by fundamental sciences. Congress does not appropriate money to advance human knowledge. If we advance human knowledge in the Government service it is incidental. Congress appropriates money for the solution of certain very definite and practical problems. It may be a problem involving the utilization of waste land, it may be a problem involving the utilization of some waste agricultural product, it may be a problem involving the prevention of disease and the improvement of the public health, but it is always a practical object, and the Congressman sees in terms of practical things.

That being so, the purpose for which money is appropriated by Congress, the objects for which we work being thus, what would happen if you grouped all the chemical work in one place? This would happen: You would expect a mining engineer to send his work, his chemical analyses, to a central laboratory. He does not know who does the work, he cannot be sure that it is going to be done by a first-class man; it might be done by a second-rater. The man who wants the chemistry of a serum studied, or the chemistry of bacteria in connection with the public health problem, has got to send his work to the same place. Fertilizer work has got to go to the same place; paper and pulp and metal and steel; and it has all got to be done without any special reference to the particular object in view.

Government Inventions Are Incidental to Research

You must not go away with the idea that we people in the Government service are at work for the purpose of making inventions. Most of the work that is going on is of two types; it may be research designed to advance the enforcement of some statute, as for example the enforcement of the food and drug act—we are carrying on in the Bureau of Chemistry a great amount of work on methods of analysis of foods and drugs, in order that we may be able to detect sophistications of various kinds. At the same time our people are in constant touch with these industries; they see problems that the industry is not aware exists; they see inefficiencies and wastes that the men in the industry, because they are so close to them, do not see. They may in that way develop processes or inventions that are of benefit to the industry, incidental to their law enforcement work.

There are other inventions that are made which are purely incidental to fundamental research. A man is engaged upon some fundamental research, and incidentally, as a byproduct, develops something of use. And there are inventions that are made in connection with what I call the small industries, industries like farming, canning and making turpentine, which are small and must remain small, must be broadcast over the land; inventions which are absolutely necessary and which would be done by no other agency.

Example of Calcium Arsenate

Take, for instance, the discovery of a new insecticide. I have in mind, for example, the use of calcium arsenate in combating the boll weevil, for it seems that thus we have a means by which the boll weevil may be kept down. Such an invention would certainly never have been made by any manufacturer. In the insecticide and fungicide industries the manufacturers have, and have always—and I can say that with some knowledge, for my father was a manufacturer of insecticides—trailed the agricultural experiment stations and the agricultural colleges.

Now, we took out some patents on calcium arsenate. We applied for a patent for every conceivable method that we could figure could be used to make calcium arsenate, and we did that very deliberately. We did not care whether a patent was granted or not, we wanted to prevent somebody else from getting it, because we did not wish to have repeated the experience with lead arsenate, which was discovered by scientists in the Government and state services as valuable for insecticidal purposes, and the manufacture of which, a rather simple matter, was patented. We wanted to prevent some one coming along and patenting the method of making calcium arsenate, the real discovery not being how to make calcium arsenate—anybody can do that —but the discovery being that calcium arsenate is a valuable insecticide.

Most of the applications were thrown out by the Patent Office, just exactly as we anticipated, but having made the record we don't care. Actually the calcium arsenate is now being made by one of the methods that have been patented under Dr. Haywood's name, and of course everybody is using the method and nobody is paying tribute for the use of the patent.

So that, at least in the Bureau of Chemistry, is the way most of these inventions develop. There is not a deliberate attempt on the part of anybody, or has not been in the past, to invent something; but a man is engaged in some law enforcement work that deals with some industry, he sees an inefficient method or a waste in that industry—and there is an awful lot of it in the food and drug industries—and he has an idea how that inefficiency may be rectified or how that waste may be used. He does some work which leads to an invention; but he is engaged upon fundamental research, and incidentally he runs into something of value.

What Is to Be Done With These Inventions?

For example, one of the chemists in the bureau was interested in the organic chemistry of xylose, and he looked about for a convenient and cheap source of xylose. He found that he could get very easily 15 per cent of xylose calculated on the dry weight of corncobs. He made a little of it, he made the derivatives that he was interested in, and incidental to that work discovered that there were a number of useful things which you could get out of corncobs, such as 3 per cent of acetic acid and 2 per cent of furfural, and 30 or 40 per cent of an adhesive as good as many grades of dextrine. What would you have him do with it?

Explanation of the Bill

By Frederick G. Cottrell

The bill has appealed to the public very largely as a bill to provide compensation for Government employees who may take out patents. It has appealed to the public in many cases as that being its prime object. That is rather a natural way for it to appeal to the public, because the public thinks of patents in general in that personal way, of the effect on the patentee, the inventor; that is, as a means of rewarding the inventor as the sole object of the patent system. I have tried to develop, in what I have said tonight, a sense of the other point of view, that the really important thing, the thing that justifies our patent system today, is not so much the return to the inventor, no matter how laudable that is and how important that is, but the thing that affects the public as a whole with me is the efficiency that the patent system has attained in getting new things through to the general public and reaching a far larger number of people, and more effectively, more powerfully, than it possibly can the small group of inventors. In other words, from a public standpoint the patent system is justified not by what it returns to the inventor primarily, but what it does for the public in getting things through more efficiently, and representing greater progress to society as a whole.

Just so in this bill there is an element of possible reward to the inventor, but the important thing in it, to those of us who had to do with its framing and its carrying through to the present point, is in making more effective the material that is developed primarily in the Government service, in the Government laboratories, bringing that thing through to the public, so that the public at large will stand a better chance of getting material benefit in their everyday life eventually from those discoveries. Incidentally, if we can encourage the workers in the Government service to keener efforts in that regard, and give them a fairer deal in that, so much the better. But of the two points the first one is by far the more important, and I for one should be perfectly willing to see the return to the inventor entirely wiped out of that bill rather than see the other sacrificed, because there are other ways in which that can be done, through recognition in promotion, salary and so on, as it is now. I have looked upon that as a very small incidental to the whole matter.

I was not surprised that that point of view was missed, as I say, because it has been so much the habit of the public to look at the individual effect; the inventor stands up in patent work as an interesting factor, he is always a rather picturesque character which appeals to our emotional side, and is played up in every story of invention; whereas the humdrum working out of the invention in the multitudinous fields of industry and through those channels is a thing that is so generalized that it does not make very good material for the popular writer, and we are not so apt to think; we do not think in generalities quite so much. We think in personal terms much more easily.

Perhaps I might read the bill, with that much introduction, so that you will get the text of it, at this point.

The following shows the text as passed by the Senate March 22, 1920, and as amended by the Senate in Section 10 of H. R. 11,984, June 4, 1920.

Matter in brackets is matter cut out June 4; italicized matter is matter added June 4 by the Senate. When read, by ignoring bracketed matter and reading italicized matter, you have the bill as it will go to conference in December, 1920:

Section 10—That the Federal Trade Commission be, and hereby is, authorized and empowered to accept assignment of, [or license or other rights or powers under, to develop, to issue or refuse to issue licenses under, to encourage the industrial use and application of, and otherwise administer,] on behalf of the United States under such regulations, and in such manner as the President shall prescribe, inventions, patents and patent rights which said commission deems it to the advantage of the public to be so accepted, as these may from time to time be tendered it by employees of the various departments or other establishments of the Government [or by other individuals or agencies;] and to co-operate, as necessity may arise, with scientific or other agencies of the Government in the discharge of the duties herein set out, and the Federal Trade Commission is hereby authorized and empowered to *license and* collect fees and royalties for licensing said inventions, patents and patent rights in such amounts and in such manner as the President shall direct, and shall deposit the same with the Treasurer of the United States; and of the total amount of such fees and royalties so deposited a certain percentum, to be determined by the President, shall be reserved, set aside, and appropriated as a special fund to be disbursed as directed by the President to remunerate inventors for such of their inventions, patents and patent rights contemplated by this section as may prove meritorious and of public benefit; *provided, that nothing herein shall be construed to give said commission or any other governmental agency any authority to engage in the manufacture of any such invention or patented article.*

The Commissioner of Patents is hereby directed to grant all patents and record all assignments and licenses contemplated by this section without the payment of any fee.

You will notice that the Federal Trade Commission is not obliged to accept all that is presented to it. It can simply choose those that are worth while. In that way it can reject and leave out those patents that it thinks can run on their own feet, the things that do not need nursing to go through into the industry.

There is nothing in the bill making it mandatory that any department or any individual shall turn these things (inventions, patents, patent rights) over.

It says various Government departments, "or by other individuals or agencies." That "other individuals or agencies" has been adopted, too, as broadening the scope beyond the Government field; the reason for that being put in in the original bill was to give an opportunity to carry out in this same way the work that is often done between Government departments and private industries, in co-operation.

Legal Side of the Patent Question

The clause "and to co-operate as necessity may arise with scientific or other agencies of the Government in the discharge of the duties herein set out" means simply that it is not intended that the Federal Trade Commission shall go to work and build up, within itself, a great system of scientific bureaus developing new inventions or carrying them on beyond the point. They shall administer simply the legal side of the patent question, the side of the business economics of it. In the Bureau of Mines we are interested, for example, in developing certain technical results. When we get the technical results we want that to go out into the industry. We are willing to follow the technical results and help the industry in the technical details, but we do not want to have to go out also and build up a legal bureau to study the proper relationships of these patent regulations. That is a function directly of the Federal Trade Commission, and there is where we can co-operate to a very great extent to avoid this duplication that we are speaking of.

All Patent Receipts to Be Pooled

The matter of licenses, fees and royalties is a subject that cannot be worked out on the floor of the houses of Congress by general discussion; it is an economic study, it is the same sort of thing that they come to in the bureau matter, of referring that sort of study to a man who can sit down in quiet and study it as a scientific problem, and arrive at scientific methods of distribution. This is intended to indicate clearly that the return to the individual inventor is not necessarily in proportion to the amount of royalty received on that particular patent; the funds from all patent receipts are pooled, you notice. It goes into the general treasury, except for a certain percentum of the whole that is set aside for a reward. The only thing that is determined there, in the early part of the procedure, is what proportion of the total receipts from all the patents is a fair thing to be set aside as a stimulation fund for the inventors, as a recompense for this sort of work.

My own feeling is that the distribution of that particular percentum among those who receive it should be placed in the hands of an entirely separate body from the Federal Trade Commission, and should be disassociated from the body which actually does the business work.

For example, suppose somebody invents or works out and patents a therapeutic serum or other medical preparation, that from the very nature of the case is produced and sold and carried through at a minimum of cost, and reaches a comparatively small number of cases, from which the monetary reward is very small, but the saving of life and the effect on the nation is tremendously important. And alongside of that comes somebody who incidentally invents some little part of a piece of farm machinery, perhaps, in the regular course of his duties in road work or dairying or something of that kind, but that happens to be handy and convenient but of no immense significance, but happens to go into a large manufacturing field, and from the initial license happens to develop a very much larger fund than was expected from that. Fundamental justice in that thing, viewed broadly, would sanction the distribution of the reward between those two inventors, from this general pooled result, in entirely different proportions from the actual returns derived from those particular patents.

Another thing, if you pool them in that way, it takes away largely this feeling of fear that the Government employee will be apparently dominated by a commercial spirit to run after the things that are going to make money.

Discussion

Discussion was opened by R. P. Perry, who spoke in part as follows:

Dr. Cottrell and Dr. Alsberg have outlined in a very interesting way an explanation and some justification of the proposed departure.

One ostensible purpose of this departure is to aid chemical industry by Government co-operation. My own analysis is that it will do just the reverse—that is, it will hurt chemical industry by Government competition.

Our genial speakers have told us that we are mistaking their purposes and misunderstanding their aims. Perhaps so, but it is rather surprising that we who have made chemical industry our life work should not be able to understand a plain proposition even if the somewhat devious ways used in securing authority and appropriations from Congress surround the plan with considerable haze.

Disregarding the very real political difficulties which are bound to develop when the Government enters the commercial field even in a developing or advisory capacity, I make the point that the proposed departure takes the Bureau of Chemistry from its proper sphere of standardizing materials and methods of testing.

Development Work Leads to Manufacture

The first step did not look very far reaching, but see how it led to the next. A Bureau of Chemistry employee patented a process and the bureau consented to license manufacturers to use the process, as to which license I will say a word in a few moments. They found that a laboratory process did not get very far, and so it is now proposed to have a small experimental plant and an engineering force. They will next find, as we in industry know, that small experimental plants do not go very far and they will want a larger scale operation. This will inevitably produce material in commercial quantities, and may be expected to lead to sales of the products to other Government departments, and perhaps to the public in competition with private manufacture, and the proceeds used to extend the work.

Such a development of semi-commercial or commercial manufacture may also be expected if the bureau finds, under the necessary surrounding conditions, that chemical concerns are loath or slow to co-operate on the Government terms, and the bureau may then feel itself driven to save the industry against itself by not only showing how it can be done but also doing it—at the taxpayer's expense, including of course the chemical industry's tax contribution. Mark, too, that the public notes say, naïvely, that "for the present the work will be confined to discoveries made in the Bureau of Chemistry." A later logical step would be to extend the work to many other lines.

It seems to me clear that by this departure the Government will lose its position of impartial judge and compete with business. Being supported by the taxpayers, it will compete on an unfair basis, and, wishing appropriations from Congress, it may be led to show or attempt to show fictitious profits.

The Case of Phthalic Anhydride

Speaking of fictitious profits, CHEMICAL & METALLURGICAL ENGINEERING of Oct. 6 quotes from a recent address of the Secretary of Agriculture, telling of the large savings to American industry due to a single discovery in the Color Laboratory, "the catalytic oxidation of naphthalene to phthalic anhydride," which it is stated results in a saving of $700,000 per year compared to the old German process. We in the industry have tried to figure this saving of $700,000 per year, but cannot come within a mile of it, but that is not the whole story.

I do not wish in the least to detract from the work of Dr. Gibbs and the Color Laboratory in discovering this process, but it is not a fair statement to set out this process and the alleged saving as a justification of the proposed line of development work. It may interest some of you to know that two other parties apparently made the same discovery considerably before publication of the Bureau of Chemistry results, one a German of the Badische company and the other in our own laboratory. This important process would not have been lost to the United States if it had not been for the work of the Color Laboratory. Do not misunderstand me. I do not wish to belittle in the least their work, but I do say private industry was on the trail and found the same process about the same time.

Difficulty of Licensing Patents

And this phthalic case brings up another point which shows the difficulties bound to develop when the Government tries to go into the licensing of patents. It endeavored, undoubtedly in good faith, to develop a fair license to secure the co-operation of private companies in manufacturing phthalic, and offered a form of license to us. The form which I have here is too long to analyze in detail, but it contains, among other things, a provision which requires any concern taking a license to turn back to the Department of Agriculture, and indirectly to the public, any new and patentable process developed during the course of the co-operative work. We criticised this clause as being manifestly unfair, and although two new editions of the license form have later been submitted to us this clause remains the same; and yet it appears that in one case at least the department waived this clause to another concern without notifying us of its change of base. A slip, you may say, but it is a very bad thing for the Gov-

ernment to slip when setting out to deal with the public on one uniform set of terms.

There are many other objections to specific features of the plan, but I have already taken more time than I would wish and will gladly leave it to others to develop the subject further. I do hope that all will grasp the significance of the proposed departure and what it will logically lead to—the Government in competition with private industry. I know industry does not want it and I do not believe the American chemists, or the American people, want it.

E. A. Sperry said: "I think that any such proposition will grow on and on in point of socialistic control, which I very much hate to see advanced in the slightest. I hope it will die in committee good and dead, I am sure."

Mr. Husted, Dr. Weston, Mr. Deppe and Dr. H. E. Howe also joined in the discussion.

Reply by Dr. Cottrell

In replying Dr. Cottrell said in part:

I do still feel that work of this kind has a distinctly constructive point of view, and the big things that I should hope would gradually come out of this bill--not immediately, but in the long run—would be a careful study and clarification of the whole patent administration, from a bigger and broader standpoint than perhaps it has been approached from today.

I do not feel that the knowledge or the judgment, in the application of these matters, of those who have it in charge, those who are working with the problem now, is by any means infallible. We are learning as we go along.

This whole bill was framed as carefully as we knew how to frame it, as an enabling rather than a mandatory act, so that those mistakes would correct themselves as rapidly as possible, and as much pressure could be brought from the outside in trimming up and working with that as possible. If there is any way that that can be put into safer and more guarded terms I hope you will work with us.

I am glad that one of the speakers brought out, or suggested, a point that I forgot, or at least a point that should be mentioned, as one of the dangers not only in this bill but in connection with Government work in general. That is the research bureau's tendency to work in too close to what we may call the normal advancing front of industry, a tendency that is very naturally human, to look for credit and the easiest credit, to try, sometimes unconsciously, to reach for the thing that is just going over the hill, it is just going to succeed, and grab it before it goes over and let it tow you through. That is a tendency that we have got to fight all the time, and we have got to rely on the people of bigger vision to try to inspire that sentiment in the worker.

Somebody spoke of this bill authorizing the Government employee, in getting in and co-operating with the industry, to take the results of what he found in industry and come out and patent it in the Government service. I fail to see, frankly, just how that applies to the concerns that we are working with in our Government work. We find where we have worked with them pretty closely that there is a certain large group of patents that they are quite willing to co-operate with us on. There are certain others that they do not want to co-operate with us on, and very properly so. Now this bill is not intended necessarily to apply to every patent that is ever taken out or that might be taken out. You have got to realize that no piece of legislation of this kind is universally applicable. There is another reason why we made it simply a permissive measure; where the thing fits in and will help to forward an industry, everybody has a chance to set down and work that out. If somebody wants to co-operate with a Government agency in doing this work, in some such form as this, quite well and good. If they do not want to, there is no reason for bearing down. Yet it is the permissive feature of the legislation that I would like to emphasize. It is a question for experimental work. It gives us a chance to try the thing out and determine in actual practice what is possible.

Reply by Dr. Alsberg

Several important points were brought out in Dr. Alsberg's reply.

If we have some men at work on fundamental problems and if they are any good they are going to get things that will have commercial value, and you cannot stop them. What will we do with those things? Publish them? Patent them and forget them? Patent them and endeavor to have them used? And what is the machinery that should be devised to have them used?

I quite agree with those who have said that we should not turn the Government into a machine for doing industrial research, but I believe firmly that too much fundamental research cannot be done, and that there cannot be too many places in which fundamental research can be done. The industries do not do it. Tell me, how many chemical concerns in the United States have done fundamental research that has been published for the benefit of scientists generally? You can count them on the fingers of one hand. There are such places; there has been some wonderful work done in two or three; but that is all there are. The fundamental research, the research that makes new industries possible, real progress possible, is not being done in the industries themselves, and it should not be done there, as a rule. It is being done in universities, it is being done occasionally in the Government service, in this and in other countries.

Further Discussion by Dr. Cottrell

In conclusion, Dr. Cottrell added a few points which he felt had not been made sufficiently clear.

It is recognized that on those things that are natural monopolies you have got to figure for control, and work it out as a public service matter. There are not a great many patents, I grant you that, that meet that condition; that need this regulation, need that application of this law. There is a great deal of material that can be handled just as we do now, by publication without patenting, or we may go a step further and use our present method of patenting and dedicating it to the public, where we know that the thing fits into industry so well, without any further or any new risk of capital, that all you need to do is to get it well on the market, and see that there is no monopoly, and everybody will go ahead and use it. But there are a great many things that need a certain degree of protection in order to carry them through the first stage, and this bill is primarily to work upon that material. Now if it is too broad, if there is danger of other things, let us try to define that and try to educate the people up in administering to that.

American Iron and Steel Institute

Account of the Eighteenth General Meeting Held Oct. 22, 1920, With a Review of the Technical Papers Presented—Blast Furnace, Basic Open Hearth, Residual Manganese, Copper Steel and Alloys for Automobile Construction Were Discussed

JUDGE GARY addressed the usual large assemblage of men interested in iron and steel, at the eighteenth General Meeting of the American Iron and Steel Institute, held in New York City, Oct. 22. The greatest part of his address covered an account of a recent trip through Belgium, France and Spain. After paying a glowing tribute to the American soldier and his effective aid in ending the war, prompted by a pilgrimage in the path of the American Army, Mr. Gary gave his impression of the industrial outlook in France and Belgium. Generally speaking, he said, the people there were extremely industrious, grimly determined and making good progress toward rehabilitation, indeed much better than one would expect, despite the fact that from one-half to two-thirds of their young men are gone, victims of German kultur.

Then passing briefly to the business outlook in America, Judge Gary said that as far as he could see there were no clouds in the sky at the present time nor were there any dangerous storms to be predicted in the near future. The decreasing volume of sales and lowering of selling price he regarded as an extremely good indication, inasmuch as nearly every line has been up to now unable to supply the demands for its product. Prices in general are outrageously high, especially as regards middlemen and some classes of employees. Mr. Gary, however, made it very plain that this statement should not apply to the wages paid to the average workman. Consequently, in his opinion, the average of the general scale of prices ought to be reduced, and the present tendency is toward a lower basis, notwithstanding the fact that every individual is willing for all others, besides himself, to make large reductions in their asking price.

Recent Developments in the Iron and Steel Industry in India

C. P. Perin discussed "Recent Developments in the Iron and Steel Industry in India." In ancient times India produced a considerable quantity of extremely high-grade iron and steel products, but until within very recent years no modern developments for commercial output of these products have been successful. About fifty years ago a steel plant was erected in Bengal, which at the present time is operated by the Bengal Iron & Steel Co. Its steel plant and rolling mill have been down for several years, but the company is making cast-iron pipe and track chairs with the product of four 80-ton blast furnaces.

About fifteen years ago some Indian capitalists headed by Mr. Tata became interested in the possibility of developing an Indian iron industry and instituted a survey to determine just what the country's resources were. Extraordinary quantities of the highest grade iron ore have since then been located. Over 20,000,000,000 tons of iron ore has now been located with a fair degree of probability, within an average of about 150 miles of the coal regions. Unfortunately, however, coal has not been located in sufficient quantity to smelt nearly this amount of iron, coking coal being especially rare, only 2,000,000,000 tons of this having been found.

The coals are low in sulphur but high in phosphorus and ash, the best coals running 12 per cent of ash and this ash analyzing 1 per cent of phosphorus. At the present time, for instance, the Tata Works are using Coppe non-recovery ovens, the coke running from 17 to 20 per cent ash—a fuel which would not be looked upon with favor in America. However, a reasonable blast-furnace production is possible on account of the extremely high grade of iron ore, it containing little or no silica. The plant comprises two blast furnaces which were expected to produce 250 tons of iron per day, but actually are turning out 375 tons. The company has also constructed four 40-ton open-hearth furnaces, a combined railroad and structural mill, and several merchant bar mills. This plant was operating successfully in 1913, after several years of construction and preliminary operation.

A company called the Indian Iron & Steel Co. has two modern blast furnaces under construction. Its ore deposit contains 100,000,000 tons of 65 per cent ore. There are also two other iron companies in the formative stage at the present time. In view of the astounding reserves of exellent iron ore and cheap labor, available at from 20c. to 30c. per day, there seems little reason to doubt that within the next decade India will be able to export iron and steel products to many parts of the world.

The Basic Open-Hearth Process

"The Basic Open-Hearth Process" was discussed by F. L. Toy, superintendent of the open-hearth department of the Homestead Works, Munhall, Pa. Mr. Toy's paper was a general discussion of the furnace and its construction from an operating standpoint, and a consideration as to whether it could not be largely improved from both a mechanical and a metallurgical standpoint. It was pointed out by the author and others speaking afterward that the present construction is far from efficient; and is largely the evolution of years of experience. Changes have been slow, in a few cases the result of engineering analysis, but in the great majority of cases as a result of "cut and try," consequently the final result is due more to the operator than to the engineer.

An approximate heat balance of a modern open-hearth furnace is as follows:

	Per Cent
In the melted metal	14.0
In molten slag	3.3
Absorbed in reduction and other chemical reactions	2.8
Radiation loss	17.3
Going to the checkers	62.5

This gives a net over-all efficiency of slightly over

20 per cent. Of the 62.5 per cent heat going to the regenerators, 4.5 per cent is lost between the checkers and stack, while 34 per cent goes up the stack.

Efficiency in regenerators as ordinarily constructed is much lower than the thermal efficiency of blast-furnace stoves, ranging from 20 to 38 per cent. Extremely low efficiency in checker work may be expected where the furnace layout is built to fit a site rather than vice versa. Mr. Toy was understood to advocate a change in regenerator design to approximate that of a blast-furnace stove, but some of his critics took sharp issue with him, holding that the extreme high temperature and dust content of the gas entering the open-hearth checker work presented so much more severe conditions that a blast-furnace stove would need to be modified to a point where it could hardly be recognized.

Residual Manganese

A comprehensive discussion of the use of high-manganese iron in basic open-hearth practice was given by E. A. Wheaton, superintendent of the open-hearth department, Bethlehem Steel Co. The whole discussion revolved about the greatest problem now before the American steel maker—namely, a sufficient supply of low-sulphur fuel. Mr. Wheaton's contention was that iron high in managanese could come from the blast furnace high in sulphur and yet produce open-hearth steel containing residual manganese, low sulphur and oxygen, and excellent in quality. Bethlehem Steel Co.., in an effort to solve the sulphur problem, operated its No. 3 open-hearth for several months on material which must undergo the severest inspection, and records for this furnace have furnished information for Mr. Wheaton's paper.

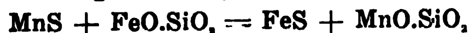
TABLE I. LOSS IN SULPHUR BETWEEN BLAST FURNACE AND OPEN HEARTH

No. of Tests	Average Mn at Blast Furnace	Average S at Blast Furnace	Average S at Open-Hearth	Per Cent Loss in S
21*	1.39	0.09	0.04	53
89	1.72	0.07	0.035	50
26	2.13	0.07	0.031	57

*Contains a number of high-sulphur casts. Low manganese must be held longer in the ladle to effect desulphurization.

When a blast furnace works on an ore which will furnish hot metal containing 2 per cent manganese, sulphur may run as high as 0.1 in the pig iron without danger. This means that lean slags may be run with a correspondingly low coke ratio, which in itself is a considerable advantage. High manganese causes an elimination of at least one-half such sulphur during the 80 min. the hot metal is en route from blast furnace to open hearth. Figures covering over 100 tests are accumulated in Table I.

Silicon must be low, below 1 per cent, for this elimination of sulphur, since apparently in high-silicon irons manganese sulphide reacts with $FeO.SiO_2$



$$MnS + FeO.SiO_2 = FeS + MnO.SiO_2$$

If $SiO_2:MnO = 0.8$ in the mixer slag, good removal of S in the mixer will occur; in these tests it averaged 0.006 per cent.

Open-hearth operators are opposed to high-manganese charges on the ground that they decrease the tonnage of the furnace, decrease the percentage of ingot production, and badly scorify the furnace banks and the ladle linings. Experience at the Bethlehem plant seems to controvert all of these contentions. Since August, 1920, No. 3 furnace (50-ton capacity) was able to tap 70 tons of alloy ingots at an average time of ten hours and fifteen minutes, the shortest on record. During this time the slags were notably easy to work. Ingot yields were found to be very good if no run-off slag was used. Iron oxide in the slag will average around 9 per cent with high-manganese pig and from 15 to 20 per cent with low-manganese pig. Several months' experience with this furnace shows that scorification is not severe. A bottom delay of eleven minutes per heat was recorded. As for ladle linings it was possible to get eighteen heats per ladle, using one of ninety tons capacity and teeming through a 1½-in. nozzle.

In discussing the action of sulphur on finished steel Mr. Wheaton pointed out that all metallurgists agree that both sulphur and oxygen give much trouble in subsequent working, and then proceeded to argue that residual manganese reduces both of these harmful elements. A steel bath has a tendency to absorb sulphur from a furnace atmosphere in the following manner: Sulphur in the fuel is distilled as such in the gas-producer or burns to oxide. At any rate, the gas when burning in the furnace produces a considerable quantity of SO_2, a little of which may be further oxidized to SO_3. The latter gas coming in contact with the slag forms calcium sulphate with the free lime, and this salt later comes in immediate contact with hot iron, is reduced by the metal, and iron sulphide eventually absorbed. The reaction is



$$CaSO_4 + 4Fe = FeS + CaO + 3FeO$$

Manganese sulphide appears to be soluble both in the slag and the metal and manganese in the bath acts as a continual carrier of sulphur from metal to the atmosphere. Table II shows results from about 200 heats, and on the whole shows that final sulphur in the metal decreases as the residual manganese increases, and also that the elimination of sulphur in the practice under consideration varies directly with the amount of manganese in the charge and the residual manganese in the metal.

TABLE II. RELATION OF RESIDUAL MANGANESE AND SULPHUR

No. of Heats	Mn in Charge	Residual Manganese	S in Charge	Final S
40	0.75 to 1.00	0.15	0.052	0.046
40	1 to 1.5	0.22	0.053	0.043
40	1.5 to 2	0.26	0.055	0.041
40	2 to 2.5	0.38	0.061	0.038
15*	0.66	0.17	0.034†	0.038
15	2.35	0.28	0.039†	0.029

* Nickel-bearing scrap used.
† In pig only.

Unfortunately we have no method of analyzing steel for oxygen, but it is generally considered that under certain circumstances iron takes up so much oxygen that the combined action of such deoxidizers as carbon, phosphorus and silicon cannot eliminate it all.

Red-shortness probably results when oxygen combined with iron is as low as 0.01, while five times as much makes metal unusable. Red-shortness is apparently reduced by manganese; the iron oxide is perhaps not removed, but its bad effects are certainly neutralized. A residual manganese of 0.40 has been found very effective in this respect. Table III shows metal and

TABLE III METAL AND SLAG ANALYSES FOR TYPICAL HEAT

Tests	Slag Analysis FeO	Slag Analysis MnO	Mn in Metal
1:00 p.m.	19.95	10.06	0.26
1:30	11.09	12.64	0.22
2:00	9.46	9.68	0.32
2:30 tap	9.20	9.93	0.32

slag analyses for one of Mr. Wheaton's typical heats. He holds it to be almost self-evident that a heat which for more than two hours contained an increasing quantity of manganese in the metal certainly cannot be suffering from an overdose of oxygen.

Observations of ingot from this furnace during their passage through the rolling mills showed much less tearing while blooming, and the billets required one-third less chipping for surface defects. Total yield equaled 103 per cent of comparative low-manganese rollings.

Corrosion Resistance of Copper Steel

D. M. Buck presented "A Review of the Development of Copper Steel," in which he cited a long list of investigations, made since 1900 both in the laboratory and under service conditions, showing that normal open-hearth steel is corroded at a much higher rate than when it contains 0.15 to 0.30 per cent pure copper.

Storey[1] investigated a large number of samples of fence wire which had been in actual service for varying lengths of time, comparing the analytical results with the history and length of life of the wires, and from this very carefully conducted piece of work states: "It has been definitely established that the durability of old steel fence wire is due to the presence of copper. Hoyt[2] in 1919, from an extensive series of careful experiments states: "The general conclusion which, it is believed, may be drawn from this exposure test is that the so-called copper-bearing steel, in which the copper content is about 0.20 to 0.25 per cent, offers the greatest resistance to corrosion of the common sheeting materials." The *Railway Age* for July 23, 1920, describes a series of tests conducted by the New York Central Lines on the influence of copper in the reduction of corrosion of steel tie plates. Standard steel tie plates showed approximately eight to ten times the loss as for the special copper treated ones. As a result of these experiments the New York Central has placed an order for 650,000 tie plates, or 4,000 tons, to be rolled according to the railway's standard specifications, with the addition of 0.25 per cent of copper.

The author also makes brief allusion to the results of tests by the American Society for Testing Materials.[3]

"At the inland industrial location, out of 146 sheets of 22-gage copper-bearing materials (0.15 per cent copper or over), forty-one sheets, or about 28 per cent, had failed after forty-one months exposure, while out of eighty-four non-copper-bearing sheets eighty-one, or 97 per cent, had failed after forty-one months exposure.

"With this overwhelming mass of evidence, we may consider it as proved that by alloying a small copper content (0.15 to 0.25 per cent) with normal open-hearth or bessemer steel the corrosion rate is enormously reduced wherever the products are exposed to alternate attack of air and moisture, which conditions prevail in practically all characters of atmosphere. It is certainly very conservative to estimate that the life of sheet metal is doubled by this treatment.

"The manufacture of copper steel has heretofore been largely confined to sheet metal, and the product has been tremendously improved. The usefulness of this discovery may readily be broadened by the use of copper in other steel and iron sections, and their life thereby greatly increased. To mention a single example, steel freight cars, especially those of the open type, suffer greatly from corrosion. If the life of the thousands of such cars that have passed out of the field of usefulness during the past few years could have been increased only 20 to 25 per cent, the result would have gone far toward relieving the severe car shortage which has recently existed." Several hopper-bottom and gondola cars were made six years ago for the Bessemer & Lake Erie Ry., one-half the sheathing of each being ordinary plates and the other half of copper-bearing steel. Recent inspection shows much better paint adherence, and less than half the loss due to corrosion and abrasion.

"We have a simple, easily controlled, and comparatively inexpensive method of improving all of our products that are called upon to resist the attack of air and moisture, thus greatly increasing their period of service and at the same time effecting an immeasurably important step in the conservation of our natural resources."

[1]O. W. Storey, "The Corrosion of Fence Wire." *Proceedings* Am. Electrochem. Soc., 1917.

[2]S. M. Hoyt, "Exposure Tests of Sheeting Materials." Chem. & Met. Eng., Aug. 1, 1919.

[3]Chem. & Met. Eng., vol. 22, p. 1189, June 30, 1920.

Alloy Steels for Automobiles

Discussion of the proper heat treatment for automobile steels was presented by R. R. Abbott of the Peerless Motor Car Co., Cleveland, Ohio. In view of the fact that a great deal of research on many different lines had failed to produce an alloy steel markedly superior to any of those which have been known and manufactured for several years past, it appears that the art of manufacturing alloy steels for high strength is quite well established. On the other hand, not nearly so much is known about the correct methods of heat treatment.

Eventually, it will be possible to calculate critical temperatures, merely by knowing the chemical composition. At the present time a few laboratories do this for some of the steels which they control in great quantity and which do not vary much in percentage of the principal alloying elements.

Mr. Abbott was under the impression that no one alloy was superior to all the others now on the market. Consequently, he was of the opinion that personal preference of the user was largely responsible for his choice. Personal preference, of course, is based upon certain facts, and in this case they may be grouped together in two classes: First, the user may have been purchasing a certain brand or analysis of steel for many years and have found it to give him consistently good results, consequently he will swear by that particular alloy. Second, not all heat-treating departments are as well equipped with scientific information as they should be, and consequently they do not vary the heat treatments corresponding to different steels. Consequently one steel matches best the common heat treatments and that particular steel is the one which they like.

Future progress may be looked for by refinements in heat treating even more than in the introduction of new alloy combinations. To support this statement the author has cited the tremendous amount of research work which went on during the war to produce light armor plates of better quality than that specified during pre-war times. After doing a large amount of work on extremely complex alloys, just at the end of the war it was discovered that a very simple and old-fashioned 3½ per cent nickel steel after a suitable but simple heat treatment was far better than anything which had been produced up to that time.

An Improved Greaves-Etchells Electric Furnace Installation

A Description of the Greaves-Etchells Electric Furnace and of the Arrangement of the Electrical Equipment as Installed at the Plant of the Halcomb Steel Co. —Records of Operation

BY EDWARD T. MOORE

DURING September, 1918, the Halcomb Steel Co. placed in operation two 3-ton Greaves-Etchells electric furnaces, constructed and supplied by the Electric Furnace Construction Co., of Philadelphia, which were the first 3-ton furnaces of this type to be started up in this country.

These furnaces are used exclusively for the manufacture of alloy and high-speed steels, and therefore much attention was given to details of design, as operating conditions are much more severe in the refining of high-grade steels. In passing, it might be remarked that this company was the pioneer in the manufacture of electric furnace steels, having installed the first electric furnace in this country in 1906, this original furnace being still in daily operation.

Some years ago H. A. Greaves in collaboration with Harry Etchells realized that in the first place independent regulation of the electrodes was desirable. Secondly, that whenever a short circuit occurred on one arc of an electrode, the surge should be distributed if possible over all the primary supply phases. Thirdly, means should be taken to check short circuits and surges without impairing the permanent power factor of the furnace by introducing extra reactance.

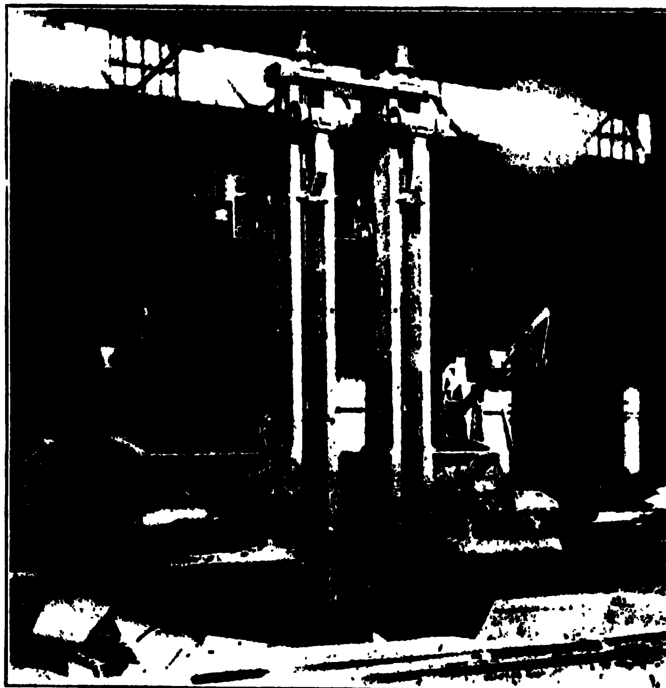


FIG. 2 ARRANGEMENT FOR HANDLING THE ELECTRODE HOLDERS



FIG. 1. A GREAVES-ETCHELLS ELECTRIC FURNACE

To fulfill the first two conditions they decided that the furnace must have a conductive hearth, but to assist in fulfilling the third requirement they decided that this hearth should have a certain degree of electrical resistance and should thus act as a resistance check on short circuits. If they could have made the ohmic value of this hearth resistance equal to that of one arc gap, all would be simple and they could have used a three-phase system with two phases applied through separate suspended upper electrodes and one phase applied to the hearth of the furnace. Such a scheme was impracticable for many reasons, but they succeeded in elaborating something which at first sight appears very similar.

In effect three transformer windings are used, the three primary windings being connected in "delta" to the three phases of primary supply.

The secondary windings are connected in "star," two legs being connected to the two upper electrodes and the third leg to the hearth. The third leg, however, which is connected to the hearth, maintains a lower voltage than either of the other two—for instance, the lower leg maintains approximately 27 volts, while each of the upper legs of the "star" transforms to 60 volts. We believe this latter voltage has been standardized at 65 volts. For refining voltage the values are 22 and 45.



FIG. 3. ARRANGEMENT FOR TILTING

The resistance between the two upper electrodes will be equal to that of two arcs, and the resistance between either upper electrode and the lower electrode will be equal to that of one arc, plus the resistance of the hearth; so that, in order that the system may be balanced, the resistance of the hearth must be equal to that of one arc to bring the total resistance to that of two arcs, and this results in nearly one-third of the energy being distributed by the hearth. Now a basic hearth is a conductor of the second class, and the resistance decreases as a function of the rise in temperature. The resistance of the bottom material near the hearth surface is made very high, but decreases rapidly toward the bottom of the lining, so that the heat generated in the hearth, through its resistance, is principally toward the top, which is in nearer contact with the steel. In proof of this theory, the temperature of the bottom of the furnace shell and the copper electrode in contact with it is such that the hand may be held comfortably in contact with them. This bottom source of heat undoubtedly assists in the circulation of the bath and accounts for the rapid deoxidation of the metal. This circulation has a still more important function in making alloy steels where rapid assimilation of the alloys and a homogeneous bath are very essential.

Description of the Greaves-Etchells Furnace

In general, the furnace is composed of a rugged rectangular boiler plate shell of $\frac{3}{4}$ in. thickness mounted upon rockers which roll upon a toothed guide bolted to the concrete foundation (Fig. 1). Rising vertically from the furnace shell, and securely riveted at their lower ends to the shell, are four 10-in. channels. The tops of these channels are tied together with two 3-in. angle irons (Fig. 2). These channels serve as a support for two electrode holders and for two worm shafts which are used to raise and lower the electrode holders (Fig. 1). Two $2\frac{3}{4}$-hp., d.c. motors, totally inclosed, furnish the motive power for raising and lowering the electrodes.

The method of tilting, Figs. 1 and 2, is by the balanced rocker type first adopted by the Electric Furnace Construction Co. for this installation, with the object of requiring a minimum effort to tilt the furnace, while the furnace remain safe in any position, accomplished by having the center of radius of the rockers always above but very close to the center of gravity of the furnace in any position, thereby avoiding the excessive effort and heavy structure of the fulcrum type. A 5-hp., three-phase, twenty-five-cycle, 220-volt, slip ring motor situated in a pit remote from the furnace through suitable gearing and a long bronze nut operates an Acme threaded screw, which being fastened to one end of the furnace tilts it through an angle—for normal operation—of 30 deg. forward for teeming and 15 deg. backward for slagging. The tilting screw lies in an oil bath for ideal lubrication and freedom from dirt. The controller for operating the tilting motor is located on a pulpit (Fig. 3) on the melting floor. Automatic limit switches limit the travel of the furnace in both directions, but should special occasion arise, the forward tilt may be exceeded by raising the limit switch.

The electrode holders (Fig. 1) each have a carriage provided with four flanged wheels which roll on the edge of the upright channels and also four pins which slide thereon.

Electrodes of amorphous carbon 14 in. diameter are held into the holders by a series of twenty-eight copper blocks which extend around the electrode, and outside of these blocks are wrapped two thicknesses of 6 x $\frac{1}{4}$-in. copper bus with their ends bolted to the main conducting bus. Outside the copper bus is placed a flexible supporting chain so arranged that it can be tightened by a draw bolt, thus pressing the copper bus and blocks, and clamping the electrode into position.

A new type of cooling ring has recently been added to the furnace which cools the gases escaping from the furnace between the roof ring and the electrode. The

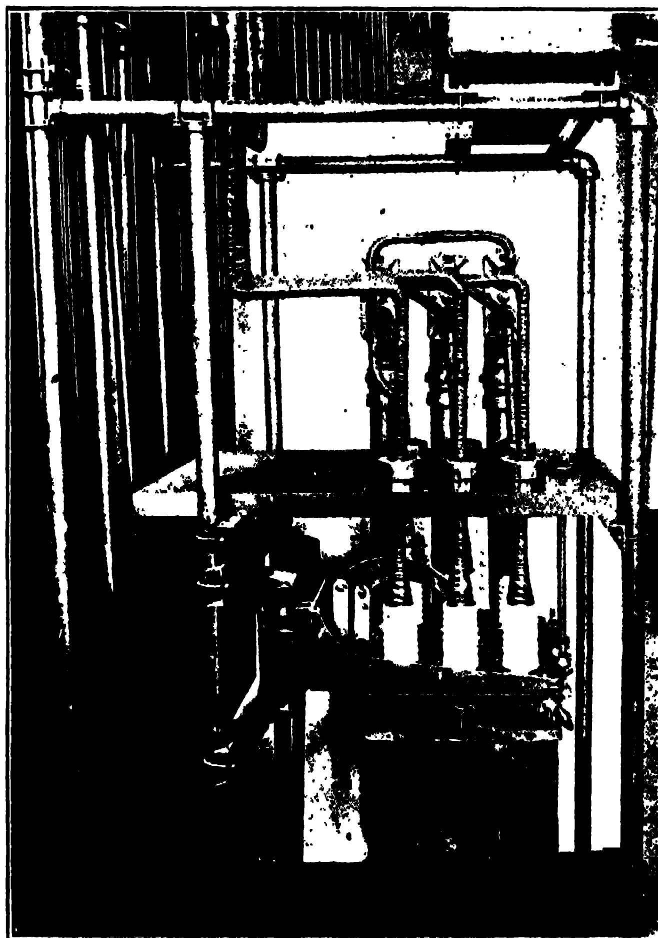


FIG. 4. TRANSFORMER, DELTA CONNECTIONS

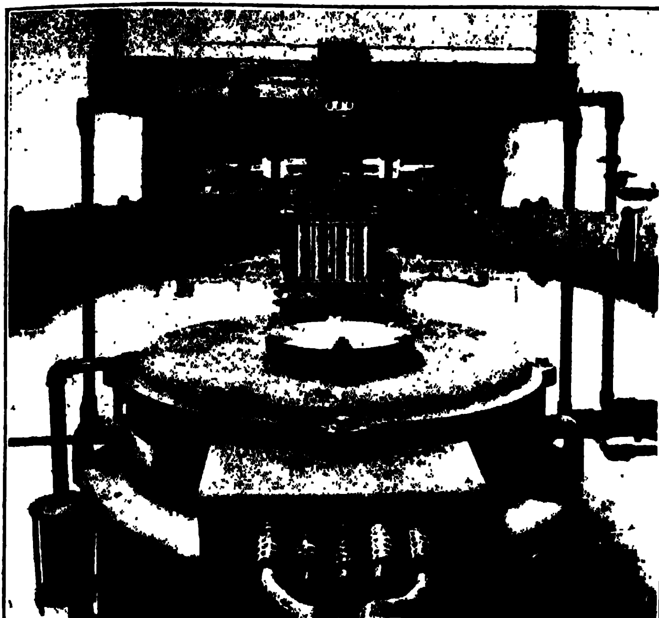


FIG. 5. TRANSFORMER, STAR CONNECTIONS

gases generated in an electric furnace during operation are combustible only at high temperatures and nearly all the present-day cooling rings have for their principal object the cooling of the electrode and the port holes of the roof, which means that if these gases escape to the atmosphere, they are hot enough to burn and in doing so burn up part of the electrode itself, also having a very objectionable effect on the electrode holder.

In this new cooling ring, the roof port holes are kept cool, also the electrode, and still further the gases leaving the furnace are cooled to a temperature at which they will no longer burn when they meet the oxygen of the atmosphere.

The furnace is equipped with separate teeming and slagging spouts.

Linings of the Furnace

As previously mentioned, the hearth lining is especially graded as to resistance and composed of approximately equal quantities of magnesite and "syndolag" mixed with pitch and tamped into a thickness of 22 in. at the bottom. The bottom is burned in by starting a coke fire and gradually bringing up the temperature over a period of thirty-six hours. This method produces a firm bottom, which is necessary when the hearth is used as a resistor. The brick portion of the original bottom of one furnace—that is, the brick lining immediately above the furnace shell—is still in service after having supported 1,047 heats and when the furnace was last relined with the magnesite and "syndolag" an inspection of the brick work revealed a satisfactorily working bottom.

For the very high grade of steels made we insist upon our furnace linings being in perfect condition and for this reason we have made a practice of repairing or renewing the top layers of magnesite-syndolag about once a month, which is approximately after 100 to 115 heats.

The side walls are composed of chrome brick from the hearth to well above the slag line and from this point to the roof with silica brick. The roof is also built of silica brick. In order to permit as near perfect metallurgical conditions as possible the roofs are also changed about every sixty-five heats.

As shown in Fig. 3 the electrical equipment is mounted in a separate building, but adjacent to the furnaces. The primary power used is 11 kv., three-phase, twenty-five-cycle, and is brought to the furnace substation in a No. 0000 B. & S. gage, three-conductor, paper-insulated, lead-incased cable placed in a subway. This cable is terminated in a pothead in the sub-station at a three pole double throw disconnecting switch, and then carried to a 300-amp., Type K-12 oil circuit breaker equipped with inverse time limit overload relays. From the main breaker the three conductor cable is No. 0000 B. & S. gage, varnished cambric, lead-incased and placed in a 3 in. sherardized conduit, the cable terminating at the top stud of two sets of three pole disconnecting switches mounted on the wall, 17 ft. from the floor. From each set of disconnects a No. 00 B. & S. gage, three-conductor, varnished cambric, lead-incased cable in 3 in. sherardized conduit extends to each of the furnace oil circuit breakers, 300-amp., Type K-12, equipped with inverse time limit overload relays and set to trip on 900 kw. load in fifteen seconds. From each furnace breaker a No. 2 B. & S. gage, three-conductor, varnished cambric, lead-incased cable in 3 in. sherardized conduit extends to the transformers. All cables are terminated in potheads.

Each bank of three single phase transformers is composed of two 300 kva. and one 200 kva. transformers, manufactured by the General Electric Co., and they are of the self-cooled circular coil, core type. On account of the resistive bottom serving as a current-carrying medium, which adds additional resistance in one phase, the transformer which is connected to the bottom is of smaller capacity than are those connected to the electrodes. The load in all phases on the primary side is balanced except for a short time when baking in a new bottom.

The transformers are connected in delta on the high tension side and Fig. 4 shows this connection using potheads and solderless connectors. The secondary side is "star" connected (Fig. 5) so that a load on any phase will be borne by two transformers. The units are built for 150 per cent load for one-half hour and 200 per cent load for five minutes.

The 300 kva. units have a secondary voltage of 60 for melting and 45 volts for refining and the 200 kva. units have 27 volts and 22 volts respectively; additional

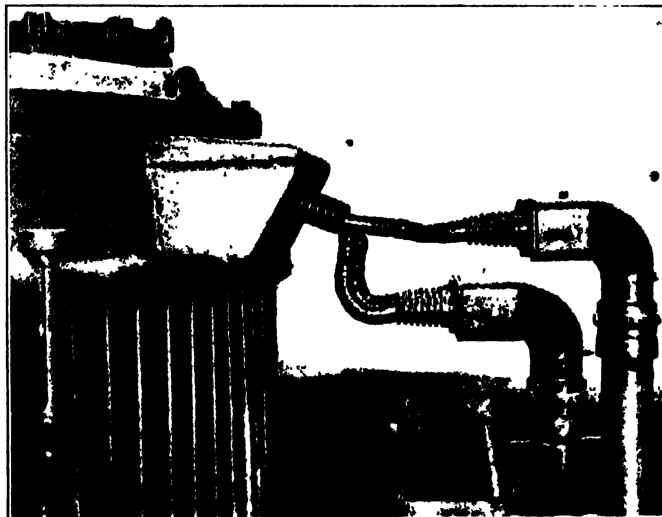


FIG. 6. TRANSFORMER EQUIPPED WITH "SAFETY FIRST" HIGH-TENSION CONDUCTORS

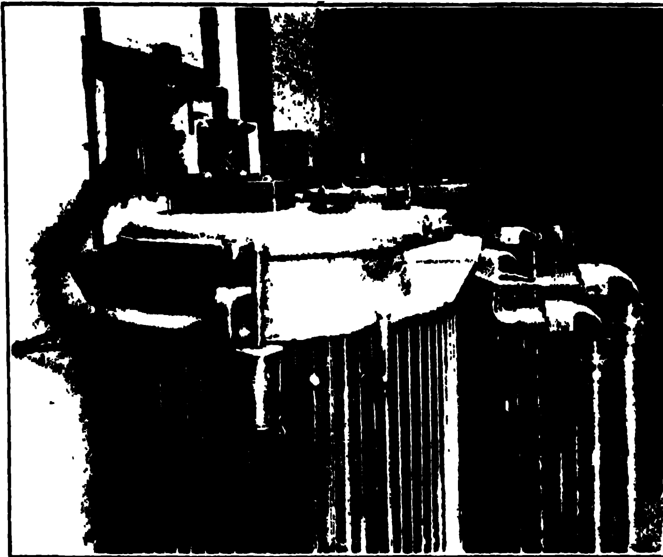


FIG. 7. A BATTERY OF TRANSFORMERS EQUIPPED WITH "SAFETY FIRST" HIGH TENSION CONDUCTORS

full capacity taps are installed to change the above voltage values as required. This lower voltage increases the useful life of the refractories, especially of the roof, 15 to 20 per cent. The lower voltage during refining gives especially a greater length of life to the roof, since the electrodes shield a shorter arc and protect the brickwork above. Additional taps are provided so that a wide selection of voltages for melting and refining are available.

This change in voltage for melting and refining is accomplished by means of a three-pole, double-throw airbreak switch which is manually operated and interlocked with the furnace oil circuit breaker so that it is impossible to move the tap switch without first opening the oil breaker.

The main high tension conductors to the transformers

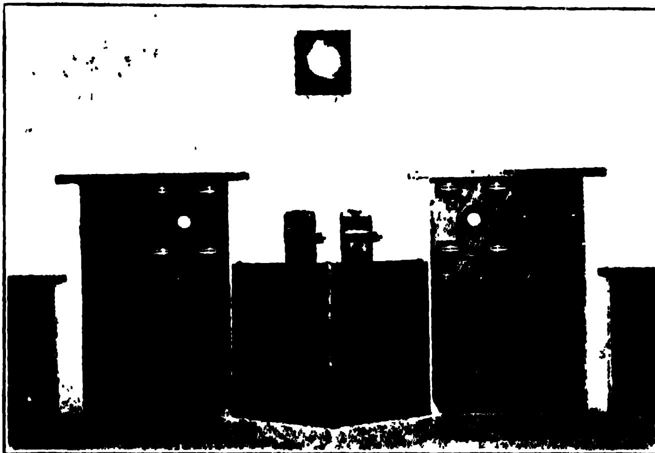


FIG. 8. SWITCHBOARD

are brought to the transformer bushings through No. 2 B. & S. gage, two-conductor, varnished cambric, lead-incased cable in 3 in. sherardized conduit and terminated in two conductor potheads opposite the transformer bushings. (Fig. 6). The tap connections are brought to the transformer bushings through No. 2 B. & S. gage, three-conductor, varnished cambric, lead-incased cable in 3 in. sherardized conduit and terminated in three conductor potheads opposite the transformer bushings. (Fig. 6). The two conductor potheads carrying the main leads are placed over the three conductor potheads carrying the tap connections in order to avoid placing the riser conduits side by side, as by the method used it is possible to remove any transformer from the bank without disturbing the others, which would not be possible were the other method used. The leads from the transformers are connected to the cable conductors by solderless connectors which have proved very satisfactory for this class of construction. The exposed conductors between pothead bushings and transformer bushings are insulated with varnished cambric to withstand five times normal voltage, or 55 kv. By this arrangement of connectors a transformer may be disconnected from the system in a few moments.

All high-tension conductors were manufactured under

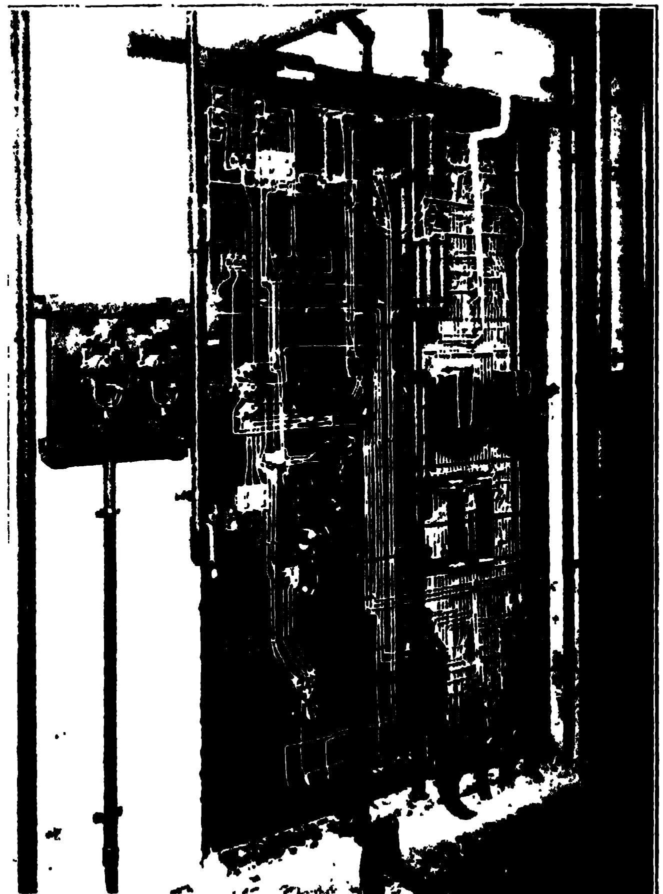


FIG. 9. METER WIRING

specifications made by the Halcomb Steel Co. and are lead incased and all terminate in potheads, the only exposed cable being at points where the conductors pass into the transformer bushings, the oil breaker bushings, the tap switch lugs, and the delta connection. In these instances the conductors are insulated with varnished cambric tape to a thickness to withstand five times normal voltage, or 55 kv., then painted with compound to render them non-absorptive.

This method of construction (Figs. 6 and 7), which may be called a "Safety First" installation, is the only one of its kind, so far as we are aware, in existence, and letters patent are being applied for, covering this method of construction. With the present types of exposed high-tension wiring in use much trouble has been experienced from flash overs on insulators due to dust, and many accidents, some fatal, from men coming into contact with the high-tension equipment while

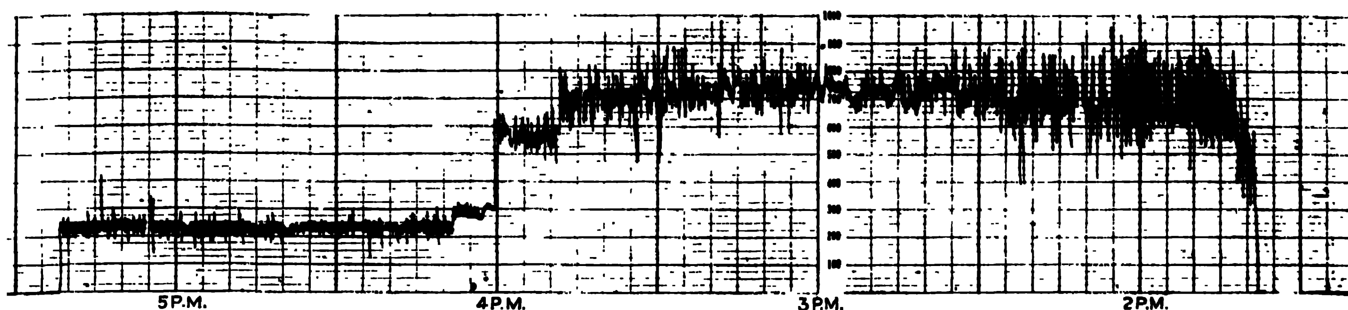


FIG. 10. GRAPHIC RECORD OF KILOWATT VARIATION DURING A HEAT

about their duties. With this improved method it is possible to climb all over the equipment without danger and since its installation it has not cost a single cent for maintenance or repairs. This "Safety First" type of construction will increase the cost of the electrical wiring system about 60 per cent over the regular open wiring method, and for a 3-ton installation this amounted to $2,200 in 1918.

From the secondary coils of the transformers, copper busbars extend in interlaced formation to the wall which separates the transformers from the furnaces. In an opening in this wall the "star" connection is formed (see Fig. 5), and outside the wall on the furnace side the current transformers are mounted, and thereby recording the time a circuit breaker is opened or closed and the duration of time in each position. From the chart on this meter it is a simple matter to count the number of times the breaker is operated, which serves as a guide for determining when to change the oil in the breaker tank. The potential and current transformers on the primary side are mounted on a pipe frame behind the switchboard but a sufficient distance away to prevent any trouble being communicated to the wiring on the back of the switchboard. All meter wiring (Fig. 9) is of fire-proof insulation and is suitably terminated on terminal blocks so that tests can be made without cutting or opening a circuit.

The auxiliary hand control panels for operating the electrode motors by hand are shown in Fig. 8 at extreme left and right of cut. Current for electrode motors is furnished by a 20-kw., 230-volt, d.c. compound wound motor generator set located in the substation.

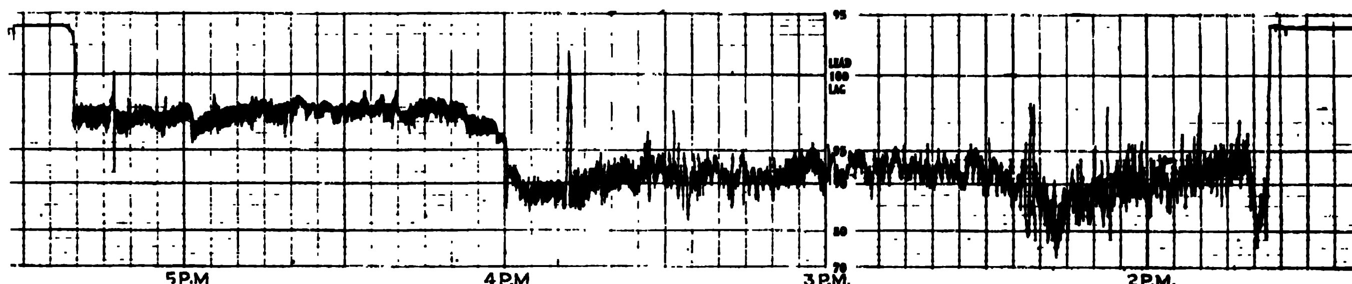


FIG. 11. GRAPHIC RECORD OF POWER FACTOR VARIATION ON THE HIGH-TENSION SIDE OF THE TRANSFORMERS DURING A HEAT

the flexible cables, which loop to the furnace in phase groups, are attached to the ends of the bus just outside the "star" connection. These cables, of which there are twelve for the center phase and eight for the outside phases, are 600,000 circular mils and composed of sixty-one strands—seven wires to the strand and rope laid. The groups of cables forming a phase are supported on wooden grooved drums so as to take away all strain and weight from the cable lugs.

The switchboard (Fig. 8) contains an indicating wattmeter, watthour meter, low tension voltmeter with voltmeter receptacle and plug, two ammeters, inverse time limit overload relay, contactors, contact-making ammeters, oil breaker operating mechanism and tap switch operating wheel. A General Electric automatic regulator controls the position of the electrodes, and consequently the power input of the furnace. A graphic polyphase wattmeter and graphic polyphase power factor meter are installed in the substation. A recording thermometer is also installed having two pen movements—one to record the room temperature, the other to record the oil temperature in the transformers. The oil breaker operating handle is connected to a signal switch which lights a red or green signal lamp to indicate visually the position of the breaker. The signal switch also has a separate contact for connection to a recording meter having pens which move laterally,

Fig. 10 is a reproduction from a polyphase graphic

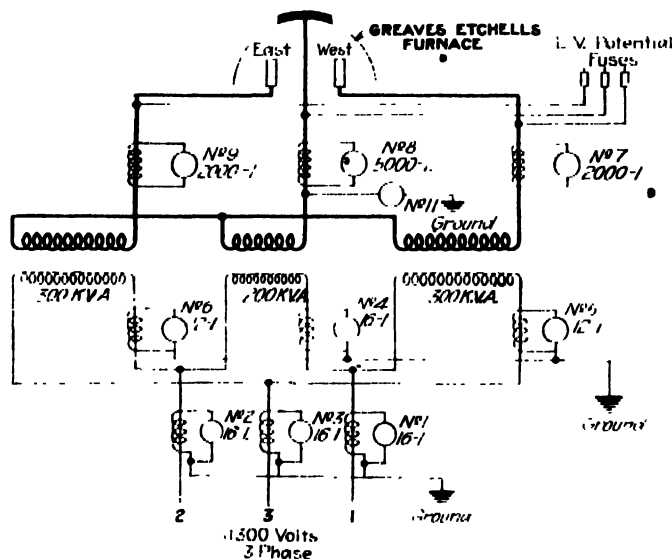
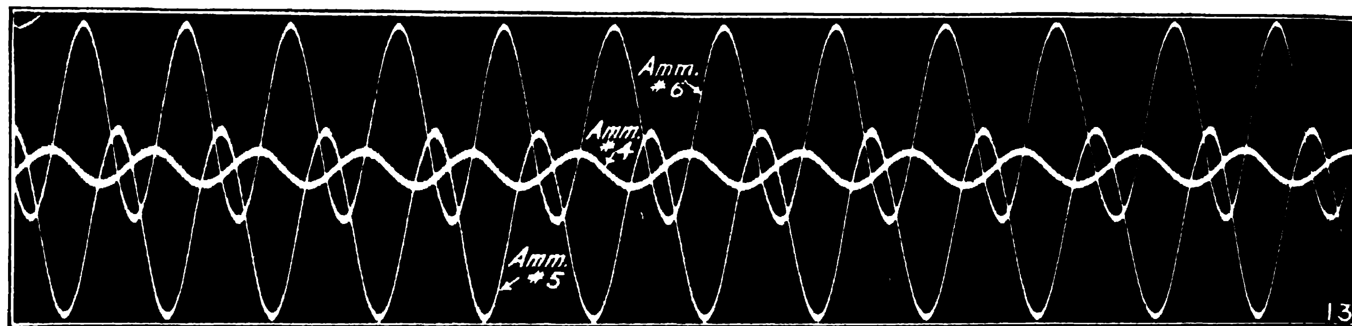
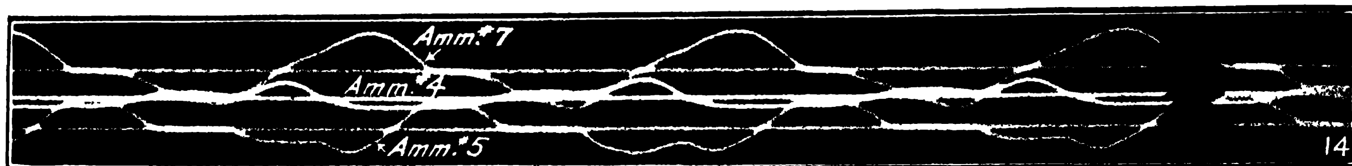
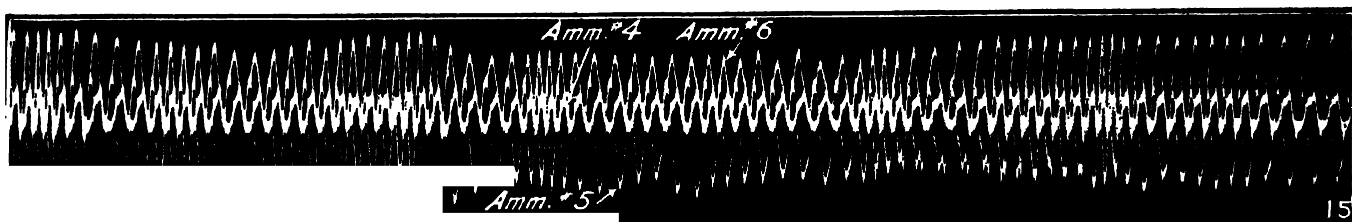
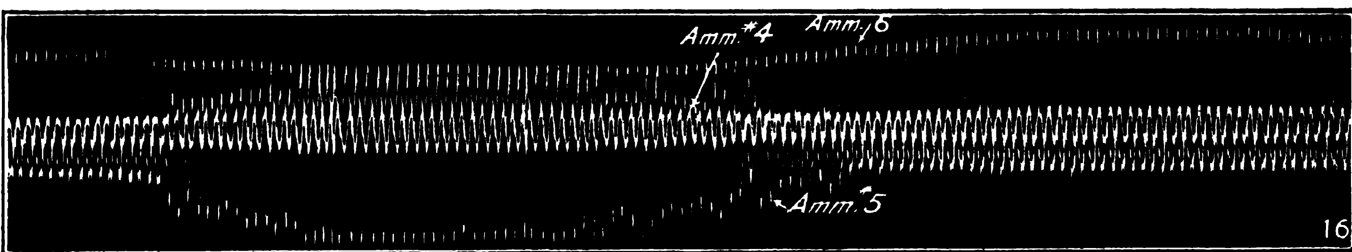


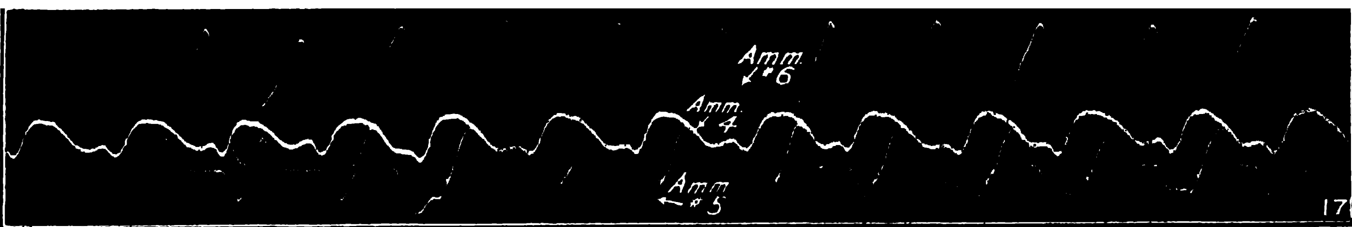
FIG. 12. FURNACE NO. 6 TEST CONNECTIONS

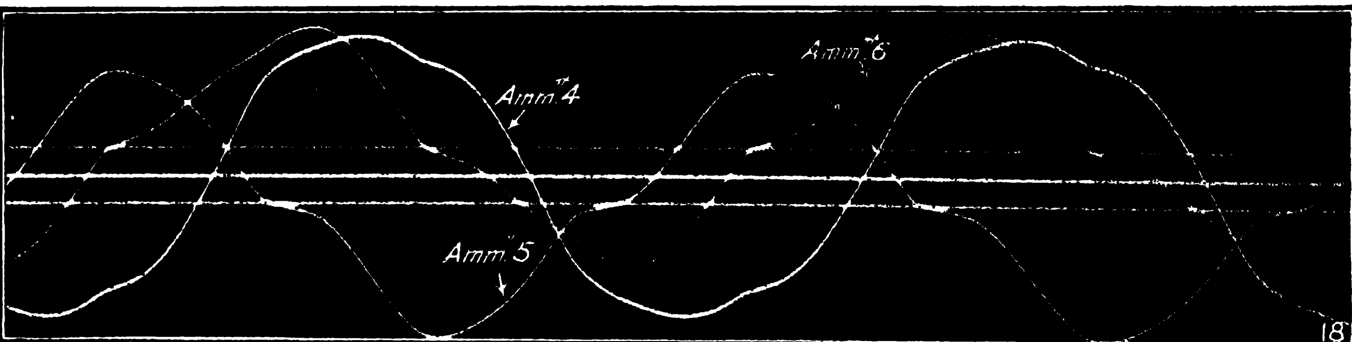












FIGS. 13 TO 18. OSCILLOGRAPH TESTS OF GREAVES-ETCHELLS ELECTRIC FURNACE NO. 6 AT THE HALCOMB STEEL CO. PLANT

Current waves on furnace No. 6: Fig. 13. Hand control, electrodes purposely shorted. Highest current values (effective amperes) attained: Amm. No. 5, 96.8; No. 4, 48.7; No. 6, 87.9. Dec. 31, 1918. Fig. 14. Hand control at start of run. Highest current values: No. 5, 29.5; No. 4, 26.2; No. 7, 35.4. Dec. 31, 1918. Fig. 15. Hand control, 1 to 1½ hr. after start of run. Highest current values: No. 5, 75.4; No. 4, 70.8; No. 6, 54.5. Dec. 31, 1918. Fig. 16. Hand control: 1 to 1½ hr. after start of run. Highest current values: No. 5, 94.6; No. 4, 36.6; No. 6, 60.5. Dec. 10, 1919. Fig. 17. Automatic control. High secondary voltage used during melting. Highest current values: No. 5, 52.3; No. 4, 37.3; No. 6 73.6. Dec. 31, 1918. Fig. 18. Automatic control. Low secondary voltage used during refining. Highest current values: No. 5, 25.3; No. 4, 14.5; No. 6, 16.9.

wattmeter recording the kilowatt variation during one of the heats. The melting period started at 1:38 p.m., and by 2:25 p.m. a considerable pool of molten metal was formed. At 3:48 p.m. the metal was all melted and the voltage was reduced to the low refining voltage with an input of approximately 575 kva. At 4 p.m., the load input was reduced to 300 kva. and at 4:08 p.m. was further reduced to 230 kva., where it remained until the end of the heat at 5:22 p.m., a total length of three hours forty-five minutes. The exceptionally low input required to maintain the heat balance during the refining period is worthy of note, and this low input can be obtained only by using a low voltage relatively during refining. The advantage of the use of a lower voltage for refining than for melting was first discovered and used in this country by the Halcomb Steel Co., and patents were applied for some time ago covering the process and apparatus in connection therewith. Fig. 11 is power factor chart for above heat, and represents the operating power factor on the high-tension side of the transformers.

Electrode consumption over a considerable period was 30.6 lb. per net ton of steel produced, including electrode breakage. Due to "war quality" electrodes, this figure is somewhat higher than during normal times, as a consumption of less than 20 lb. per net ton, including breakage, has been secured over many monthly periods.

The temperature of the transformers during a day's run varied quite gradually from 32 deg. C. at 9:30 a.m. to 50 deg. C. at 7:30 a.m., the ambient or room temperature varying during the same period between 12 and 20 deg. C. The time between heats of the charging period causes a small reduction in temperature. The room temperature was only 4 to 5 deg. higher than the outside air and demonstrates the efficiency of the ventilating system used in the substation.

In order to determine the maximum overload currents which could be drawn by the furnace, instruments were connected into the circuit with instrument transformers as per Fig. 12. The numbers used in the following data refer to the corresponding numbers in Fig. 12.

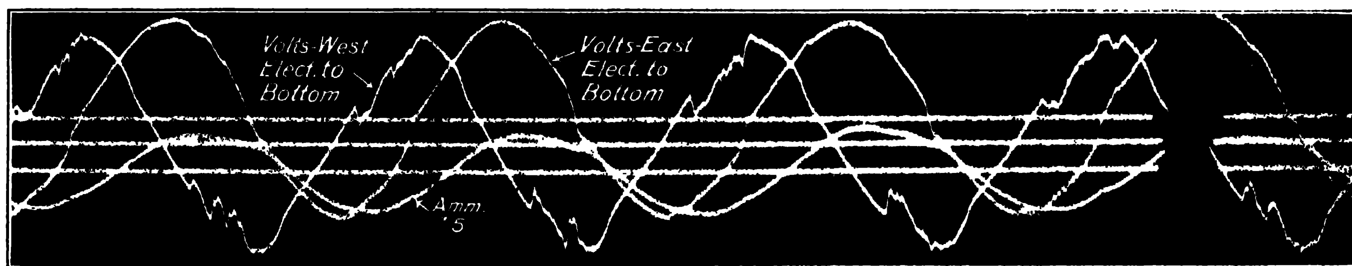
Primary volts, 11,300--11,500. Secondary volts, 59--61--81.

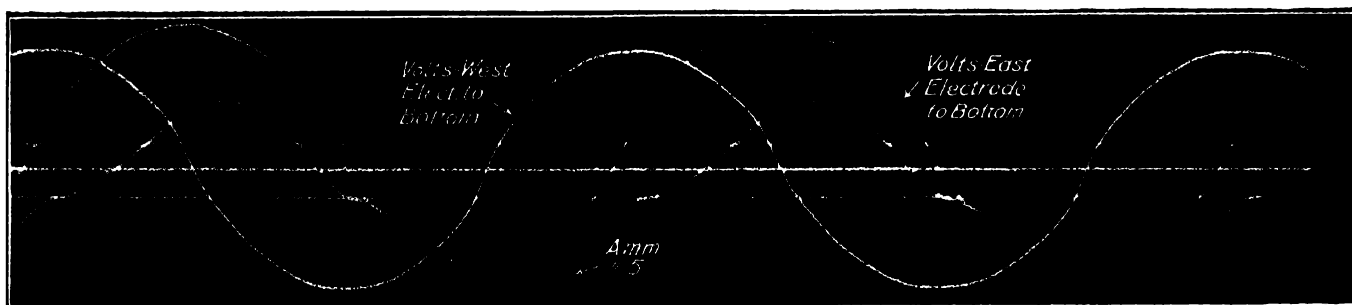
Meter	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Starting heat	35.2	24.0	51 2	6 4	31.2	22 8	7,000	2,000	7,000
1 hr. after start	48.0	36.8	27.2	16.0	27.6	25 2			
	33.6	33.6	35.2	14.4	23 4	22 8	4,600	5,750	4,200
	36.8	32 0	37.6	14 4	27.0	22 2			
2 hr. after start	38 4	40.0	41.6	16 8	27 0	28 2	5,000	6,500	5,000

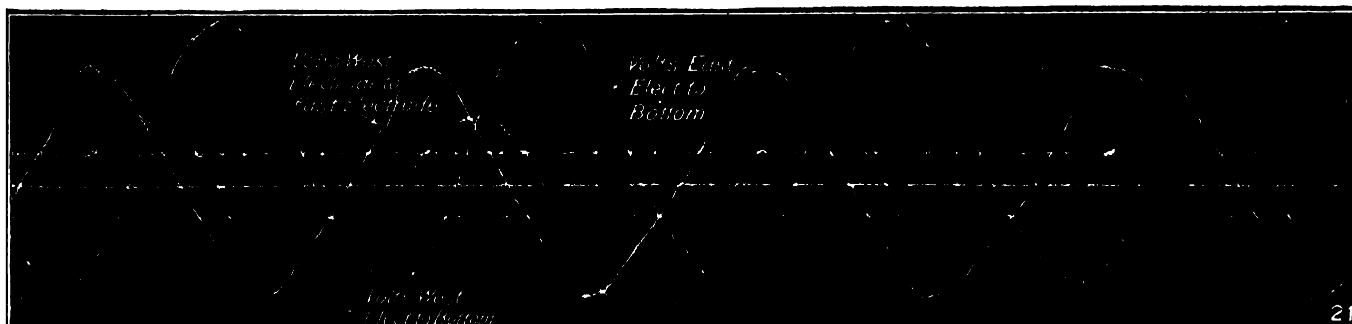
There were swings as follows:

. 0 84.0 84.0

This indicates clearly the bottom of the furnace has a very high resistance when cold, although this does not prevent an adequate current flowing for rapidly baking in a new bottom.







FIGS. 19 TO 21. OSCILLOGRAPH TESTS OF GREAVES-ETCHELLS ELECTRIC FURNACE NO. 6 AT THE HALCOMB STEEL CO. PLANT

Fig. 19. Current and secondary voltage waves in furnace No. 6. Hand control. Start of heat. High secondary voltage. Amm. No. 5, 51.4 effective amperes. Voltage on Nos. 2 and 3, 60 volts, read on portable meter. Vib. No. 2, volts west electrode to bottom. Vib. No. 3, volts east electrode to bottom. Dec. 31, 1918. Fig. 20. Current and secondary voltage waves in furnace No. 6. Automatic control-refining. Amm. No. 5, 19.9 effective amperes. Voltage on Nos. 2 and 3, 60 volts, read on portable meter. Vib. No. 2, volts west electrode to bottom. Vib. No. 3, volts east electrode to bottom. Dec. 31, 1918. Fig. 21. Secondary voltage waves in furnace No. 6. Automatic control. 400 kw. in furnace. Vib. No. 1, volts west electrode to bottom. Vib. No. 2, volts west electrode to east electrode. Vib. No. 3, east electrode to bottom. Dec. 31, 1918.

Referring to the oscillograms, the following table indicates the effective values of the maximum currents observed:

Fig	300 K Eff.	200 K Eff.	300 K Eff.	
13	96.8	43.7	87.9	Hand control. Electrodes purposely shorted
14	29.5	26.2	35.4	Hand control. Start melting period.
15	75.4	70.8	54.5	Hand control. 1 to 1½ hr. after start of heat.
16	94.6	36.6	60.5	Hand control. 1 to 1½ hr. after start of heat.
17	52.3	37.3	73.6	Automatic control. High secondary voltage used during melting.
18	25.3	14.5	16.9	Automatic control. Low second[illegible]ltage used during refining
	Eff Amp	Volts	Volts	
19	51.4	60.0*	60.0*	High control. Start of heat High sec[illegible]dary voltage.
20	19.9	60.0*	60.0*	Automatic control Low voltage refinin[illegible]
21	Volts west electrode to center	Volts west electrode to east electrode	Volts east electro[illegible] to cent[illegible]	Automatic control; 400 kw in furnace Low voltage refining period

* Voltage on 2 and 3, east electrode to [illegible] electrode to be read on portable meter

By referring to the oscillograph curves it will be noted that during the melting period the load is constantly changing from zero to three to four times normal. The frequency of these surges is such that a very few seconds may exist between them, although with a properly designed installation they are not severe enough to make this class of load undesirable to the central station—in fact, a furnace load is a very desirable one due to its 24-hr. use. With several furnaces operating on a system the diversity is such that only occasionally are demands excessive. There is also some variation in the severity of the load with different furnace charges. In other words, the position and shape of the scrap metal which is next to the electrodes when starting the heat is such that occasionally the initial melting of the charge is more severe than at other times.

These tests indicate that electric furnace loads are more severe on transformers than are the usual lighting and power loads, first, because breaking the low voltage arc on the cold metal may, with the proper combination of conditions, set up oscillations in the transformers, and second, because subjecting transformers to a severe short-circuit occasionally is a very different matter from subjecting it to hundreds of partial short-circuits per hour. It is for these reasons that furnace transformers should be especially designed to withstand the tremendous mechanical stresses produced.

Figs. 19 and 21 show evidences of high frequency, although not especially high, being between 6,000 and 9,000 cycles.

The current records in Fig. 17 are not symmetrical, which would indicate a partial rectification.

The maximum current values found in the oscillograph tests are not as high as those found in the meter test. This is because it was possible to observe the meter over a longer period of time and thus determine the maximum of many current rushes. The oscillograph measured the maximum current for the particular current rush for which the film was taken, but the one just before or after might have been higher. It would be very desirable if a very long film holder could be devised so that a reasonably long record could be obtained—long enough to cover any reasonable observable period—as under operating conditions it is very difficult to determine just when the looked-for phenomenon is to occur.

The phenomena of high frequency and rectified currents are not peculiar to this type of electric furnace, as similar results have been secured during oscillograph tests made on other makes of furnace—in fact, the electric arc itself is responsible for whatever currrent rectification takes place.

Our experience has been that an electric furnace installation when properly designed and constructed is a desirable load for a central station and with this type of furnace the fluctuations seem to be such that it has proved itself to be an attractive proposition to us as steel makers and also to the central station supplying us with power.

Syracuse, N. Y.

Who Is Your Boss?

You're working day after day in the big shop.

You're getting a certain amount of money for your work.

You're either satisfied and happy or else you're sore about something.

If you're satisfied and know you're getting along all right—fine!

If you're sore, I want to ask you one question.

Do you know who is your boss?

"Sure, Mike," you say, "I'm working for the man who owns this business. He's my boss!"

But that's not so—not on your life!

You're working for yourself.

You betcha are!

Sounds funny, don't it?

It's a fact just as sure as you're a day old!

You're in business for yourself just as much as the big guy who owns the business.

The big guy isn't your boss at all.

He's your customer, and you're selling something to him, just like he's selling something to the people.

The only difference is that he's got a lot of money tied up in the business which he takes a chance on losing.

You've got your money in the savings bank where it's safe.

Now, the "boss," he's selling goods to his customers, the people—because the people need them.

And you're selling your work to your customer, the "boss"—because he needs it.

Now, supposing the "boss" starts in to make poor goods. He don't give the people full value for their money.

What happens?

Why, the people find it out and won't buy his goods. They buy some other guy's goods and he loses his customers.

Now, supposing you start in selling your customer, the "boss," poor work. You don't give him a full day's work for a full day's pay—what then?

Why, the boss is going to do the same thing with your poor work that the people would do with his poor goods.

He's going to buy someone else's work. You lose your customer and have to look for somebody else to sell your work to.

The people have got a right to buy the best goods they can get for their money.

The "boss" has got the right to buy the best work he can get for his money.

You've got to look at it this way before you can get ahead.

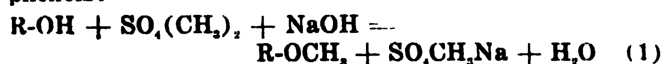
—*Arizona Mining Journal*, October, 1920.

Precautions in the Use of Dimethylsulphate

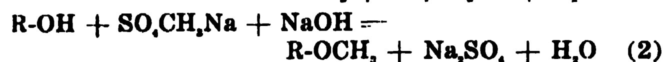
BY MAX MUELLER, PH.D.

ALTHOUGH dimethylsulphate is known to be the most convenient methylating agent and is used in large quantities in Europe in both the dyestuff and the synthetic perfume industries, it has not yet met in this country with the attention it deserves. This is due principally to the widespread opinion that it is an extremely dangerous poison. Text books have exaggerated its poisonous effects when many things more dangerous —things in common use—are not so mentioned. The danger with it is not greater than, for example, with aniline, provided the proper precautions are taken.

The reasons why dimethylsulphate should be preferred to other methylating agents are first, because it acts at low temperatures; second, the methylation can be conducted at atmospheric pressure. The following reactions show the mechanics of the methylation of phenols:



$$R\text{-}OH + SO_4(CH_3)_2 + NaOH = R\text{-}OCH_3 + SO_4CH_3Na + H_2O \quad (1)$$



$$R\text{-}OH + SO_4CH_3Na + NaOH = R\text{-}OCH_3 + Na_2SO_4 + H_2O \quad (2)$$

Reaction (1) is complete at ordinary temperature; reaction (2) generally requires 100 deg. C.

The reaction with amines is more complicated since, as is the case with all methylating agents, all the possible methylated products may be formed.

$R\text{-}NH_2$ may give $R\text{-}NHCH_3$,

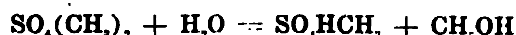


$$R\text{-}N(CH_3)_2, \text{ and } R\text{-}N\begin{matrix}-CH_3\\-SO_4CH_3\end{matrix}$$

By choosing the right conditions, however, the desired compound can be obtained in good yield.[1] As a rule the methylation is carried out by adding simultaneously dimethysulphate and alkali to an aqueous solution or suspension of the phenol or the amine. Sometimes the results are better when dimethylsulphate is added first and then the alkali. The temperature varies from 0 to 30 deg. C. Also benzine, ether or dimethylsulphate itself are used as diluents in some cases.

Commercial dimethylsulphate is almost chemically pure. It is a colorless or faintly yellow liquid of sp.gr. 1.334 at 15 deg. C. It boils at 188 deg. C. It has rather a pleasant etherial odor. It does not contain free acid and does not attack metals, and so may be kept in iron drums or containers.

Some danger thus lies in the harmless appearance of this compound. Moreover, the danger is increased by the fact that it has a considerable vapor pressure in spite of its high boiling point, and that its action on the skin and mucous membrane is not immediate. The vapors attack the delicate membrane of the eyes and respiratory organs, while the liquid is readily absorbed by the skin and then acts internally. Its poisonous action is a combination of the actions of its decomposition products when it reacts with water.



$$SO_4(CH_3)_2 + H_2O = SO_4HCH_3 + CH_3OH$$

The action of the methylsulphuric acid is local. It blisters the skin and forms sores which take a long time to heal. The action of the methanol is general, affecting the central nervous system and in some serious cases a weakening of the optic nerve was observed.

As pointed out by Weber[2] some men died by its action in the early days of its use, but during the last ten years no fatal accidents have been recorded. During the writer's twenty years experience in handling dimethylsulphate only very few serious cases occurred and these during the earlier years. Most of these were due to the carelessness of the workmen.

Its action thus being known, the following precautions should be observed:

All containers of dimethylsulphate should be kept out of doors, but in a dry, cool place. Small bottles for laboratory use should be kept in a separate room with other dangerous chemicals. Storage tanks for the plant should be installed in sheds outside the methylation building. The reaction tank should have a tight cover and a ventilating pipe leading through the roof, equipped with a steam injector so that a slight vacuum is formed in the pipe and any dimethylsulphate vapor escaping is destroyed. All transferring of dimethylsulphate from one tank to another should be done by vacuum.

It is not as easy to destroy dimethylsulphate as one would think from its reaction energy. It is slightly soluble in water and is not instantly decomposed even in presence of an excess of alkali. The decomposition is rapid only at about 80 deg. C., but proceeds then with such a production of heat and so quickly that if any considerable amount of dimethylsulphate is present, vapor produced will project the whole contents of the tank through the openings. So if apparatus containing dimethylsulphate has to be cleaned, the greatest amount of it has to be removed. What remains is destroyed by adding enough diluted caustic soda for neutralization and passing a current of steam through the whole apparatus until its temperature is higher than 80 deg. C.

Any amount of dimethylsulphate dropped on the floor should be covered immediately with dry soda ash or caustic lime and then washed away with water after a few minutes. If working in an atmosphere of dimethylsulphate is necessary, a tight army gas mask should be worn. It proves to be efficient for fifteen minutes at least.

The treatment of men gased by dimethylsulphate depends on the gravity of the case. If the eyes are attacked, they should be washed two or three times with carron oil. This treatment is somewhat painful, but if done in time prevents all serious trouble and generally allows the man to go back to work the following day.

In more serious cases dimethylsulphate vapors may get into the respiratory organs, provoking an inflammation of the larynx and bronchial tubes. In this case it is best to send the man to the hospital or at least to keep him under close observation, as sometimes breathing may become difficult for a few hours and the administration of oxygen may become necessary.

Clothes impregnated with dimethylsulphate must be removed immediately and washed with boiling water and soda ash.

With the ordinary precautions of cleanliness and care that should be exercised with any organic chemical, no serious consequences will ever result and the writer wishes to impress upon the profession to set aside the previous exaggerated conception of the danger of this product.

[1]See Ullmann, Encyclopædie der techn. Chemie, vol. 1, pp. 262-268; Weyl, vol. 2, p. 604; Decker and Koch, *Ber.* vol. 40, p. 4794 (1907); Werner, *J. Chem. Soc.* vol. 105, p. 2762 (1914); Shepard, *J. Am. Chem. Soc.*, vol. 38, p. 2,507 (1916).

[2]Weber, *Chem. Centr.* vol. 1, p. 361 (1[illegible]

Legal Notes

BY WELLINGTON GUSTIN

Widow May Not Recover Where Employee Assumed Risk of His Employment

In an action under the common law for damages for death of an employee the Court of Appeals of Georgia has dismissed the case brought against the Donalsonville Oil Mill by the decedent's widow. It was alleged that the negligence of the defendant corporation consisted in not furnishing the deceased a safe place in which to work. It was shown that complainant's husband had at least equal means with the Oil Mill company of knowing that the place in which he worked was unsafe and that he voluntarily continued, and without objection, in the employer's service. Therefore, said the Court of Appeals, it was not error to dismiss complainant's petition, it showing there is no right of action accruing, and judgment was affirmed.

Meaning of c.i.f. as Distinguished From f.o.b.—Rules Governing Such Contracts of Shipment

Some interesting propositions of law arise in the case of Fred O. Seaver against the Lindsay Light Co. decided for the plaintiff by the Supreme Court for Kings County, New York.

A broker in London asked the defendant in Chicago if it had thorium for sale. The broker was referred to defendant's brokers in London, who would quote prices. After various correspondence between the two brokers, defendant's broker submitted an offer from the defendant. This was accepted in a cable sent the defendant at Chicago, and the defendant's confirmation of this acceptance was contained in a cablegram sent to its London agents and transmitted by them to the first broker. The acceptance of the final offer showed that the goods were being purchased for a corporation in Holland. The thorium was to be delivered in six monthly installments at the price of $4 a lb. cash in advance, c.i.f. Rotterdam. Later, by mutual consent, the contract was changed to c.i.f. London dock. A portion of the monthly deliveries was never shipped, and this action was brought to recover the damages sustained by the buyer, the plaintiff being its assignee.

PLACE OF DELIVERY THE IMPORTANT FACTOR

The buyer claimed the contract was made in London, the seller claimed it was made in Chicago. The court thought the latter contention correct, but held this was immaterial, for in an action between buyer and seller for damages for non-performance of a contract of sale the place of delivery is the important factor. The damages are measured by the value of the goods at the place of delivery, and not at the place where the contract was made.

The question as to what was the place for delivery under this contract is to be determined according to the intention of the parties.

Ordinarily, in the absence of special facts, a contract to sell goods is completed when the seller delivers them to a carrier to be transported to the buyer. That constitutes a delivery to the buyer, and this is true although the goods are not then paid for.

But this rule does not apply, said the court, if the seller agrees to deliver the goods at the buyer's place, or makes some other agreement showing a different intention of the parties. So, under the common provision f.o.b. place of shipment, the seller's obligation is completed when he ships the goods, and title to them passes then, and he is not obliged to pay the freight. But if the agreement is f.o.b. place of destination, the seller must pay the freight, and may be deemed to have retained the title to the goods until their arrival at the point of destination. But where the intention of the parties is different that will control. Hence the fact that the freight was paid by the seller is not conclusive that the delivery was to be at the place of destination.

MEANING OF THE TERM C.I.F.

The provision c.i.f. seems rarely to have been used in commercial contracts in this country, and many textbooks contain no mention of the term. It is defined in II Corpus Juris, p. 765, as an expression indicating that the price fixed covers the cost of the goods and insurance and freight on them to the place of destination. Under a contract containing such a provision, the seller must ship the goods, arrange the contract of affreightment to place of destination, and pay its cost or allow it from the purchase price, and procure insurance for the buyer's benefit for the safe arrival of the goods and pay therefor. When the seller has done this and forwarded the papers to the buyer, he has fulfilled his contract, and delivery is complete. There is no obligation by the seller to deliver the goods at the place of destination.

The above principle was stated and approved by the Supreme Court of the United States in Thames & Mersey Insurance Co. vs. United States, 35 Sup. Ct., 496. This is the meaning and effect of the letters c.i.f., in the absence of any agreement to the contrary or any provisions showing a different intention. The court was convinced no different intention was shown in the cause on trial, and this was emphasized by the requirement that the seller must procure insurance for the buyer's benefit. This indicates, said the court, that delivery was to be complete at the place of shipment and that the title to the goods was in the buyer from that time. Hence the buyer required the seller to secure insurance for him. If the goods were still the seller's until they reached their destination, the risk of their safe arrival would be the seller's and the buyer would have no concern about that. He would lose nothing if the goods did not arrive; the loss would fall upon the seller. This and similar provisions in contracts have been held to be controlling factors in determining the intention of the parties.

If it had been the intention of the parties that delivery should not be complete until the goods arrived at London, an "f.o.b. London" provision could have been inserted in the contract. The difference between an "f.o.b. London" contract and a "c.i.f. London" contract has been pointed out.

So there is nothing here to show the parties had in contemplation that the value of thorium in London should be the measure of damages. The buyer proved the value of thorium in London, but offered no proof as to its value in Chicago. The seller's proof of the Chicago value plus freight and insurance charges was therefore undisputed, and must be accepted as the basis upon which the buyer's damages must be calculated. The same rule of damages applies where there is no shipment made as where a shipment is made that does not conform to the contract.

Industrial Excursions of the Chicago Meeting of the American Chemical Society

Notes on and Views of the Doehler, Sherwin-Williams, Pullman, Fleischmann, Steel and Tube, Northwestern Terra Cotta, Fansteel, Sears-Roebuck and Heath & Milligan Plants

WEDNESDAY afternoon and all day Friday, Sept. 8 and 10, of the program of the Chicago meeting of the American Chemical Society were given over to industrial excursions. The following notes and views are offered both by way of report of the meeting and as a record for future reference of the important plants operating in this district.

DOEHLER DIE CASTING CO.

While this plant is a small one as compared to some of those visited, it is nevertheless important from the point of view of uses of alloys in the construction of machine parts. These alloys are made up with a zinc base, a tin base, a lead base, an aluminum base and a copper base. They are melted in the foundry, a corner of which is shown in Fig. 1, and cast in ingots for subsequent use in the die-casting machine. It is not economical to make a die casting where less than 5,000 pieces are required, as the dies are extremely expensive to make.

At the Chicago plant gas is used for fuel and requires from 1½ to 4 cu.ft. per lb. of metal produced, the higher figure being required in the making of an aluminum alloy. A large quantity of compressed air is used in the operation of the die-casting machines and is supplied from one Ingersoll-Rand and two Sturtevant air compressors at a pressure of about 200 lb. per sq.in. The casting operations are extremely interesting from a mechanical point of view. As the pieces come from the machine they are cleaned, hand filed and often trimmed in dies.

Tin-base alloys are not attacked by organic acids and can therefore be used for food containers. They are slowly corroded by minéral acids and alkalis but are comparatively unaffected by water, neutral aqueous solutions, and damp or warm climatic conditions.

Lead-base alloys are insoluble in dilute sulphuric acids and are consequently well adapted for fire extinguishers, etc. They are soluble in nitric acid, but very slowly soluble in hydrochloric acid. Contact with organic acids form the base of lead salts which are poisonous.

Aluminum-base alloys are readily soluble in alkali solutions, but insoluble in nitric acid. They are also readily soluble in dilute hydrochloric and sulphuric acids, and soluble with difficulty in these acids when concentrated.

SHERWIN-WILLIAMS CO.

This plant is one of the largest manufacturers of insecticides, paint and varnish and the raw materials for these products in the world. It also manufactures lithopone pigments, tin cans, dyes, dry colors, wood preservatives, tar products, and makes the largest amount of acetic acid for its own consumption of any plant in the world. The old Dutch process white lead plant, which was visited by the members of the society, will be described in a subsequent issue.

The company is just erecting a new quick-process white lead plant which will increase the capacity for white lead production 15,000 tons per year. This new plant under construction is shown in Fig. 2. At the same time the company is erecting a plant for the manufacture of red lead and litharge.

THE PULLMAN CO.

From the point of view of large-scale manufacturers the Pullman Co. was one of the more interesting plants visited. The underframe of the Pullman car is first erected on temporary trucks, the end frames are then set on and the next shop puts on the sides and roof. When all the heavy steel work is erected the permanent trucks are substituted for the temporary trucks and the car goes to the yards for a sand blasting. A priming coat is put on over the outside and finally the finishing coat.

The first work done on the interior is the construction of a "chanarc" steel floor over which a cement floor is laid. This cement consists of magnesium oxychloride. The interior finish of the car requires the work of many craftsmen, including woodworkers, electricians, plumbers, interior decorators, etc. The completed car costs between $20,000 and $50,000.

The shops cover space ½ mile wide and 1½ miles long and employ 9,000 to 13,000 men in the operation. The capacity of the plant is two Pullman cars and four coaches per day. These coaches, together with the freight cars, are made in a separate shop.

The company is just putting into operation a new freight-car shop which will produce a completed freight car every fifteen minutes, the assembly being carried on after the manner in which Ford automobiles are assembled.

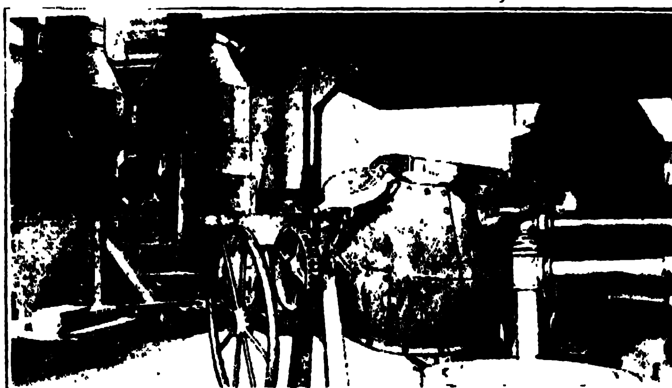
The work in the chemical laboratory consists mainly in supplementing the work of the Committee of Standards and analyzing material for the purchasing department.

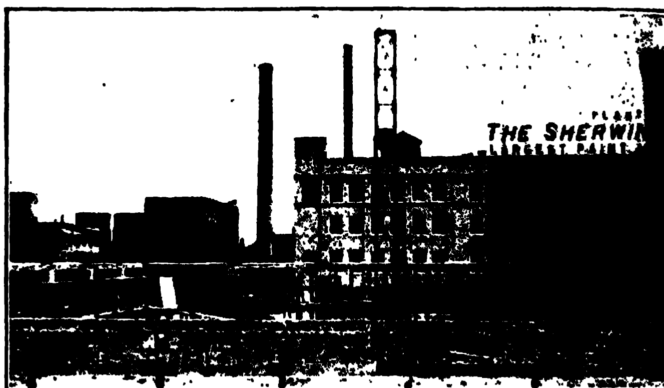
The company is also engaged in the manufacture of automobile bodies.

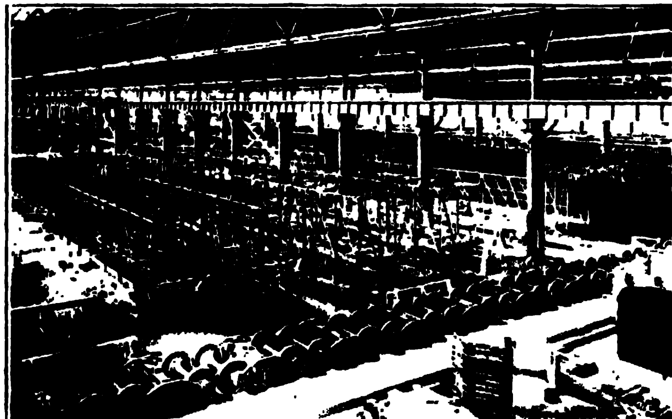
FLEISCHMANN CO.

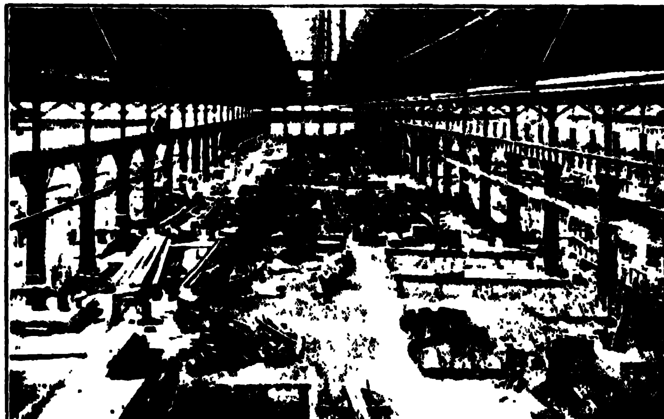
This plant manufactures cider vinegar, malt vinegar, white wine vinegar and yeast. The most interesting process inspected by the members of the society was the manufacture of yeast.

This is made from a mixture of corn, rye and barley malt. The grain, on arriving at the factory, is first subjected to a cleansing process by which all dust and any foreign substances are removed. Grains are subsequently ground separately in regular milling machines of the same type as those used for grinding wheat in the manufacture of flour.













FIGS. 1 TO 6

Fig. 1. Cupolas in Doehler foundry.
Fig. 3. Erecting shop of the Pullman Co.
Fig. 5. Centrifugal yeast separators.
Fig. 2. Sherwin-Williams plant.
Fig. 4. Machine shop of the Pullman
Fig. 6. Yeast presses.

The preparation of the mash consists of setting the ground grains to soak in filtered water. This has the effect of softening the starch, and in order that the final solution may contain all the elements for nourishing the yeast cells, the different grains are treated in distinct ways. For example, the corn is mashed at a high temperature, the rye being put into the mash after the corn is cooked. Malt at a lower temperature is added to convert the starch of the corn and rye into sugar. This is accomplished by the diastatic power of malt. The mash itself is sweet and contains no alcohol.

The next step is the addition of lactic acid bacteria. During this process the temperature is carefully regulated and within sixteen hours the lactic bacteria have multiplied to such an extent that the mash has a distinctly sour taste.

Upon completion of the lactic process the mash is run into filter tubs having perforated bottoms. The solid particles of the grain are held back and a perfectly clear extract known as wort is obtained by the filtration. This is then heated to a high temperature to remove other bacteria besides the lactic ferment. The wort is then conducted through pipes into huge copper tanks (fermenters). In these tanks specially prepared pure culture yeast is introduced. Compressed air is forced in, the oxygen in the air aiding the growth and reproduction of the yeast cells from the mother or culture yeast first introduced. During this process the temperature of the wort is carefully controlled by a system of cold-water coils in the fermenters; the yeast cells under proper conditions of temperature and aëration multiply very rapidly and in about twelve hours a large amount of yeast substance is formed.

The yeast substance is then separated from the liquid by means of centrifugal separators shown in Fig. 5 in the same manner that cream is divided from milk.

The yeast leaves these separators in fluid form like heavy cream and is conveyed by pumps through a cooling apparatus into a receiving tank and from there into a series of filter presses. Here the superfluous water is squeezed out and compressed yeast remains in the

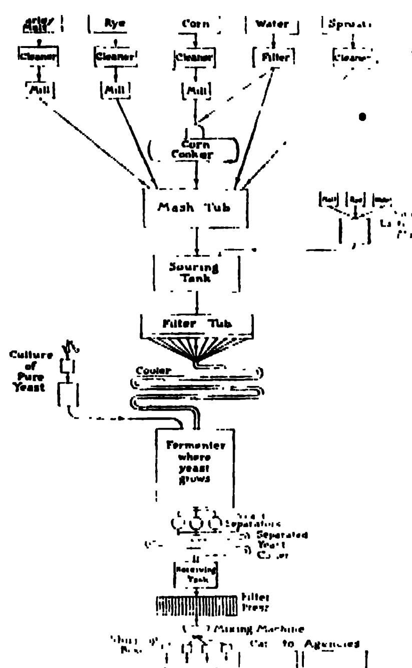


FIG. 7 DIAGRAM OF YEAST MANUFACTURE

presses. After removal from the presses the yeast is thoroughly mixed by machinery, packed by hydraulic pressure in 80-lb. boxes, and placed in a large refrigerator. A flow-sheet of the complete operation of the plant is shown in Fig. 7.

STEEL & TUBE CO. OF AMERICA

This plant is one of the most modern in type of equipment of any in the United States. It has every known labor-saving and safety device for increasing the output and protecting the workers. About 2,000 men are employed at the present time and the output is between 1,500 and 2,000 tons of steel per day.

Ore is unloaded from the steamers from the Lake Superior regions by cranes at a point where it can be easily transferred to the blast furnaces. Approximately 100 tons of coal is used at the plant every hour in the coking operation. Between 15,000,000 and 16,000,000 cu.ft. of gas is made every day. This gas is consumed in the steel plant.

A bessemer plant is now under construction as an addition to these works. Improvements will include a cupola, mixer and converter building, bottom house, office building, power plant and boiler houses. The cupola building will contain three cupolas each having a capacity of 40 tons per hour. This is quite an addition to the colonies of steel mills on the lake shore in the Chicago district.

One of the features of operation of this plant is the new town which is being built to house employees. About 200 houses have been built, together with a boarding house containing fifty rooms. The town is complete in every respect, containing garages, stores, sewage and water systems with capacity to supply the town. The houses are of masonry construction with hollow-tile walls, stucco on the outside.

THE NORTHWESTERN TERRA COTTA CO.

In addition to the brief outline given on page 370 of CHEMICAL & METALLURGICAL ENGINEERING, vol. 23, No. 9, the most recent development of this large ceramic ware plant is the addition of the new 320-ft. Dressler tunnel kiln. It is estimated that the efficiency of fuel consumption is 75 per cent, against 10 per cent efficiency in the periodic type of kiln. Without a doubt the tunnel kiln is the coming method of burning in the ceramic industries just as the byproduct coke oven has superseded the beehive type for the production of coke. Fig. 8 shows a car of ware entering the kiln. Fig. 9 shows the exit end. Note the sheet-iron jacket at this end, which absorbs the heat in the cooling zone and transfers it to the carrier drive on the upper floors. Fig. 10 shows the pipe for conveying the heat away from the kiln in the cooling section. Fig. 11 shows the walls and arch of the kiln during process of construction. Fig. 12 shows the construction of the section at the head end of the kiln. Figs. 13, 14 and 15 are additional views of the kiln during the erection.

While the temperature in the main heating zone reaches 2,100 deg. F., the construction of the brickwork and car is such that the track and iron trucks of the car were so cool a piece of paper laid between the rails would not be scorched by the heat above.

THE FANSTEEL PRODUCTS CO.

Fig. 16 shows a general view of this plant, and while the process of manufacturing tungsten has been described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 22, No. 1, page 9, the research laboratory of the company is now concentrating on improving the process for the manufacture of molybdenum mainly because it is a more ductile and easily workable metal.

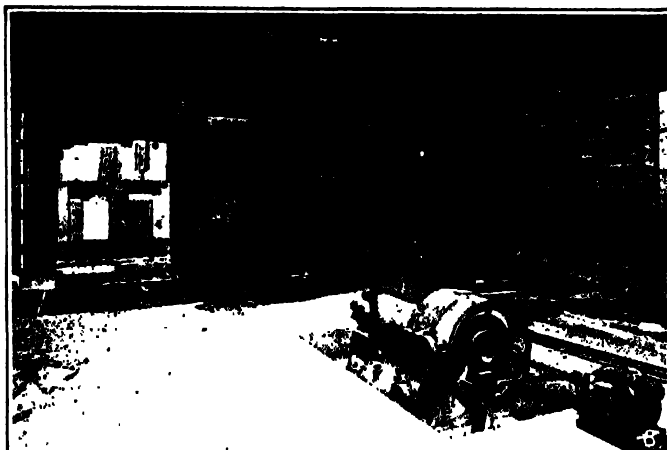
The company manufactures molybdenum metal principally for supplying the electrical trade, and for the manufacture of its own electric furnaces used in working tungsten metal. A very considerable amount of molybdenum goes to vacuum tube or audion manufacturers for plates in wireless telegraphy. Its low coefficient of expansion, which enables it to be welded to Pyrex glass, makes it extremely desirable in this connection. It has a melting point of approximately 2,500 deg. C. and a relatively low vapor pressure.

Generally speaking, the Fansteel company starts from commercial molybdic acid, although at present it is running down a small quantity of molybdenite, MoS_2, by roasting on a cast-iron base. This method is the commercial method and could be worked out to give a very satisfactory product. It is also possible to break up the molybdenite with nitric acid, leaving a molybdic oxide. The latter, however, is expensive and not particularly efficient.

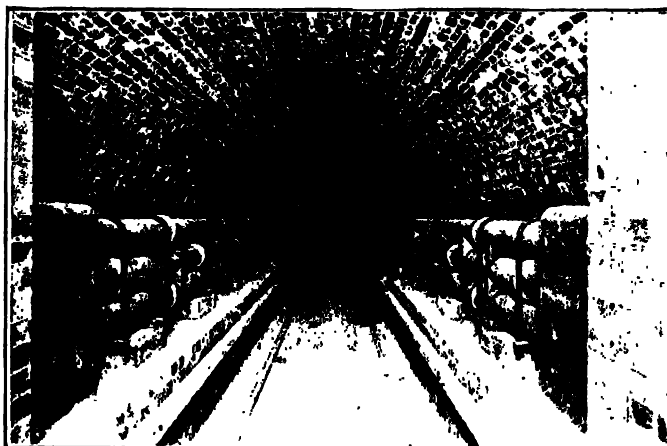
The product of roasting is dissolved in ammonia, filtered and precipitated with nitric acid. This gives a relatively pure molybdic acid which is then ignited at a temperature below 1,000 deg. C. to molybdic oxide, a pale yellow-brown material.

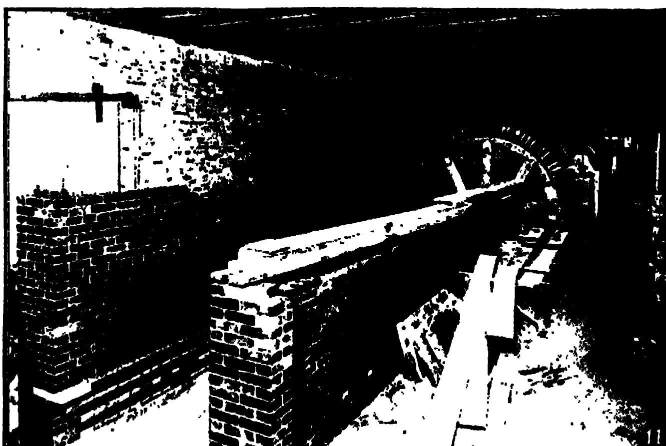
It is necessary in the purification process to be sure that copper and all the alkali earth metals are eliminated. Their presence in the actual metal is of little consequence except that they retard seriously the reducing of the oxide to metal by preventing the removal of oxygen.

Molybdenum is reduced from the ignited oxide in nickel or nichrome trays placed in iron tubes. A stream of hydrogen previously dried and purified is run through











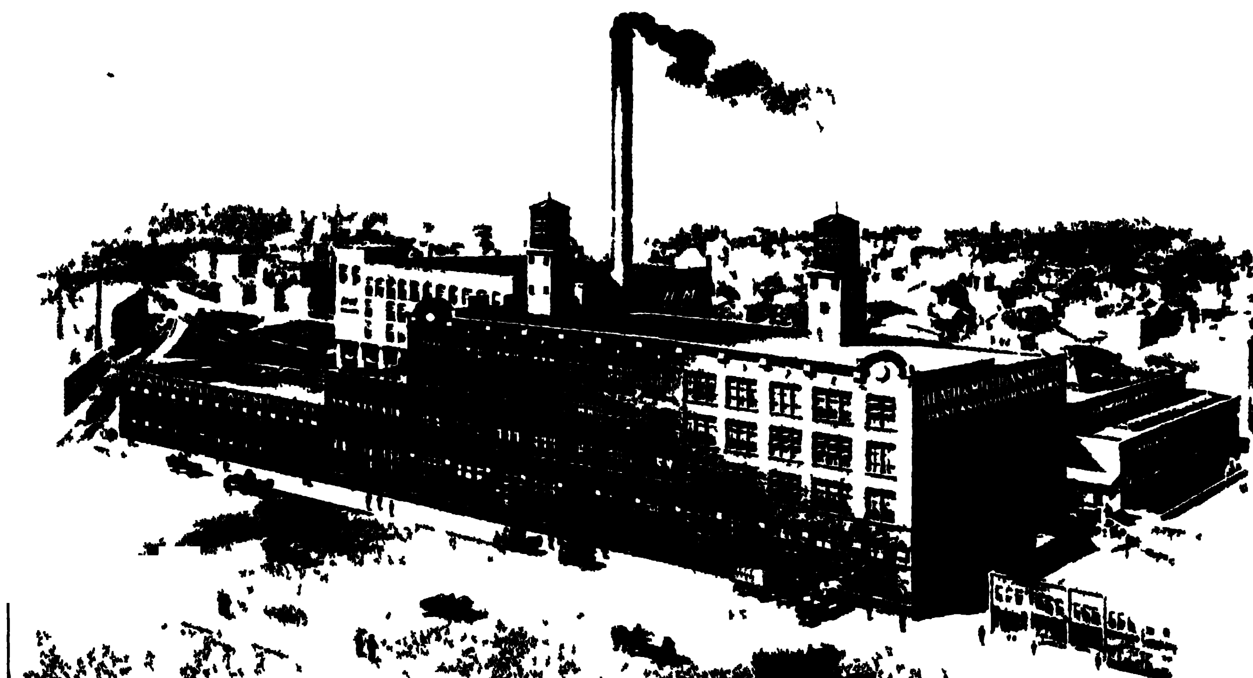






FIGS. 8 TO 15. DRESSLER TUNNEL KILN INSTALLATION

Fig. 8. Car of ware entering kiln.
Fig. 9. Exit.
Fig. 10. Pipe heat conveyor.
Fig. 11. Kiln walls and arch in construction.
Fig. 12. Construction of head of kiln.
Figs. 13 to 15. Views of construction.



FIGS 16 TO 21

Fig 16 Fansteel Products Co Fig 17 Color mixing tank Fig 18 Color vats Fig 19 Filter presses Fig 20 Kaolin mixers Fig 21 Heath & Milligan Co plant

the tubes, which are subjected to temperatures approximately 1,000 deg. Reduction of molybdenum is extremely difficult as compared with tungsten; it is frequently necessary to run a furnace containing trays of the oxide for forty hours before reduction is complete enough to make a workable metal.

The metal powder is removed from the boats, screened and pressed into bars in a hydraulic press, the process varying from that of tungsten only in minor details.

The pressed sticks of metal are placed between electrodes of an electric furnace and brought up to approximately 2,400 deg. C. by passing an electric current through them. This operation is, of course, performed in an atmosphere of hydrogen. The molybdenum shrinks very considerably and the follow-up on the electrodes must be unusually long in order to develop sufficient grain growth in one operation. The ingots must not show any cracks except very slight ones at the end, unavoidable because of the cooling effect of the electrode.

The material is then rolled into sheets, or may be swaged round in ordinary swaging machines. The drawing operation in the manufacture of molybdenum wire may begin as large as 0.100 in. A piece $\frac{1}{16}$ in. in diameter may be bent cold in a radius of approximately 3 in. The material is machinable and is highly resistant to most alkalis and acids. It takes a very high polish.

The Fansteel company is issuing a series of loose-leaf sheets which it is intended will cover the subjects of tungsten and molybdenum with some thoroughness. Arrangements have been made so that copies of these sheets may be secured on application.

The laboratory of the company is engaged in assembling data for publication from its extensive work with both metals.

SEARS, ROEBUCK & CO.

Four departments of the plant were visited by the members—namely, the color plant, the paper mill, the wallpaper printing mill and the shade-mounting department.

The raw material for the manufacture of wallpaper is gathered from the waste baskets in Sears, Roebuck & Co.'s large establishment, and in addition is purchased from employees at a price of about 2c. a lb.

All this paper is unbaled on platforms in front of a dust remover, which consists of a revolving screen within a chamber where exhaust air is applied. It comes from this dust remover onto a belt, where it is picked by hand and the various qualities of scrap thrown into chutes. From these chutes it is carried by belt conveyor to the various bins. The company is erecting a new plant which will produce forty-five tons of wallpaper daily, against the present production of eighteen tons.

The paper is pulped in hot water at a temperature of about 140 deg. F. in a mixer, while color, together with a rosin sizing binder, is added. The pulp passes from the mixer to a screen, where the heavy particles are removed and returned for further mastication. Material which passes through the screen goes to a Fourdrinier paper machine, which makes a roll of about 40 in. in width. From the Fourdrinier the paper passes through a first and second set of pressing rolls and then into the drying rolls, thence to large calenders, and finally into the slitter and winder, where it is cut to 19½ in. widths —the standard size for wallpaper.

The color plant employs vegetable, mineral and coal-tar dyes. The individual ingredients are dumped into the agitated mixing tank shown in Fig. 17 and various colors are drawn off from these tanks into larger vats shown in Fig. 18. From these vats they are pumped into a filter press shown in Fig. 19. The cake from these processes is ready for mixing with the clay base. The additional unit which is being installed at the plant, instead of a filter press, includes a 6 x 6-ft. Oliver filter wheel.

The clay, which is a South Carolina kaolin, is beaten to a creamy mixture in the apparatus shown in Fig. 20 and then pumped to mixing tanks on the upper floor.

In these tanks the ground coat for printing on the paper is colored by the material brought from the filter presses. The other inks which go over this ground coat are mixed by hand with the clay in tanks near by. One of the printing machines applies a varnish coat which goes on over the color. It is a cold cut gum spirit tile varnish. A specialty oil-color mixing plant is also in operation and is equipped with Kestner & Hecht apparatus throughout. The departments auxiliary to the wallpaper plant are a modern white tile laboratory, a complete machine repair shop, a wallpaper catalog printing department and a roller manufacturing department.

The rollers from which the designs are printed onto the wallpaper are made of wood, the designs being hammered in from cut pieces of brass. After the pattern is thus made on the roll the metal is turned down to exact diameter for the presses.

HEATH & MILLIGAN CO.

This is a modern and well-operated plant for the grinding and mixing of various paints and colors. Some of the raw materials used are English whiting, barytes, white mineral primer, arctic zinc, polar zinc, Carter white lead and National white lead. The various departments involve the grinding and mixing of enamels, varnish, paint, heavy outdoor paints and dry colors.

The laboratory of this plant has done a large amount of research work in the past and is completely equipped for paint analyses and control.

The company has issued a booklet entitled "Select Methods of Paint Analysis," which involves methods of analysis for mixed paint, white pigments, sulphur trioxide, various color pigments, including red lead and orange mineral, analyses of Chinese white and blue, ultramarine blue, chrome green and many other special products.

Since this company has been recently purchased by the Glidden Varnish Co., the research work will probably be carried on elsewhere.

New Sulphuric Acid Plant for Montevideo

A factory, equipped with the most modern apparatus for the production of sulphuric acid in large quantities has been installed recently in Montevideo as an annex to the Chemical Institute in that city. It is reported by Consul David Myers that the capacity of the plant is greater than the needs of the country, and that its product, of 66 deg. test, can be sold at 8.5 centesimos per kilo (3.98c. per lb.), while the imported article is quoted at 10 centesimos per kilo (4.69c. per lb.). It is expected that the loan of 130,000 pesos ($134,420), which was made by the Bank of the Republic for the installation of the laboratory, will be paid by the profits of the establishment within ten years. The name of the director of the Chemical Institute, who is an American, may be obtained from the Latin American Division.

The Manufacture of Lime for Chemical and Metallurgical Purposes*—I

A Description of Shaft Kilns, Their Design, Construction and Method of Operation—An Improved Shaft Kiln With Reinforced Concrete Shell—Furnace Box and Arch—Cooling Cone—Distribution of Heat—Fuels and Their Consumption

BY RICHARD K. MEADE

KILNS employed for burning lime may be divided into two classes—intermittent kilns and continuous kilns. The latter class in turn may be subdivided into rotary kilns and shaft kilns. The shaft kilns may be again subdivided into mixed-feed and separate-feed kilns.

The intermittent kilns are usually known as "pot kilns" from their shape. They are primitive, uneconomical and are seldom used except for burning lime for the farm, where they are employed to some extent because they are inexpensive to construct, as they can be built of rough local stone. These pot kilns are built in the side of a hill in order that the limestone may be dumped into the top by means of carts.

In charging such kilns, an arch of the larger pieces of limestone is first built 2 to 3 ft. from the ground and the limestone to be burned is piled on top of this, using pieces averaging in size from 2 to 8 in. thick. A wood fire is started below the arch and the flames from this pass up through openings in the latter and between the stone. The fire is usually maintained for about two days, when the kiln is cooled. Old kilns of this sort are to be seen along the roads in any limestone country.

CONTINUOUS SHAFT KILNS

As has been noted, the continuous shaft kilns may have either a mixed feed or separate feed. Both types are used for producing chemical and metallurgical lime. In the former class, the fuel comes in contact with the limestone; in the latter, the fuel is burned on grates and only the products of combustion come in contact with the limestone. The common type of mixed-feed kiln employed by lime manufacturers is similar in design to a large pot kiln, but is equipped with gates at the bottom of the kiln through which the lime may be drawn as burned.

Vertical kilns of mixed-feed type used in chemical plants are very similar to the separate-feed kilns described further on except that they are not provided with fireboxes on the side of the shaft. They consist generally of a shaft 40 to 50 ft. high lined with firebrick and covered either with a steel jacket or with steel bands. They are equipped with gates through which the lime may be drawn at regular intervals from below. When such kilns are used in the sugar and soda industries they are provided with a closed top and the products of combustion are drawn off by means of a fan in order that the carbon dioxide may be utilized. No detailed description of such kilns need be given, as in a well-constructed mixed-feed kiln the structural features are quite similar to those described further on for separate-feed kilns.

In charging such a kiln, the fuel (coke or small size anthracite coal) and limestone are added in alternate layers. Fire is started at the bottom and works its way up. The process of charging and drawing the kilns is continuous. These kilns are economical of fuel and for the same size kiln give a larger quantity of product than that given by the vertical kilns with separate feed. Their exit gases are also usually somewhat richer in carbon dioxide. On the other hand, the lime is contaminated by the ash of the fuel. When such lime is used for building purposes or for metallurgical work, it must be carefully sorted in order to discard the lumps to which the fuel ash has adhered. Where the lime is to be slaked for milk of lime, the separation of the ash and the lime can usually be effected by passing the milk through a screen, or where used to causticize, by placing the lime in a wire cloth basket and dipping in the causticizing tank.

IMPROVED SHAFT KILN

The vertical kiln with separate feed usually consists of a steel cylinder lined with firebrick, into the top of which the limestone is charged. The kiln is heated by from two to four dutch ovens built into the side of this so that the products of combustion pass into the latter while the ash of the fuel remains on the grates. The burning is done in the zone between the ports of the furnaces. The lime is drawn out below.

Fig. 2 illustrates a shaft kiln designed by the writer which may be taken as fairly representative of this type of kiln. There is nothing very original about the general design, but the lines have been so worked out as to give the proper fuel economy and quality of lime. Added to this are certain features intended to facilitate the operation of the kiln, cut down repairs, cheapen the construction, etc.

The dimensions of the kiln are altered usually to suit local conditions and the lime to be burned. With soft limestone, the kiln is not usually made so high as with the hard stone, because the former will not stand so great a weight of stone without crumbling. Where the limestone is hard to burn, the diameter is usually less, while with easy burning material such as dolomite, the diameter is greater. The diameter is also increased where gas is used as fuel.

Generally speaking, the kiln consists of a steel shell 11 ft. in diameter and about 38 ft. high. This shell rests on a solid block of concrete and terminates in a steel cooling cone. This shell is divided into two parts. The upper 5 to 6 ft. is unlined and forms a

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

bin for the storage of the stone so that the kiln does not have to be continuously charged. The lower section of about 32 ft. is lined with firebrick, and in this the stone is burned.

Furnace and Cooling Cone

The kiln is equipped with two furnaces, one on each side. These are supported on a reinforced concrete floor level with the bottom of the shell and 12 ft. above the floor on which the lime is drawn. Usually the reinforced concrete firing floor is extended from 10 to 20 ft. beyond the firebox front in order to give ample space for the burners to work and on which to pile the coal for burning, etc.

The cooling cone is of steel plate and is so placed that the air can circulate freely around it. This cone receives the red hot lime from the burning zone of the kiln. The function of the cone is to cool the lime. The bottom of the cone is closed by means of a pair of doors which swing from pivots supported by two small I-beams. The doors are pulled outward by means of a pair of levers when the lime is to be discharged and pushed shut when this has taken place. The cone is far enough from the floor to allow a car to be run under the doors into which the lime is discharged. The levers operating the doors are located outside of the kiln and permit the operator to stand away from the dust and heat while the lime is being drawn. The doors can be adjusted to give a close fit to the bottom of the cone. There is a free passage entirely around the cone and no blocking up occurs as in most other forms of discharge. The cone is provided with a poke hole closed by a sliding shutter to be used in case the lime does not discharge freely due to arching. In some of the writer's newer kilns he has placed a water-jacket around the upper part of the cone in order to increase the life of this.

The track by means of which the kilns are charged passes over one side of the kiln so that the cars dump directly into the center of the kiln, giving an even distribution of the charge. The track is supported on light steel I-beams and a platform of perforated metal supported by brackets and inclosed by railings runs around the top of the kiln and between the rails. A heavy ring of steel plate protects the top of the brick from damage by the falling stone.

Where these kilns are used for building lime it is usual to carry the lime from them by means of barrows or cars. A more approved method, however, would be to place a pan conveyor under the cooling cone and draw the lime immediately onto this and so convey it to the point of use.

Reinforced Concrete Shell

During the last few years the cost of the steel jacket for the kiln has been quite an item and a cheaper material which could be substituted for this has been desirable. Having great faith in reinforced concrete, this latter material naturally suggested itself to the writer.

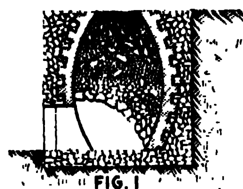
As the result, plans were drawn about three years ago for two kilns with reinforced concrete shells which were built at a small plant in Virginia. These have been in use for several years, long enough to show that the material and form of construction are entirely satisfactory. Since these were built the writer has designed reinforced concrete kilns for several other lime plants. There are other advantages in this form of construction besides cheapness, the principal ones being that the shells do not have to be painted, as they are not subject to corrosion, and there is less loss of heat by radiation.

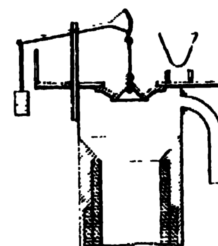
The reinforced concrete kiln does not differ very materially from that which I have illustrated. Proper means are, of course, taken to heat-insulate the concrete shell. The cooling cone is made of steel and there is the same unlined top serving as a stone bin.

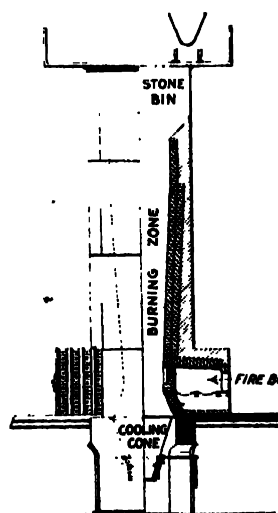
The arches over the furnace ports are a weak point in the shaft kiln. These arches are not only subject to destruction from the heat but they carry the weight of the lining, etc., above them. In the reinforced concrete kiln, this weight has been taken off of the arch by means of a reinforced concrete girder extending over the firebox.

Draft and Distribution of Heat

With all types of shaft kiln one of the points to be watched is the draft. This must be so regulated by the design that the contents will be uniformly heated, otherwise some of the lime will be overburned and some of it not burned enough. In some instances stacks are placed on the shaft in order to induce a better draft. Induced draft is also employed, the products of combustion being sucked from the top of the kiln by means of an exhauster. Where this is







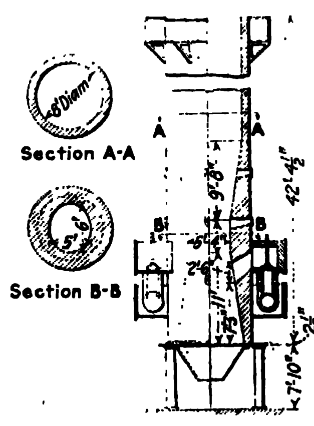


Fig. 1. Old style pot kiln. Fig. 2. Shaft kiln with separate feed. Fig. 3 Closed top for shaft kiln. Fig. 4. Producer gas-fired kiln.

done it is, of course, necessary to close the top of the kiln and to charge the limestone into the latter through a door or a charging "bell" somewhat similar to that of a blast furnace. Fig. 3 shows such an arrangement. When the kiln gases are drawn off for their carbon dioxide this bell type is generally employed.

A less satisfactory method of artificial draft is to force the fire by means of a blast below the grates. This usually takes the form of a steam blower. If

the fire is blown, there is a tendency for the flames to come out around the furnace door rather than to pass through the shaft, but the steam itself is beneficial.

If the kilns are too large in diameter, the heat will usually not carry to their centers and so the stone in the center of the kiln will not be burned properly. The writer has found that, owing to the fact that the gases from the firebox show a tendency to hug the sides of the kiln, the latter may be made of greater diameter across the center line of the fireboxes than along this line. This makes a horizontal cross-section of the kiln at the fireboxes elliptical in shape. Two sides of the kiln are straight down to the cooling cone, while the other two sides are drawn in slightly as shown in Fig. 2. If drawn in too much, and with some stone if drawn in at all, the charge will stick and hang up in the kiln.

The lime is usually drawn every three to six hours, although a few plants draw oftener and some less frequently. Large kilns are sometimes provided with a continuous draw. The objection to drawing too often is that each time the lime is drawn cold air enters the kiln through the drawing doors and cools off the charge. This s .ie objection has been raised to kilns provided with a continuous draw—namely, the continual current of air entering where the lime is drawn passes up through the center of the kiln and prevents the proper burning of the lime at this point.

The charge sometimes sticks in the kiln, and openings closed by proper means are usually left on both sides of the shaft just above the furnaces through which bars may be introduced. It is claimed that kilns lined with silica brick show less "hanging up" than kilns lined with ordinary firebrick, due to the fact that the silica brick lining very soon scorifies and becomes smooth.

Fuels and Their Consumption

This type of kiln may be heated by wood, coal, oil, natural or producer gas. Wood is supposed to burn a better quality of lime than any other fuel, due to the low temperature of the flame and the length of this, and for this reason it is sometimes used for burning building lime; but it is very seldom used for burning chemical and metallurgical lime owing to its cost. The majority of kilns of the type given employ coal. This should be what is known as "long flame" coal, high in volatile matter and preferably low in sulphur and ash.

Where obtainable, oil makes an excellent fuel. When it is used in the kiln described, the burner is placed in the door openings of the fireboxes and these are bricked in with firebrick, leaving openings for the burner and for observing the lime, etc. The grate bars, if already in place, are covered with firebrick, or if a new kiln, the firebox is simply filled up to the point of the grate bars with some suitable material and covered with firebrick.

Natural gas may be used in this kiln and also producer gas, but better results can be obtained by modifying the lines of the kiln to suit this latter fuel.

Producer gas is quite extensively employed for burning lime. Its advantages and disadvantages are a matter of dispute. One of the principal good points is the fact that very much larger gas-fired kilns can be built than is possible with hand firing. Some of the more recent gas-fired kilns have a capacity of from forty to sixty tons of lime per day each. This increased size of the kiln is made possible by the introduction of gas and air at various points around the kiln so as to obtain uniform temperatures throughout the stack. Fig. 4 shows a gas-fired kiln.

Producer-gas kilns are slightly more economical of both fuel and labor than grate-fired kilns. Unless carefully handled, however, they give lime which is unevenly burned. More skill is required in burning lime with producer gas than with any other fuel, and considerable experimenting is usually done before satisfactory results are obtained.

In applying producer gas to vertical kilns, the main points to be watched are proper mixing of the gas and air in the shaft and preventing the accumulation of lime in the gas ports. This latter blocks the flow of gas, causing irregular distribution of the heat and hence under-burning of the lime in certain parts of the shaft. In the type illustrated this trouble has been avoided by sloping the gas ducts downward toward the kiln. The points given further on in this

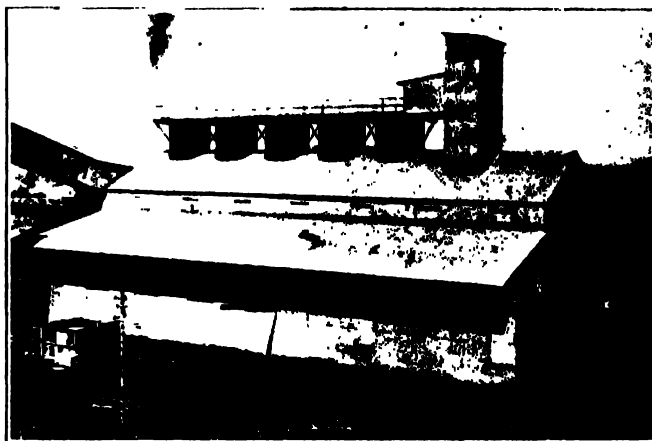


FIG. 5. LIMEKILNS OF THE CLINCHFIELD PORTLAND CEMENT CO.

series under "Producers for Heating the Rotary Kiln" follow also with the vertical.

The shaft kiln described, heated with wood, coal or oil, will produce from eight to twelve tons per day depending on the kiln and quality of the limestone employed. When fired with gas the capacity will be from seventeen to twenty-five tons.

Quantity of Fuel Required

The quantity of fuel required varies also and depends on many things, among which may be mentioned the kind and quality of fuel, skill of the operator and the limestone itself. Magnesian stone burns more easily than high-calcium stone. The amount of fuel actually required is about as follows:

One ton of good bituminous coal hand fired will burn from three and one-half to four tons of lime.

One ton of good bituminous coal in the gas producer will burn from three and one-half to five tons of lime.

One barrel of fuel oil will burn one to one and one-quarter tons of lime.

One cord of seasoned hard wood will burn from two and one-quarter tons to two and three-quarters tons of lime.

The problem of carrying the stone to the top of the kilns is usually taken care of, where the kilns are lo-

cated at the quarry, by means of a hoist and an incline, the latter running from the quarry floor to the top of the kiln. At chemical plants where the stone is brought in by rail the incline may be used, or in many cases a platform elevator is to be found more satisfactory because of the room saved.

A plan adopted at one of the plants designed by the writer would no doubt be satisfactory in many chemical works. In this plant the railroad cars are pushed on a trestle over storage bins. Each bin has an iron chute closed by a swinging gate through which the stone is discharged. A track extends in front of the stone bins and 9 ft. below the bottom of them and the stone is discharged through the chutes into small side dump cars, which are pushed along the track into the lime plant. The track is covered by a shed so that the drawing of the stone is not interrupted by bad weather. The cars after entering the kiln building are carried to the top of the kilns by a platform elevator.

Fig. 5 shows a battery of shaft kilns. Where only eight to twenty tons of chemical lime is required one or two shaft kilns will prove the best plant, but where larger outputs of chemical lime are needed the rotary plant will prove more economical.

Parts II and III, dealing with Rotary Kilns and Operation, respectively, will appear in subsequent issues.

The Camphor Industry in Foochow

TREES fit to be used for camphor distillation must be at least twenty years old. When a suitable tree is found a crude native distillery is set up at the spot. This consists of a boiler, with an iron base and a wooden top, connected to a distilling vat partly filled with water. The camphor upon being conducted to the vat precipitates as crystals on the inner walls, while the non-precipitable portions drop down as oil, which floats upon the water. About 5½ lb. of camphor and camphor oil, in the proportions of 70 per cent camphor and 30 per cent camphor oil, can be produced from 240 lb. of chips.

The districts where most of this initial distillation is done are Kienning, Yuchi, Yungan, Yenping, Tatien, Shaowu, Shahsien and Ningte, reports Vice-Consul E. B. Price, in *Commerce Reports.*

It is almost impossible to say how many men are engaged in the industry, but there cannot be many. Their wages are equal at the present rate of exchange to about $0.38 a day.

The crude product is carried by porters to the Min River or one of its tributaries, and then carried to Foochow by native boat. Boat hire is approximately $1 per cwt. from the interior to Foochow.

How Marketing Is Done

The marketing of camphor is done very largely through brokers in Hongkong. The distilleries seldom do their own marketing, with the exception of the Japanese and Portuguese. There are also brokers in Foochow able to handle foreign orders in the English language.

It should be borne in mind that the camphor market is an extremely sensitive and dangerous one for the uninitiated. The factors of supply, governmental supervision, freights, stocks in Foochow and Hongkong, and three markets—Foochow, Hongkong and the foreign market—all enter into the situation. Hence no better scheme than the brokerage system can be suggested, unless the foreign buyer is prepared either to go into the producing end of it or into the buying and holding of considerable stocks himself.

Distillation of the Oil

The product as it leaves the distillery in the interior consists of crystals and camphor oil. The crystals are ready for marketing, but the oil is put through a process of redistillation at Foochow. This process is a simple one, and need not be described here in detail. The effect is to distill from the oil all the remaining camphor; 133 lb. of oil produces 64 lb. of camphor and 27 lb. of desolated oil. The camphor derived from oil is of a cheaper grade than that derived originally from the wood chips. The desolated oil is used as a base for dyes and paints.

There are twelve of these distilleries in Foochow which produce camphor from the oil. They are known as the Yuan Cheng, Hsing Chi, Cheng Chi, Hsiang Chi, Fu Sheng, Hsieh Chi, Kao Fang and Tao Ho—all Chinese; Ting Te—Portuguese; and Mitsui Bussan Kaisha and Tai Hua—Japanese. When working, each distillery produces on an average 325 lb. of camphor a day.

The Government Camphor Bureau

The various districts producing camphor have each an official camphor bureau under the control of the Provincial Commissioner of Industry. Each bureau has the authority within the district it covers to collect certain taxes and to buy camphor trees and distill camphor. In American currency the tax is approximately $6 on every 133 lb. of camphor in transit. The taxes collected and the camphor produced are sent to another government bureau called the Fukien Government Camphor Industry, Transportation and Tax Collection Office. Its duties are to take in and turn over to the provincial government the taxes remitted by the various district bureaus and to take in and market the camphor that is received.

There is still a third bureau which has authority to buy camphor oil and distill it into camphor, marketing its product independently.

Private producers must take out licenses and agree to pay the taxes hereinbefore mentioned. In addition to this there is a license fee of $2 local currency per month per vat.

Regulations for Foreigners

Foreigners wishing to go or send into the interior to purchase camphor under what is known as the "transit pass" system, permitted by treaty, may still do so. Under this system the foreign exporter may bring the native product to the seaboard and export it to a foreign country by paying the regular 5 per cent export duty plus a surtax of half the export duty. The foreigner may purchase either from the private producers or from the government bureau. The effect of the government bureau system is to tax the product just the same, because the foreigner may not operate his own distillery in the interior, and government taxes are imposed on the distillery and its product before the foreigner purchases the camphor.

Japanese distilleries operating in the city of Foochow are not taxed, according to information given by the Japanese consulate in Foochow.

Synopsis of Recent Chemical & Metallurgical Literature

Titanium Pigment Industry in Norway.—In view of the growing importance and increasing output of titanium dioxide as a pigment in active competition with lithopone, the *Chemical Trade Journal and Chemical Engineer* has published (Sept. 25, 1920, p. 407) a short account of the process used by the Titan Co. of Fredrikstad, Norway.

Although extensive deposits of titanium ore are found in the New World, Africa and Australia, the only deposits of any importance in Europe occur in Scandinavia and in the Urals, where the titanium oxide is found in combination with iron oxide, as titaniferous iron ore or ilmenite. The most interesting deposits in Scandinavia are found in Norway, in Sogndal, south of Egersund, at Raagefjord, and Jössingfjord. These are Laxedalsfelterne, with ore containing about 35 per cent of TiO_2, in quantity 250,000 tons; Blaafjeldet, with ore containing about 40 to 45 per cent TiO_2, in quantity about 100,000 tons; and Storgargen, with ore containing about 25 to 40 per cent TiO_2, in quantity about 3,000,000 tons. It is from the two latter deposits that the Titan Co. obtains its ore.

The ore is sorted, pulverized, classified and washed over washing boards. The dressed ore is now carried seven kilometers by rail to Raagefjord and from there shipped to Fredrikstad. After being dried and finely ground the ore is thoroughly mixed with sulphuric acid in a special mixing apparatus, and the mixture is then transferred to a decomposition plant, where the reaction between the acid and the ore is started by gas heating. The apparatus works continuously and delivers the decomposed titanium ore and sulphuric acid mass in the shape of cakes, in suitable sizes, which are crushed and ground and then dissolved in water. The titanium and iron solution obtained in this way contains particles of non-decomposed minerals. It is necessary to separate these particles from the solution. Filtration has been tried in every possible way, but the problem could not be solved in a practical manner. In the present process the undecomposed mineral is separated by settling in large vessels. Certain devices are used by which the speed of the settling is greatly accelerated. The quite clear solution is then electrolytically reduced, whereby the ferric iron is converted into ferrous iron. On boiling in a vessel provided with internal steam coils the titanium dioxide falls out as a white amorphous powder.

The elimination of ferrous sulphate and free sulphuric acid from this powder constituted one of the most difficult technical problems. It was impossible to find a suitable filter, both on account of the extreme fineness of the titanium oxide particles, and on account of the corroding effect of the acid solution. A washing system was eventually adopted, in which practically all the iron is removed. Traces of sulphuric acid are eliminated by the addition of barium carbonate, and so the final product contains a certain amount of barium sulphate. Very minute traces of iron—0.02 per cent—are sufficient to discolor the product, and the details of how the last small traces of iron are removed are not divulged, although it is suggested that it is effected by adding substances which form colorless compounds with iron. The product is calcined, ground to such a fineness that 99.95 per cent passes through a mesh of 5,000 to the sq.cm. The pigment is then mixed with linseed oil and a little zinc white is added. After thorough incorporation in the edge-runner mill, the product is ready for use.

As compared with white lead and zinc oxide, the advantages titanium-white offers are said to be considerable. It possesses a greater covering power than either, is non-poisonous and is chemically inert. Unlike zinc oxide, it exerts no saponifying action upon the linseed oil. Its low specific gravity (4.0) renders it very easy to apply.

In connection with the experimental work on titanium-white, Prof. V. M. Goldschmidt, who microscopically investigated the differences in covering power of titanium-white in various states of subdivision, arrived at the conclusion that among other things the covering capacity of a pigment depends upon the difference between its own refractive index and that of the binder used, and in this connection it is interesting to note the following figures: If the refractive index of linseed oil be assumed to be 1, then the refractive index of zinc oxide 1.34, of white lead 1.36, of amorphous titanic oxide 1.48, and of crystallized titanic oxide in the shape of rutile 1.80. This difference in refractive indices would seem to account for the greater covering capacity of titanium-white.

It is interesting to note in connection with the foregoing abstract that the titanium pigments which are being made in the United States by the Titanium Pigment Co. of Niagara Falls resemble lithopone both as to barium sulphate content and as to specific gravity. Thus, BXX Titanox (sp. gr. 4.28) consists of 25 per cent TiO_2 and 75 per cent $BaSO_4$ while a well-known brand of lithopone contains 30 per cent ZnS and 70 per cent $BaSO_4$ and has the same specific gravity (4.28).

Commercial Possibilities of Government Nitrate Plants.—The first issue of *Army Ordnance*, the organ of the Army Ordnance Officers Association, contains an interesting general article on the nitrate situation, written by Colonel JAMES H. BURNS, Chief of the Nitrate Division. It contains some new pictures of the Muscle Shoals nitrate plant. The author enters into the uses of nitrogen compounds in war and peace, the sources of supply and the Government developments in nitrogen fixation during the war. After touching upon the by-product coke-oven supply in peace time he writes as follows:

"We have made quite careful and thorough analyses of the costs of producing nitrogen compounds at the No. 2 Plant (Muscle Shoals), and as a result thereof we believe that the materials can be produced at a price that should be satisfactory to both the Government and the consumer . . . and it is our judgment that the market can easily absorb the products without appreciably interfering with the present sources."

Before outlining the War Department scheme for the solution of the problem of operating the nitrate plants as incorporated in the United States Fixed Nitrogen Corporation bill, now enjoying a position of prestige on the calendar when the Senate again convenes, the Government made every effort to lease or sell the plants to private interests, but met with no success. The article is a clear, concise and reasonable exposition of the Government's case.

Recent Chemical & Metallurgical Patents

British Patents

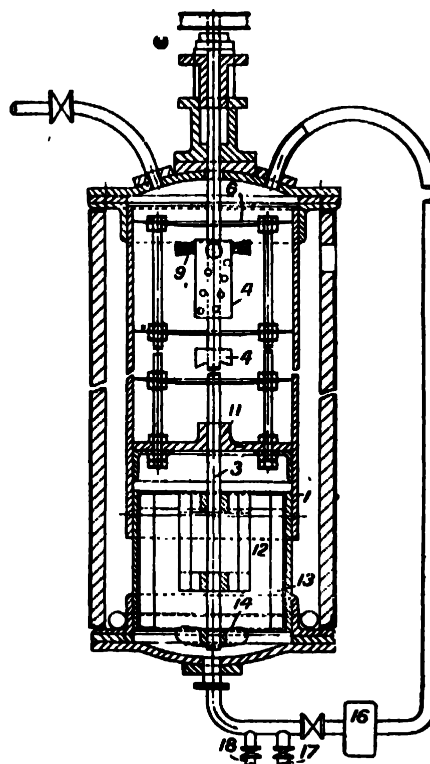
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treating Vegetable Fibers.—Vegetable fibers of all kinds, whether in the mass or in the form of lap, yarn of fabrics made therefrom, are given the character of wool and an increased affinity and absorbent capacity as regards basic and other dyestuffs, by precipitation thereon of products resulting from the action of concentrated nitric acid upon starch or other amylaceous substance, the precipitation being effected either by washing with water or by treating with dilute solutions of acids, bases or salts followed by washing with water. The fibers may be impregnated with the solution of starch, etc., in concentrated nitric acid, the excess being pressed out, and the nitrated amylaceous substance precipitated upon the fibers by washing; or the fibers are impregnated with a paste or aqueous solution of starch, etc., dried, passed into concentrated nitric acid, and the nitrated amylaceous substance precipitated upon the fibers by washing. Print effects may be obtained on plain fabrics by direct impression or by the use of resists either by means of a solution of starch or other amylaceous substance in concentrated nitric acid, or by means of a paste or aqueous solution of starch, etc., which is treated, after drying, with concentrated nitric acid, the fabric being, in each case, treated with water or with dilute solutions of acids, bases or salts followed by washing with water to precipitate the nitrated amylaceous product. In an example of treatment, a paste is prepared by heating together 40 kilos of maize starch and 75 liters each of water and acetic acid. The textile is dressed with the paste, dried, treated for three to five minutes with 72 per cent nitric acid at a temperature of 15 to 20 deg. C., the excess of acid is pressed out, and the material is passed through a 10 per cent solution of sodium bisulphate, and washed with water. Specification 136,568 is referred to. (Br. Pat. 144,204—1919. GILLET ET FILS, Lyons, France, Aug. 5, 1920.)

Lead and Silver Chlorides.—Sulphide ores and products containing silver, lead and zinc sulphides are partially chloridized, for instance by heating with enough zinc chloride to chloridize the silver and lead, and the product, from which the excess of zinc chloride may be removed by leaching with water acidified with hydrochloric acid, is then leached with a solvent such as cold brine containing ferric chloride and which may be saturated with lead chloride, so as to extract the silver alone, and the residue is then leached with hot brine for dissolving the lead chloride. (Br. Pat. 144,260—1919. AMALGAMATED ZINC (DE BAVAY'S), LTD., Melbourne, Aug. 5, 1920.)

Sodium Hydrate. — Caustic soda is obtained by emulsifying a soda solution with lime by means of a "turbo-mixer" having at least one turbine-wheel or centrifugally-acting blade-wheel. The reaction is effected in the cold, for instance in about fifteen minutes. (Br. Pat. 144,266—1919. SCHWEIZERISCHE SODAFABRIK ZURZACH, Argovie, Switzerland, Aug. 5, 1920.)

Hydrogenating Oils and Fats.—An apparatus for use in the hydrogenation of oils and fats comprises a vessel 1 jacketed for heating and provided internally with means for converting the mixture of oil and catalyst into a mist or rain, and externally with a pump 16 for withdrawing the oil from the lower part of the vessel and returning it to the upper part for the treatment with hydrogen to be repeated; the means for spraying the oil comprises a series of buckets 4 mounted on a rapidly-rotating vertical shaft 3 and provided on their peripheries with sockets in which brushes 9 with short flaring bristles are mounted, so that oil delivered into the buckets by disk-shaped plates or partitions 6 is by centrifugal force caused to travel along the interstices of the brushes and to be delivered into the atmosphere



of hydrogen within the vessel as a mist or rain. The shaft 3 is mounted in a steadying plate 11, and below this is a stirring device for the oil that collects, consisting of blades 12 carried by the shaft 3 and blades 13 fixed to the casing; and below this, also carried by the shaft, is an agitator 14 to prevent settling of the catalyst. Connections 17, 18 are provided for the supply of oil and hydrogen. Specification 1380—1915 is referred to. (Br. Pat. 144,478—1919. BLAIR, CAMPBELL & MCLEAN, D. A. BLAIR and J. L. FERGUSON, Glasgow, Aug. 11, 1920.)

Azo Dyes.—Azo dyes are prepared by coupling diazo compounds containing a sulphonic or carboxylic acid group in *o*-position with 5 : 5'-dioxy-2 : 2'-dinaphthylamine-7 : 7'-disulphonic acid. According to examples there are obtained: A monoazo dye from 4-chlor-2-aminobenzoic acid and the second component; a primary disazo dye from two molecules of anthranilic acid and the second component; a primary disazo dye from 4 : 5-dichloraniline-2-sulphonic acid, 4-chlor-2-aminobenzoic acid, and the second component; a primary disazo dye from anthranilic acid, 4-chlor-2-aminophenol, and the second component; a trisazo dye by diazotizing the monoazo dye from anthranilic acid and 3-amino-4-cresol methyl ether and coupling with the monoazo dye from

anthranilic acid and the second component; a primary disazo dye from 1-naphthylamine-2-sulphonic acid, 4-chlor-2-aminobenzoic acid, and the second component; a primary disazo dye from two molecules of 4-dimethyl-amino-1-amino-benzene-2-sulphonic acid and the second component. The products dye cotton red to blue shades fast to ironing and the dyeings may be aftertreated with copper sulphate. (Br. Pat. 144,310—1919. FARBENFABRIKEN VORM. F. BAYER & CO., Leverkusen, Germany, Aug. 5, 1920.)

Borneol.—Borneol is prepared by heating pinene with tetrachlorphthalic acid and hydrolyzing the resulting dibornyl ester. (Br. Pat. 144,604—1919. FABRIQUES DE PRODUITS, CHIMIQUES DE THANN ET DE MULHOUSE, Thann, France, Aug. 11, 1920.)

Freeing Anthracene From Carbazole.—Crude anthracene is freed from carbazole by boiling with caustic potash in a neutral solvent—e.g., naphtha—while distilling off the water formed. The potassium-carbazole formed precipitates and is removed and worked up to carbazole. (Br. Pat. 144,648—1919. See also 144,656—1919. KINZLEBERGER & CO., Prague, Aug. 11, 1920.)

American Patents

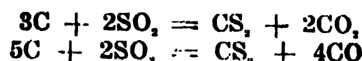
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Sulphuric Acid Manufacture.—Another sulphuric acid plant design which shows the tendency away from the lead chamber process is that of KENNETH B. QUINAN of Somerset West, Cape Province, South Africa. Instead of passing through the customary lead chambers, the gases are forced upward through diaphragms over which a constant flow of sulphuric acid is maintained. Products of the gaseous phase reactions and heat of reaction are rapidly absorbed by the circulating acid. It is convenient to arrange the diaphragm devices in series or in series-parallel. (1,348,-736; Aug. 3, 1920.)

Barium Peroxide.—Barium monoxide may be converted into peroxide by treatment in an air-tight ball mill with dry ozidizing gas at a pressure of 20 to 60 lb. per sq.in. The temperature range for uniform oxidation is from 400 to 600 deg. C. By the use of a revolving mill of the type referred to, dense as well as cellular or porous monoxide may be treated with equal facility. (1,349,417; HERMAN FLECK of Golden, Col., assignor to the Peroxide Specialty Co.; Aug. 10, 1920.)

Electrolytic Chlorine Cell.—An improved form of electrolytic cell for the decomposition of brine consists of a suitable tank, a rectangular box-shaped cathode having perforated active end, side and bottom walls, a diaphragm covering the inner faces of all of these walls, and a rectangular tubular anode. Certain advantages result from this construction. For example, practically the entire inner face of the cathode, including the bottom, sides and end walls, is electrically active, and the exterior faces of the cathode are wholly unsubmerged in any body of electrolyte. By providing a water-tight and gas-tight pressure joint between the cathode and the free-board section, it is possible to build up the column of electrolyte in the free-board section so as to secure the desired hydrostatic head as the diaphragm becomes more or less clogged with the impurities in the brine, thus insuring a longer diaphragm life than would otherwise be possible. (1,349,597; HERBERT I. ALLEN and KENT R. FOX of Portland, Maine, assignors to Electron Chemical Co.; Aug. 17, 1920.)

Carbon Disulphide.—A charge of coke is brought to a red heat in a tumbling barrel having a refractory lining. A current of sulphur dioxide is passed through the tumbler forming carbon disulphide according to the reactions:



$$3C + 2SO_2 = CS_2 + 2CO_2$$
$$5C + 2SO_2 = CS_2 + 4CO$$

As the action is endothermic, a small amount of air is admitted with the sulphur dioxide in order to maintain the proper temperature by the combustion of a part of the coke. Since the carbon disulphide vapor which escapes is mixed with CO and CO_2 it cannot be condensed by simply lowering the temperature but must be absorbed in a suitable solvent (such as certain vegetable oils) from which it can be recovered by distillation. (1,350,858; HERBERT H. DOW and CHARLES J. STROSACKER, of Midland, Mich., assignors to the Dow Chemical Co.; Aug. 24, 1920.)

Extracting Tar From Vapors.—The removal of tar from vapors resulting from the distillation of coal or wood is accomplished by bubbling the vapors first through tar and then through cresol or anthracene oil. In the case of wood distillation the process is outlined as follows by EMILE A. BARBET of Paris, France. After passing through the tar, the vapors are at a temperature of 115 to 130 deg. C. In bubbling through the cresol, only the tar will be dissolved since at this temperature the water vapor and acetic acid vapor are superheated and cannot be retained by the cresol. (1,351,363; Aug. 31, 1920.)

Sodium Hydroxide.—The reaction between disodium phosphate (Na_2HPO_4) and milk of lime is utilized by SAMUEL S. SADTLER of Springfield Township, Pa., for the preparation of sodium hydroxide.

$$2Na_2HPO_4 + 2Ca(OH)_2 = 4NaOH + Ca_2H_2(PO_4)_2$$
$$2Na_2HPO_4 + 3Ca(OH)_2 = 4NaOH + Ca_3(PO_4)_2 + 2H_2O$$

The sodium hydroxide solution is separated from the insoluble calcium phosphate. Disodium phosphate may be recovered by treating the dicalcium phosphate with sodium sulphate or the calcium phosphate with niter cake. (1,351,693; Aug. 31, 1920.)

Acid-Resistant Alloy.—Considerable interest was aroused by a note in CHEM. & MET. ENG., Nov. 12, 1919, p. 632, concerning a new Italian alloy, "biakmetal." According to the present specification, this alloy consists of:

	Range Per Cent	Typical Example Per Cent
Copper	35 to 44	40
Iron	1.5 to 4.75	3
Tungsten	3 to 6	3
Nickel	60 5 to 45.25	54

Alloys of such composition, in cast condition, have a tensile strength of about 55 kg. per sq.mm. and an elongation of about 20 per cent. They may be forged and rolled both cold and hot. After drawing, the tensile strength in some cases exceeds 100 kg. per sq. mm. The alloy is said to resist the action of acids as follows: Sulphuric acid, any strength at temperatures under 100 deg. C.; hydrochloric, acetic, citric and tannic acids, any strength at any temperature; cold nitric acid, up to 1.40 sp.gr. (1,351,811; ARRIGO TEDESCO, assignor to Societa Anonima Stabilimenti Biak, of Turin, Italy; Sept. 7, 1920.)

Ferromanganese.—The manufacture of 80 per cent ferromanganese in the blast furnace is made possible by using a blast enriched with oxygen. (1,354,490; Estate of JOSEPH E. JOHNSON, Jr.; Oct. 5, 1920.)

Current Events
in the Chemical and Metallurgical Industries

American Petroleum Institute's Annual Meeting

The American Petroleum Institute will hold its annual meeting in Washington, with headquarters at the New Willard Hotel, on Wednesday, Thursday and Friday, Nov. 17, 18 and 19, 1920. All the general sessions and group meetings will be held at this hotel, unless otherwise announced. Group meetings covering specific subjects such as Statistics, Transportation, Taxation, Research, etc., will be held in the forenoon of each day, followed by general sessions on the afternoons and evenings of the three days, with the exception of Friday evening, which will mark the Institute's annual banquet and the closing of the convention.

The general topic for consideration on the first day will be "The World's Petroleum Problem." Speakers of national and international renown will deliver addresses covering the relationship of America, Great Britain, Mexico and other oil-producing countries to the world's petroleum problem. The general topic for the second day is "The Production and Consumption Situation."

The topic for discussion at the general session Friday afternoon will be "The Future of the Oil Business." The program as outlined for the general sessions will represent the last word as to the world petroleum situation, the present-day status as to production and consumption, and a forecast as to the industry's future. Specific subjects such as transportation, taxation, statistics, research, improvements in methods, etc., will be discussed by experts in the group meetings. Throughout the three days' session the emphasis will be upon oil. Because of its national and international character, this meeting of the Institute will mark a distinct step in the industry's progress and development.

Remuneration for C.W.S. Consulting Chemists

Some difficulty is being experienced by the Chemical Warfare Service in finding a basis for the remuneration of the consulting chemists who are to be appointed. It is believed, however, that no legal or other difficulties will prevent the payment of a per diem salary, in addition to traveling expenses. General Fries is very anxious that authority be secured to pay traveling expenses, so that he will feel less hesitant in asking a chemist living at a distance to go to Washington. It is his intention to have a large number of consulting chemists attached to the service, so that the list may include specialists in a large number of subjects. As problems arise, he would like to be in a position to send for the chemist best qualified to handle each particular one. For instance, just at this time, in the study of the physiological effect of certain gases, it is highly desirable to have the assistance, for a very few days, of a chemist in a Western city, That particular chemist is thought to be best qualified to be of service in this specific juncture. It may be months before his actual presence in the laboratory again would be imperative. General Fries wants to be in a position to pay this man's traveling expenses and a per diem salary for the time he is absent from his office.

Metric System Advocated at Meeting of Rochester Engineering Society

Members and friends of the Rochester Engineering Society heard the affirmative side of the question of the national adoption of the metric system presented by Dr. W. N. Souder, of the Bureau of Standards, Washington, D. C., Friday evening, Oct. 8. At the outset Dr. Souder made clear the position of the Bureau of Standards by reading a telegram from Director Stratton, which read as follows: "The bureau believes an international decimal system of weights and measures very desirable. It has never advocated any particular method in bringing this about. We believe that the time, method and the extent of the change in any particular branch of manufacture should be settled only after a careful consideration of the question by representatives of that industry."

Dr. Souder's purpose was not to convert the engineers to the general adoption of the metric system, but to point out the drawbacks of the present English system and to show the need for a consistent standard of weights and measures. The strongest argument against the compulsory adoption of the metric system was the fact that the changing of the weight and measurement sizes would be costly. However, if in the end this resulted in a saving of time and convenience, the first expense would soon be absorbed. Dr. Souder's final plea was that "we ought to have some sort of a consistent standard of figuring."

Nominations for President of the American Chemical Society

At a meeting of the Council of the Pittsburgh Section of the American Chemical Society on Oct. 9, Dr. Raymond F. Bacon, Director of the Mellon Institute of Industrial Research of the University of Pittsburgh, was nominated for the presidency of the Society. It is understood that this nomination has received wide and cordial approval throughout the mid-continent sections.

Dr. Edgar F. Smith, provost emeritus of the University of Pennsylvania, has been proposed by the Philadelphia and Delaware sections for presidency of the Society. His nomination has received the indorsement of the New York Section. Dr. Smith served as president in 1898 and his executive accomplishments elicited the most favorable commendation.

Prof. E. C. Franklin was proposed by the Washington Chemical Society as nominee for president of the American Chemical Society for the coming year, as a result of the action taken at its last meeting, Oct. 14. At the same meeting the following four were suggested as nominees for positions as councillors-at-large of the society: George P. Adamson, James F. Norris, Arthur M. Comey, and A. C. Fieldner.

At this meeting of the section a report was given on the proceedings of the council at Chicago, and Dr W. M. Clark spoke on "Application of Hydrogen Ion Concentration Measurements in Analytical and Biological Chemistry."

Division of Technology Discontinued

Effective Oct. 15 the work heretofore assigned to the division of technology, Prohibition Unit, Bureau of Internal Revenue will be subdivided and administered by two divisions known as the Permit Division and the Industrial Alcohol and Chemistry Division. The title "Division of Technology" is discontinued.

Dr. A. B. Adams, former head of the Division of Technology, is appointed head of the Permit Division. J. M. Doran, assistant head of the Division of Technology, is appointed head of the Industrial Alcohol and Chemical Division. The change is made necessary by the increase in the work devolving upon the Division of Technology. The Permit Division will examine and pass upon applications for the manufacture of alcoholic products; determine all non-beverage uses of intoxicating liquors and limitations of such uses; fix standards for manufactured articles containing alcohol; examine bonds; conduct trade investigations to determine whether products are bona fide and whether permitted articles are manufactured in accordance with approved formulas. The Industrial Alcohol and Chemical Division will have supervision of the construction and operation of industrial alcohol and denaturing plants and control of the work of the plant officers; develop uses of denatured alcohol by laboratory work and research; examine denatured alcohol samples; examine samples of toilet articles, flavoring extracts, etc., and report result of analysis to the Permit Division.

Contribution for Co-operative Research From General Electric Co.

The General Electric Co. has contributed $30,000 to extend the investigations of the Committee on Fatigue Phenomena of Metals, of the Division of Engineering of the National Research Council. Engineering Foundation Board about a year ago made a grant of $15,000 a year for a period of two years for the investigation of fatigue phenomena in carbon steels. Articles of agreement were drawn up among the National Research Council, Engineering Foundation and the University of Illinois, whereby the experimental work was to be done at the University of Illinois under the direct supervision of Prof. H. F. Moore.

The contribution of the General Electric Co. was made in order to extend the work to include 3 per cent and 3½ per cent nickel steel. This extension is to be considered part of the original program and no restriction is placed by the General Electric Co. on the publication of the results. Although the results of this work on nickel steels will be of immediate commercial value to the General Electric Co., they will also be of value to other manufacturers.

Quarters Sought for Chemists at Edgewood

The Chemical Warfare Service not only is having difficulty in obtaining civilian chemists at the salaries allowed by the Government, but is having trouble in keeping such chemists as are obtained, due to the absence of proper housing in the vicinity of the arsenal. General Fries has applied to the General Staff for permission to erect twenty-four five-room cottages. The General Staff is not inclined to give its permission, as it has not been the policy to supply quarters for civilians. General Fries states that it will be necessary to depart from the rule if chemists and technical men are to be induced to stay at Edgewood.

Merger of Pittsburgh Plate Glass Co., Columbia Chemical Co. and Patton-Pitcairn Proposed

To insure the full requirements of soda ash which the Pittsburgh Plate Glass Co. uses in large quantities in the manufacture of its products the company proposes to acquire the chemical plant and business of the Columbia Chemical Co. This latter company has a plant located at Barberton, Ohio, with a productive capacity of about 700 tons of heavy chemicals per day. Its principal products are soda ash and caustic soda, with lime fertilizer as its chief byproduct. The company also owns a fine limestone property near Zanesville which is being equipped and will be in operation in November.

Realizing the advisability and advantages in participating in the manufacturing and sale of kindred products such as window glass, art glass, paints, varnish and dry colors, the Pittsburgh Plate Glass Co. has also acquired controlling interest in the Patton-Pitcairn Co. and its subsidiaries, thereby securing a lasting commercial arrangement to participate in the production of these products. Consolidation arrangements have been approved unanimously by the boards of directors and it is expected that the plans will be ratified by the majority of stockholders in the near future.

Dye Bill to Be Pushed

Friends of the dyestuffs bill, which passed the House at the last session of Congress and now in amended form is at the head of the Senate calendar, have been busy during the recess of Congress securing pledges that this legislation will be pushed when Congress meets again in December.

On the other hand, it is recognized that the short session gives great advantage to such experienced opponents of the measure as are Senators Moses and Thomas. It was the Moses-Thomas opposition which prevented the bill coming to a vote at the last session. Since the appropriation bills and a vast amount of other legislation of first importance must be taken care of during the short session, there is a general disinclination to take up a matter which is certain to call forth protracted discussion. The opposition to the bill is nonpartisan. Senator Moses is a Republican and Senator Thomas is a Democrat. The administration favors dyestuffs legislation. Most of the Democratic members favor such measures as may be necessary to safeguard the domestic dye industry.

W. R. Crane Sent to Tuscaloosa

W. R. Crane has been selected as the superintendent for the new experiment station of the Bureau of Mines at Tuscaloosa, Ala. Mr. Crane has been chief engineer for the War Minerals Relief Commission for the past year.

Two non-metallic specialists are to be assigned to the Tuscaloosa station. One is to be engineer whose duties will be confined to the laboratory. The other will be a field and contact man.

New C.W.S. Examination

Thirty Army officers have announced their intention to take the examination, late this month, for commissions in the Chemical Warfare Service.

Examinations will be conducted in November at which young men from civilian life with some chemical training may qualify as Second Lieutenants.

Chemical Warfare Officers' Reserve Corps

Tentative instructions governing appointments in the Chemical Warfare Officers' Reserve Corps have been issued as follows:

Recent legislation has made the Chemical Warfare Service a permanent branch of the Army, and a Chemical Warfare Officers' Reserve Corps is now being organized as per regulations from the Adjutant General's Department. The regulations governing reserve officers in the Chemical Warfare Service will be similar to the regulations governing reserve officers in the Army at large.

In a general way appointments will be made in the section for which the officer applies or for which his records show him best suited. For this reason a number of the applications of officers who have applied for the Chemical Warfare Service in the past will automatically be referred to the Chemical Warfare Service Board. The Adjutant General has ruled that all officers now holding commissions in any section of the Officers' Reserve Corps and whose records bear notation that they are qualified and were appointed for duty in some other section, now authorized (such as the Chemical Warfare Service), will be transferred to such section with their present grade and date of commission. Accordingly, officers now holding commissions in Engineers, Quartermasters, etc., bearing the notation Chemical Warfare Section will automatically be acted on by the C.W.S. Board. Even though this be more or less automatic, it is considered advisable that each one resubmit an application through the Adjutant General, Washington, D. C., for the Chemical Warfare Service Reserve.

Pending the promulgation of regulations governing appointments in the Officers' Reserve Corps under the provisions of the act of June 4, 1920, the following tentative instructions governing appointments are published for the information and guidance of all concerned:

WHO MAY BE APPOINTED

1. Persons who served as officers of the United States Army at any time between April 6, 1917, and June 30, 1919.
2. Former officers of the Regular Army.
3. Officers of the National Guard on June 4, 1920.
4. Reserve Officers' Training Corps graduates in accordance with Changes 6, S.R. No. 43, War Department, 1919.

GRADES IN WHICH APPOINTMENTS MAY BE MADE

1. Appointments will be made in the Chemical Warfare Service in all grades from Colonel to Second Lieutenant, inclusive.
2. A person eligible under these instructions may be appointed as a reserve officer in the highest grade which he held in the Army, or in any lower grade. National Guard officers found qualified will be commissioned in the same grade as they held in the National Guard on June 4, 1920.

REQUISITE QUALIFICATIONS

Physical—(*a*) In the line of the Army, no defects disqualifying for hard field service; any minor defects to be waived. (*b*) In staff corps to have no defects disqualifying for particular kind of duty to be performed.

Professional—In general the records must show favorable recommendations, an average rating of at least 53, and suitability for appointment in the Reserve Corps.

Age—Appointees must be at the time of appointment between the ages of twenty-one and sixty years and no appointments in effect or hereafter made shall be terminated on account of age, but shall be permitted to continue in effect for statutory five years from date of appointment.

Citizenship—All appointees must be citizens of the United States or the Philippine Islands.

MISCELLANEOUS

Warrant officers and enlisted men of the Regular Army and National Guard may hold commissions in the Officers' Reserve Corps and continue their status as enlisted men.

A reserve officer may hold commission in the National Guard without affecting his reserve commission.

Employees of the Federal Government may not hold a commission in the Officers' Reserve Corps without the consent of the head of the department in which employed.

The President may order a Reserve Corps officer to active duty with any of the military forces of the United States at any time, for any period, ***but except in time of national emergency expressly declared by Congress*** no reserve officer shall be employed on active duty for more than fifteen days in any one calendar year without his consent. Mileage at the prescribed rate and compensation at the rate for the corresponding grade in the Regular Army will be paid while on active duty. There is no provision for pay while on inactive service status. A reserve officer is not entitled by law to retirement or retired pay. Reserve officers must provide their own uniforms and all articles of clothing and equipment which would be required in the public service. These articles may be purchased from the Quartermaster's Department at any time by reserve officers on the inactive list. Sales of subsistence and stores are not authorized. Any reserve officer may hold a commission in the National Guard without thereby vacating his reserve commission. Reserve officers may submit resignations from their commissions at any time, but the acceptance of same is at the discretion of the President. Notices of change of permanent address should be sent to the Adjutant General of the Army.

Expedition to Gather Scientific Data in South America

Dr. Henry H. Rusby, dean of the School of Pharmacy of Columbia University, is to start with a party composed of an ichthyologist, an entomologist, a motion picture photographer and possibly another physician for an extended exploration tour of the eastern slope of the Andes Mountains and the basin of the Vaupéz, Negro, Amazon and Madeira Rivers in South America.

This expedition has been formed to gather important scientific data on the flora and fauna of the region, with particular reference to their economic application as well as for their purely scientific value. Dr. Rusby has been in Washington in conference with heads of the various departments of entomology, ichthyology and plant industry, who will collaborate with him in interpreting the results of the data obtained by his party. An attempt will be made to introduce into our own tropical regions—the Phillippine Islands—useful native tropical plants which may be discovered with the idea of increasing their usefulness. Dye, oil-producing food and medicinal plants will receive special attention both as to their sources of supply and their useful properties.

The problem of insects as carriers of disease and destroyers of plants will be carefully investigated in order to gather information to combat their ravages.

Dr. Rusby intends also to make a study of the various arrow poisons used by the natives of this region and thereby extend our limited knowledge of these toxic substances.

Personal

FREDERICK E. BREITHUT has accepted a position with the Calco Chemical Co., Bound Brook, N. J.

Colonel G. A. BURRELL has resigned his position as president of the Island Refining Corp. to take charge of refinery construction for the France-Canada Shipping Corp., 120 Broadway, New York City. He sailed for England on Oct. 23, to be gone three months.

C. C. COOPER, Editor *Mill Supplies*, Chicago; C. J. STARK, Editor *Iron Trade Review*, Cleveland, and RAY W. SHERMAN, of Class Journal Co., New York City, were elected respectively president, vice-president and secretary-treasurer of the National Conference of Business Paper Editors at the annual meeting in the Hotel Astor, New York, on Oct. 20 and 21.

Dr. W. D. ENGLE, professor of chemistry in the University of Denver, has been appointed acting chancellor of the institution on account of the illness of Chancellor H. A. Buchtel, who was recently stricken with paralysis.

Dr. COLIN G. FINK, of New York, recently addressed the Rochester Section of the American Chemical Society on "Modern Developments in Metallurgical Research."

H. D. FOSTER will work at the Bureau of Standards as research associate on problems connected with hollow clay tile. He has been appointed to this work by the Hollow Clay Tile Manufacturers' Association, under the form of co-operative agreement which is being used by the Bureau of Standards to carry on work of this sort.

A. J. GAILEY has left the W. L. Cummings Chemical Co., Lansdowne, Pa., to accept the position of research chemical engineer for the Electrometallurgical Co., Niagara Falls, N. Y.

Major E. HOLMES has recently been appointed manager of the chemistry department of the National Lime Association.

S. Z. KRUMM, graduate of the Colorado School of Mines and until recently instructor of metallurgy in that institution, has been appointed instructor in metallurgy and ore treatment at the Case School of Applied Science.

WILLIAM RUSSELL, the Dorr Co.'s London manager, is now in the United States on his regular annual visit to study the latest practices in the chemical and metallurgical fields.

RICHARD SHELDRICK has resigned as secretary, director and sales manager of the Kalbfleisch Corp., after a connection of fifteen years, and is now associated with D. A. Kimadi & Co., Inc., New York, as vice-president.

Captain WILKINSON STARK, late of the Army Ordnance Department, has joined the engineering staff of the John Johnson Co. Captain Stark was released by du Pont at the beginning of the war to supervise the design, installation and operation of the Army's caustic recovery and cotton purification, bleaching and drying divisions at Explosives Plant "C," Nitro, W. Va. Prior to the du Pont connection, where Captain Stark was in charge of similar work at the company's Hopewell Powder Works, he was for six years Assistant State Chemist of Missouri.

Dr. R. K. STRONG has recently been appointed head of the department of chemistry at Reed College, Portland, Ore., where special attention will be given to the chemical industries of the region, among them paper pulp, which promises to be the leading industry. Dr. Strong has made a careful study of the local situation during the last three years.

G. D. VAN ARSDALE will open an office in Los Angeles as consulting engineer, specializing in hydrometallurgy, flotation, etc. Mr. VAN ARSDALE has been for a number of years consulting chemist to the Phelps, Dodge Corp., with headquarters in New York, and is still retained by that corporation in the same capacity.

Obituary

CHARLES ERNEST ACKER, manufacturing chemist, died at his home, 80 Main St., Ossining, N. Y., on Oct. 18, in his fifty-second year. He built the plant of the Acker Process Co. at Niagara Falls, and was known as the originator of processes for the manufacture of tetrachloride of tin and carbon tetrachloride, and was the first to manufacture carbon tetrachloride in this country. Mr. Acker held about fifty patents in this and foreign countries for inventions relating to the chemical and electrochemical industries. Mr. Acker was graduated from Wabash College and Cornell University, and for several years was an electrical engineer in Chicago. He was a member of the American Institute of Electrical Engineers, Chemists' Club of New York City, the Society of Chemical Industry, Society of Arts (London), the Faraday Society (London) and other organizations.

JOSEPH J. MILLER, president of the Miller Chemical Engine Co., manufacturer of hand-operated fire extinguishers, died Oct. 12 at his home in Chicago, Ill., after an illness of seven months. Mr. Miller was born in Elizabeth, N. J., Sept. 16, 1848. He had been head of this firm in Chicago for many years.

ELISHA S. WILLIAMS, vice-president of the United States Rubber Co., New York, died on Oct. 8. Mr. Williams was born in Malden, Mass., in 1873, and was educated in the Malden public schools, taking a business course in the Malden high school. He then entered the employ of the Revere Rubber Co., of which he later became president. On Jan. 1, 1910, the Revere Rubber Co. was purchased by the United States Rubber Co. and he was then elected president of the Rubber Goods Mfg. Co. He was largely instrumental in the consolidation of the tire business of the Rubber Goods Mfg. Co.'s subsidiaries by forming the United States Tire Co. in 1911, of which he was the president until 1915. In 1915 he was elected vice-president of the United States Rubber Co., in charge of the mechanical goods business. He was also a director of the United States Rubber Co., a member of the operating council and president of several subsidiary companies.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Oct. 22, 1920.

Cancellations, suspensions and postponements in the matter of steel contracts and deliveries continue, but are of diminished volume. Results of this movement are now plainly apparent in decreased operation at not a few of the steel mills. Naturally the mills affected are those that were charging the highest prices, and those that were charging the highest prices are those that had the smallest volume of business on books, for otherwise they would have been unable to promise the early deliveries for which particularly high prices were obtainable. Thus the mills that have the largest volume of cancellations and postponements are the ones that are least able to stand the operation, and accordingly their operations are promptly affected.

The fact should be noted, as having an important bearing upon the present steel market situation and the prospects for price changes, that the relative position of mills is quite different from that which usually obtains at a time when demand has greatly declined, but there remains, in the aggregate, a large volume of business on books. Ordinarily the mills are all sold for somewhat the same time ahead, since in an ordinary market prices are uniform among sellers. Since the first of the year there have been wide divergences in prices of different sellers, there having been for much of the time at least three markets. The

result is that some mills that were only recently the highest priced sellers are now the lowest priced among the independents. Again, the mills that are well sold ahead are disposed to maintain their prices and curtail their production to such extent as is necessary, while they fill the contract tonnage. Other mills are disposed to cut prices to the point at which they can book new business, for there is always a little business to be had, even in such a dull market as now prevails. No consistent and uniform policy, therefore, is likely to be adopted.

OUTPUT OF STEEL DECREASED

Production of steel has now been curtailed by so many mills that the rate of output is materially below that of August and September. Output of ingots as a whole in October, which will be reported upon in due course, will probably show a rate of something like 41,000,000 tons per annum, against a rate of about 42,700,000 tons in August and September. The Steel Corporation's rate of output has, if anything, increased somewhat.

A particularly interesting event of the week was that on Monday the Pittsburgh Crucible Steel Co. began quoting merchant steel bars at 2.35c., which is the Steel Corporation price. Previously the company had been confining its attention to the prompt market, in which it was able to secure very high prices. The action became known almost immediately to the other producers, who, however, showed no disposition to follow suit, but continued to quote from 3c. to 3.25c. Some of them have large contract tonnages, which would be more or less jeopardized if they reduced their prices, and the theory is that the company quoting 2.35c. will soon secure as much business as it requires, whereupon the price can be withdrawn.

Automobile and parts makers assert that they have secured some substantial price readjustments on steel contracts, but more adjustments are being sought. These trades are offering no new business of consequence as in the main they are fully bought, or more than bought, to the end of the year. Already they state that they expect to secure still lower prices when the time comes for them to place contracts for the first half of the new year.

FREIGHT CAR BUYING

The lightness of freight car buying, commonly attributed to inability of the railroads to finance loans upon suitable terms, should be better understood. In actual fact there is what amounts to a deadlock in the matter of prices. For a standard 50-ton open-top car the price at present is about $3,400, while the railroads feel they ought to be able to buy at about $2,700, for even that would be fully three times the lowest price before the war, and more than double the average price paid for all such cars that have been bought since the steel car came into vogue. In but very small part the extra price rests upon high prices for steel, and the car-building companies are not charged with endeavoring to make too large profits per car, but it is positively asserted that prices for the various trimmings and appurtenances which car builders buy as an assembling proposition are altogether too high. The Steel Corporation itself needs a number of cars, but is indisposed to encourage the present situation by buying cars. Certainly the corporation can have no objection to such part of the present price of freight cars as is based on the cost of steel, since the corporation would naturally furnish steel itself for any cars it should buy.

Rumors persist that the United States Steel Corporation will advance most or all of its finished steel prices by an average of say $3 or $4 a ton, the advance to be predicated upon increased costs due to the freight rate advances of Aug. 26. It seems certain that the corporation has formulated no definite policy in this matter, but undoubtedly the matter is being given careful consideration. Such slight advances might encourage the independents to drop, and thus the market would be equalized, something the independents should desire and should be willing to help bring about. Possibly the corporation will readjust its prices, instead of making a horizontal advance, so as to correct inequalities that may now exist.

There have been no further developments in basic iron since the decline in the quotable market to $42 valley reported a week ago. There has been no demand that would bring about any new condition. Foundry pig iron has been quiescent. Occasional small lots are sought by consumers from their regular sources of supply, and these have simply been sold at the $47 valley price that the furnaces recently came to the conclusion could be regarded as "the market" until competition should effect a further reduction. In bessemer iron there is to be recorded a decline of $1.50 a ton in the quotable market, a $47 valley price becoming quotable by a large producing interest formally offering a lot of 1,000 tons at this figure. A sale of a carload at $47 is reported.

As noted in last report, the declines in pig iron occur while coke is still at altogether irrational levels. Pig iron cannot find a secure and stable level as long as the cost of coke is so greatly in doubt. Connellsville furnace coke for spot shipment has declined $2 in the past week, from $17 to $15 per net ton at ovens, but even $15 is ten times the price in May, 1915. Until coal experiences the inevitable slump coke cannot get on a really proper level, as the coal used in making coke has too high a market value. The decline that has occurred in coke was brought about partly by the improved production of the past two or three weeks, but chiefly by the altered policy of a number of merchant furnacemen who, being in receipt of numerous requests for curtailment in shipment of pig iron against contracts, have concluded to bank or blow out in the near future, and to get ready for the event they either buy less spot coke in the open market or instruct coke operators to decrease shipments on contract. In some instances there are piles of coke at furnaces that are to be consumed before banking or blowing out.

The Chemical and Allied Industrial Markets

New York, Oct. 23, 1920.

The past week has shown no tendency toward improvement in the chemical market, in fact prices are uniformly descending, owing to the long deferred activity on the part of buying interests. Supplies are being accumulated on all sides and in practically every case stocks are in excess of the demand. On the other hand producers are confronted with the cost of production—which is steady, if not increasing—and have for the most part firmly maintained prices at the recent levels.

HEAVY CHEMICALS

Soda ash is firm at last week's figures of $2.50 per cwt. for light ash and $3 per cwt. for dense. Numerous rumors are abroad concerning producers' 1921 contract price, but so far nothing definite has been announced. The prophetic whisperings differ in matter of 10c. per cwt., $1.85 being the favored mark. Very little business is being done in *aqua ammonia*, which is still quoted around 10½@11c. in carboys. Although prices as low as 12c. per lb. are heard for *carbon tetrachloride*, they are few and are concessions being made by second hands, but so far producers have firmly maintained the former 13@13½c. level. Concessions are also being made on *acetic acid*, glacial, 99½ per cent, and some business was transacted at $11@$11.50 per cwt., which is $5 under the prices quoted by producers. Both *sodium nitrate* and *nitrite* dropped during the period, the former being now listed at $3 compared with $3.75@$4 of the previous week, while the latter is down to 11@12c. in car lots against 12@14c., the prevailing price for some time. The prices of *tin* products have remained about the same with the usual routine business unaffected, *bichloride*, 50 per cent, being listed at 13¾c. per lb. and *oxide* at 55@60c. per lb. by producers.

COAL-TAR PRODUCTS

Recent reports of this market have been consistently alike in summing up the business conditions. Dullness—implying absolute inactivity—has been the keynote for some time, and although prices on all items have been reduced to meet the slackness, buyers are firm in holding out for still lower levels; despite the fact that there have been no changes in the list, the trade is on the decline. The crudes on the

other hand show a healthy firmness as the supply is a trifle short of demand.

Naval Stores

It seems that the rock bottom has been reached in *rosin* prices, which is $12.45 for all grades. The local demand has been fairly heavy when compared to the recent dullness, but foreign inquiry is practically nil and as a result considerable supplies are being accumulated in Savannah. *Turpentine* also declined during the early part of the week, but a slight flurry toward the end brought the quotation back to $1.25 per gal.

Oils

Despite the low prices prevailing on *linseed* there has been no move on the part of buyers to take advantage of the present levels. Nominal quotations of $1.07 have been received but the small amount of business that has been transacted is nearer the $1 mark. *Cottonseed* remains at the 12@13c. price, and although there was a slight weakness exhibited in the early part of the period the closing market was firm. *Chinawood* dropped off 1c. and *coconut*, affected by *soya bean*, fell off slightly from 16½c. to 15½c. per lb.

The Baltimore Market

Baltimore, Md., Oct. 20, 1920.

The general waiting attitude on the part of buyers of fertilizer raw materials prevails on the local market. Offerings of all kinds are in evidence, but buyers are reluctant in expressing interest in them. It has been persistently rumored among the local trade that prices for spring on mixed goods are as follows: $5.25 per unit of ammonia; 80c. per unit available phosphoric acid; $2.50 per unit of potash. This price schedule has not been officially confirmed, but it seems to be the general belief that the finally accepted schedule will not be far out of line.

Acid Phosphate

The market continues nominal at about $18 per ton, basis 16 per cent, bulk, run of pile. Reports have been received, however, of sales as low as $17. High-grade raw rock at the mines is being quoted nominally at about $10 per ton.

Nitrate of Soda

Chilean nitrate continues to come into this port on contracts, and relatively large tonnages are being placed in storage. Resales of spot lots have been made at $3.15 per cwt. and the importers are quoting around $3.20 per cwt. ex-vessel Baltimore and other Atlantic ports of arrival.

Sulphate of Ammonia

There was reported a resale of sulphate this week at $4.50 per cwt., basis 25 per cent. This makes a drop of 25c. per cwt. since last letter. Large stocks of this material are not in evidence.

Potash

A price of $1.60 per unit of K_2O has been the lowest offering noted for kainit and manure salts; in fact, very little of this grade of potash is changing hands at any price at this time. Nebraska producers have not yet offered their forward deliveries on the market, as most of them have contracted for their output up to November and in some cases up to the first of the year. Muriate of potash is being nominally quoted at $2.20, although spot parcels are held 10@20c. higher. The lowest offering noted was a lot of foreign muriate at $1.90 per unit c.i.f., North Atlantic port for November.

Fish Scrap

Machine dried unground menhaden fish scrap is available at this writing at $6 per unit of ammonia and 10c. per unit b.p.l. delivered Baltimore. Forward deliveries are being held at $6.25 and 10c., and sales in a small way have been effected at this figure. The fishing on Chesapeake Bay has been very poor for the past week; in fact, the factories are now contemplating "cutting out" the latter part of this month or the early part of next, unless fishing improves materially within the next few days.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	-	$0.65 - $0.75
Acetone	lb.	$0.19 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	7.50 - 8.00	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboy	cwt.	14.00 - 16.00	16.25 - ...
Boric, crystals	lb.	.15½ - .16	.16½ - .19
Boric, powder	lb.	.15½ - .16½	.17 - .20
Citric	lb.	.70 - .75	.76 - .77
Hydrochloric (nominal)	cwt.	2.00 - 2.50	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	.16½ - .18
Lactic, 44 per cent tech	lb.	.10 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		-	-
Nitric, 40 deg	lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.35 - .36	.38 - .40
Phosphoric, Ortho, 50 per cent solution	lb.	.22 - .23	.24 - .25
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	-
Sulphuric, 60 deg., drums	ton	-	-
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	-
Sulphuric, 66 deg., carboys	ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - ...
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.	.70 - .73	.74 - .77
Tungstic, per lb. of WO	lb.	-	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 - 5.75	-
Alcohol, Methyl (see methanol)		-	-
Alcohol, denatured, 188 proof (nominal)	gal.	-	1.12 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	-	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05½	.05½ - .06
Alum, potash lump	lb.	.07 - .08½	.09 - .09½
Alum, chrome lump	lb.	.14½ - .15	.16 - .17
Aluminum sulphate, commercial	lb.	.02½ - .03	-
Aluminum sulphate, iron free	lb.	.04½ - .05	-
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.10½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 - .35½	.36 - .38
Ammonium carbonate, powder	lb.	.15 - .16	.16½ - .17
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.13 - .14	-
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .13	.13½ - .14½
Ammonium nitrate	lb.	- .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ - ...
Amylacetate	gal.	-	5.00 - 5.25
Amylacetate tech	gal.	-	4.75 - 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.13 - .14	.15 - .16
Arsenic, sulphide, powdered (red arsenic)	lb.	.16 - .17	.18 - .19
Barium chloride	ton	120.00 - 130.00	-
Barium dioxide (peroxide)	lb.	.24 - .25	.26 - .27
Barium nitrate	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		-	-
Blue vitriol (see copper sulphate)		-	-
Borax (see sodium borate)		-	-
Brimstone (see sulphur, roll)		-	-
Bromine	lb.	.70 - .80	.85 - .90
Calcium acetate	cwt.	3.50 - 3.55	-
Calcium carbide	lb.	.04½ - .04½	.04½ - .05½
Calcium chloride, fused, lump	ton	33.00 - 34.00	35.00 - 45.00
Calcium chloride, granulated	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	7.25 - 7.50	8.00 - 8.50
Calcium peroxide	lb.	-	1.50 - 1.70
Calcium phosphate, monobasic	lb.	-	.75 - .80
Calcium sulphate, pure	lb.	-	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.13 - .14	.16 - .17
Carbonyl chloride (phosgene)	lb.	-	1.25 - 1.50
Caustic potash (see potassium hydroxide)		-	-
Caustic soda (see sodium hydroxide)		-	-
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	-	2.00 - 2.05
Copperas (see iron sulphate)		-	-
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	-	.65 - .70
Copper sulphate, crystals	lb.	.08 - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		-	-
Epsom salt (see magnesium sulphate)		-	-
Ethyl Acetate Com. 85%	gal.	...	1.05 - 1.10*
Ethy Acetate pure (acetic ether 98% to 100%)		-	-
Formaldehyde, 40 per cent (nominal)	lb.	.40 .45	-
Fusel oil, ref	gal.	-	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	-	-
Glauber's salt (see sodium sulphate)		-	-
Glycerine, C. P. drums extra	lb.	-	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	-	.03 - .20
Iron sulphate (copperas)	cwt.	2.00 - 2.25	2.35 - 2.75
Lead acetate, normal	lb.	-	.13½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	-	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	-	1.50 - ...
Magnesium carbonate, technical	lb.	.12½ - .13½	.14 - .15
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.25	-
Magnesium sulphate, commercial	100 lb.	-	3.50 - 3.60
Methanol, 95%	gal.	-	2.70 - 3.00
Methanol, pure	gal.	-	3.40 - 3.60
Nickel salt, double	lb.	-	.14 - .16
Nickel salt, single	lb.	-	.13 - .14
Phosgene (see carbonyl chloride)		-	-
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	-	.35 - .37
Potassium bichromate	lb.	.34 - .36	.39 - .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.48 - $0.56	$0.57 - $0.58
Potassium bromide, granular	lb.	..... -	.63 - .65
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .21	.23 - 25
Potassium chlorate, crystals	lb.	.18 - .18½	.19 - 20
Potassium hydroxide (caustic potash)	lb.	27 28	.29 - .33
Potassium iodide	lb.	... - ...	3.20 - 3.30
Potassium nitrate	lb	.17 - .17½	.19 - .21
Potassium permanganate	lb.	65 - 68	.70 - .75
Potassium prussiate, red	lb.	.85 - .95	1.00 - 1 05
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$240.00 255 00	......-......
Rochelle salts (see sodium potas. tartrate)		.....	......-......
Salammoniac (see ammonium chloride)		.....	......-......
Sal soda (see sodium carbonate)		....-.....	......
Salt cake	ton	.....	48.00 - 50 00
Silver cyanide (nominal)	oz	... -	1.25 -......
Silver nitrate (nominal)	oz	.-	.60 - .62
Soda ash, light	100 lb	-.....	2 25 - 2.50
Soda ash, dense	100 lb	-	3.25 - 3.50
Sodium acetate, U S P, granular	lb.	25 - 26	27 .28
Sodium bicarbonate	100 lb	2 50 2 75	2.85 - 3.00
Sodium bichromate	lb.	22 24	26 - 27
Sodium bisulphate (nitre cake)	ton	7 00 8 00	9 00 - 11.00
Sodium bisulphite Powered, U.S P	lb.	08¾	10 - 11
Sodium borate (borax)	lb	09½ - 10	.11 - 12
Sodium carbonate (sal soda)	100 lb	2.00 - 2 10	2.15 2.25
Sodium chlorate	lb	14½ - 15	.15½ 16½
Sodium cyanide, 96-98 per cent	lb	25 - 30	.32 35
Sodium fluoride	lb.	18 -	.19 20
Sodium hydroxide (caustic soda)	100 lb.	4 25 - 4 50	-
Sodium hyposulphite	lb.	. ...	.03 .04
Sodium molybdate	lb.	2 50 - ...	3.25½- ...
Sodium nitrate	100 lb.	3 00 ...	3.25 -......
Sodium nitrite	lb.	11 - 12	.13 - 14
Sodium peroxide, powdered	lb.	32 35	.35 .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.37 - .38
Sodium prussiate, yellow	lb.	25 - 27	.31 - .32
Sodium silicate, solution (40 deg)	lb.	01½ - .01¾	.02 - .02½
Sodium silicate, solution (60 deg)	lb.	02½ .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	2 15 - 2.50	2.60 - 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	09½ 10	.10½ - .11
Sodium sulphite, crystals	lb	04 0 4½	04½ - .05
Strontium nitrate, powdered	lb	15 - 18½	.19 - .20
Sulphur chloride red	lb	.08 - 09	.10 - .10½
Sulphur, crude	ton	16.00 20 00	.... -......
Sulphur dioxide, liquid, cylinders	lb.	.09 - ...	.10 - .12
Sulphur (sublimed), flour	100 lb.	. -	3.70 - 4.35
Sulphur, roll (brimstone)	100 lb.	..-. ...	3.40 - 3.90
Tin bichloride, 50 per cent	lb.	.13¾ - .14	-.....
Tin oxide	lb.	......-......	55 - .60
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb	.13 - 13½	.13½ - .17
Zinc cyanide	lb	.45 - .49	.50 - .60
Zinc dust	lb.	.12 .13	.13 - .14
Zinc oxide, U. S. P.	lb.	.17 .25	......-
Zinc sulphate	lb.	.03½ .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb	$1.25	—	$1.35
Alpha-naphthol, refined	lb	1 50	—	1.60
Alpha-naphthylamine	lb	.45	—	.50
Aniline oil, drums extra	lb.	.28	—	.33
Aniline salts	lb.	.33	—	.36
Anthracene, 80% in drums (100 lb.)	lb.	.90	-	1.00
Benzaldehyde (f.f.c.)	lb	2 00	-	2.10
Benzidine, base	lb	1.35	—	1.40
Benzidine sulphate	lb	1.15	—	1 25
Benzoic acid, U.S.P.	lb.	.85	—	90
Benzoate of soda, U.S.P.	lb	.80	—	.90
Benzene, pure, water-white, in drums (100 gal.)	gal	.35	—	.40½
Benzene, 90%, in drums (100 gal)	gal	.33	.	38½
Benzyl chloride, 95-97%, refined	lb	.35	—	.40
Benzyl chloride, tech	lb	.25	—	.35
Beta-naphthol benzoate (nominal)	lb	3.50	-	4.00
Beta-naphthol, sublimed (nominal)	lb	90		95
Beta-naphthol, tech (nominal)	lb.	.60	—	.70
Beta-naphthylamine, sublimed	lb.	2.25	—	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.19
Ortho-cresol, in drums (100 lb)	lb	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10	—	1.15
Cresylic acid, 95-97%, dark, in drums	gal	1.05	—	1.10
Cresylic acid, 50%, first quality, drums	gal	.65	—	.75
Dichlorbenzene	lb.	07	—	.10
Diethylaniline	lb.	1 50	—	1.60
Dimethylaniline	lb.	90	—	1.00
Dinitrobenzene	lb.	.30	-	.37
Dinitroclorbenzene	lb.	.32	—	.35
Dinitronaphthalene	lb.	.45	—	.55
Dinitrophenol	lb.	.40	—	.45
Dinitrotoluene	lb.	38	—	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	38	—	40
Diphenylamine (nominal)	lb.	80	—	.85
H-acid (nominal)	lb.	1.75	—	1.85
Meta-phenylenediamine	lb.	1.25	—	1.30
Monochlorbenzene	lb.	.18	—	.20
Monoethylaniline	lb.	2.00	—	2.40
Naphthalene crushed, in bbls. (250 lb.)	lb	.12	—	14
Naphthalene, flake	lb.	.10½	—	.11
Naphthalene, balls	lb	.12½	—	.13
Naphthionic acid, crude	lb.	.75	—	.85
Nitrobenzene	lb.	14	—	.19
Nitro-naphthalene	lb.	40	—	.50
Nitro-toluene	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-benzene	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	.85
Ortho-nitro-toluene	lb.	.25	—	.40
Ortho-toluidine	lb.	.35	—	.38
Para-amidophenol, base	lb.	2.50	—	3.00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlorbenzene	lb.	.08	—	.12
Paranitroaniline	lb.	1.10	—	1.15
Para-nitrotoluene	lb.	1.25	—	1.40
Para-phenylenediamine	lb.	2.50	—	2.65
Para-toluidine	lb.	2.00	—	2.25
Phthalic anhydride	lb.	.60	—	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridine	gal.	2.00	—	3 50
Resorcinol, technical	lb.	4.25		4 50
Resorcinol, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb)	lb.	.45	—	.50
Salicylic acid, U. S. P.	lb.	.45	—	.50
Salol	lb.	.85	—	.95
Solvent naphtha, water-white, in drums, 100 gal	gal.	.30	—	.35
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.20	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Tolidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluene, in tank cars	gal.	.35	—	....
Toluene, in drums	gal.	.38½	—	.40½
Xylidines, drums, 100 gal.	lb.	.50	—	.65
Xylene, pure, in drums	gal.	.47½	—	.50½
Xylene, pure, in tank cars	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal	gal.	.32½	—	.35½
Xylene, commercial, in tank cars	gal.	.30		

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.33	$0.38
Beeswax, refined, light	lb.	.34	.37
Beeswax, white pure	lb.	.60	.65
Carnauba, No. 1 (nominal)	lb.	.90	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	.86
Carnauba, No. 3, North Country	lb.	.35	.36
Japan	lb.	.18	.20
Montan, crude	lb.	.14	.15
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¾	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	.11½
Paraffine waxes, refined, 125 m.p	lb.	.12¾ -	...
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	.18
Stearic acid, single pressed	lb.	.20	.21
Stearic acid, double pressed	lb.	.22	.23
Stearic acid, triple pressed	lb.	.24	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1 [illegible]
Pine oil, pure, dest. dist	gal.	1 50
Pine tar oil, ref, sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0 990	gal	.85
Pine tar, ref., thin, sp. gr, 1 080-1.960	gal.	.36
Turpentine, crude, sp. gr, 0.900-0.970	gal	1.75
Hardwood oil, f o.b. Mich., sp gr., 0.960-0.990	gal	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$12.45	-	
Rosin E-I	280 lb.	12.45	-	
Rosin K-N	280 lb	12.45	-	
Rosin W. G.-W. W	280 lb.	12.45	-	
Wood rosin, bbl	280 lb.	12.00	-	
Spirits of turpentine	gal	1 25	-	
Wood turpentine, steam dist	gal	1.22	-	
Wood turpentine, dest. dist	gal.	1.18	-	
Pine tar pitch, bbl	200 lb.	.....	-	8.50
Tar, kiln burned, bbl (500 lb)	bbl.	14.50	-	15.00
Retort tar, bbl	500 lb.	15.00	-	15.50
Rosin oil, first run	gal	72	-	
Rosin oil, second run	gal.	.75	-	
Rosin oil, third run	gal.	.92		

Solvents

73-76 deg., steel bbls (85 lb)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal	.38
68-70 deg., steel bbls. (85 lb)	gal	.37
V. M. and P. naphtha, steel bbls (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.26	-	$0.26½
Upriver coarse	lb	17	—	.18
Upriver caucho ball	lb	.17½	—	.18½
Plantation—First latex crepe	lb	.25	—	...
Ribbed smoked sheets	lb.	.24½	—	.....
Brown crepe, thin, clean	lb.	.22½	—	.....
Amber crepe No. 1	lb.	.22	—	....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.16½	—	$0.18
Castor oil, AA, in bbls	lb.	.15	—	.16
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.17	—	.17½
Cocoanut oil, Ceylon grade, in bbls	lb.	.15½	—	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17¼	—	.17½
Corn oil, crude, in bbls	lb.	.12	—	.13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½	—	.11
Cottonseed oil, summer yellow	lb.	.13	—	.14
Coteonseed oil, winter yellow	lb.	...	—	
Linsed oil, raw, car lots (domestic)	gal.	1.07	—	....
Linseed oil, raw, tank cars (domestic)	gal.	1.00	—	.
Linseed oil, boiled, car lots (domestic)	gal.	1.09	—	

Item	Unit	Price		Price
Olive oil, commercial	gal.	3 00	—	3.50
Palm, Lagos	lb.	.10½	—	.10¾
Palm, bright red	lb.		—	
Palm, Niger	lb.	.09½	—	.10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10¾	—	.12½
Peanut oil, refined, in bbls	lb.	.17	—	.18
Rapeseed oil, refined in bbls	gal.	1 30	—	1 45
Rapeseed oil, blown, in bbls	gal.	1 60	—	1 70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14	—	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10	—	.11

FISH

Item	Unit	Price		Price
Light pressed Menhaden	gal.	$0 80	—	$0 90
Yellow bleached Menhaden	gal.	.83	—	.84
White bleached Menhaden	gal.	.86	—	.87
Blown Menhaden	gal.	90	—	1.00

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Item	Unit	Price		Price
Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24 00	—	$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10 00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26 50	—	28 00
Barytes, crude, first grade, Missouri	net ton	10 00	-	
Blanc fixe, dry	lb.	05½	—	.06
Blanc fixe, pulp	net ton	60 00		80 00
Casein	lb	15	—	18
Chalk, domestic, extra light	lb	05		.06
Chalk, domestic, light	lb	04½		05½
Chalk, domestic, heavy	lb	04		05
Chalk, English, extra light	lb	05		07
Chalk, English, light	lb	.05		06
Chalk, English, dense	lb	04½		05
China clay, (Kaolin) crude, f.o.b mines, Georgia	net ton	8 00		12 00
China clay (Kaolin) washed, f o.b Georgia	net ton	12 00		15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00		22 00
China clay (Kaolin) crude f o.b. Virginia points	net ton	8 00		12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00		40 00
China clay (Kaolin), imported, lump	net ton	25 00		35 00
China clay (Kaolin), imported, powdered	net ton	30 00	—	60 00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7 50		8 00
Feldspar, crude, f.o.b. Maine	net ton	7 50		10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00		23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00		21 00
Feldspar, ground, f.o.b. N Y. State	net ton	17 00		21 00
Feldspar, ground, f o b Baltimore	net ton	30 00		35 00
Fuller's earth, granular, f.o.b Fla.	net ton	25 00	—	
Fuller's earth, powdered, f.o.b Fla.	net ton	18 00	—	
Fuller's earth, imported, powdered	net ton	35 (0		40 00
Graphite, crucible, 90% carbon, Ashland, Ala	lb		—	09
Graphite, crucible, 85% carbon, Ashland, Ala	lb	07		09
Graphite, higher lubricating grades	lb	11	-	40
Pumice stone imported, lump	lb	04		50
Pumice stone, domestic, lump	lb	06		
Pumice stone, ground	lb	04		07
Quartz (acid tower) fist to head, f o b Baltimore	net ton			10 00
Quartz (acid tower) 1½@2 in., f o b Baltimore	net ton			14 00
Quartz (acid tower) rice, f.o.b Baltimore	net ton			17 00
Quartz, lump, f o.b North Carolina	net ton	5 00		7 50
Shellac, orange fine	lb.	1 15		1 30
Shellac, orange superfine	lb	1 10		1 20
Shellac, A. C. garnet	lb	90	-	95
Shellac, T N	lb.	85		95
Soapstone	ton	15.00	—	25 00
Talc, paper-making grades, f o b. Vermont	ton	12.00	-	22 00
Talc, roofing grades, f.o b. Vermont	ton	9 50		15 00
Talc, rubber grades, f o b Vermont	ton	12 00		18 00
Talc, powdered, Southern, f o b cars	ton	12 00		15 00
Talc, imported	ton	60 00		70 00
Talc, California Talcum Powder grade	ton	20 00		35 00

Refractories

Item	Unit	Price
Bauxite brick, 56% Al., f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o b Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b. Chicago district	1,000	65 70
Silica brick, 9-in. sizes, f o b Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f.o.b Mt Union, Pa	1,000	55 60

Ferro-Alloys

All f.o.b. Works

Item	Unit	Price		Price
Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250 000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	—	19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	—	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00	—	175.00
Ferro-manganese, 76-80% Mn, English	gross ton	170 00	—	175 00
Spiegeleisen, 18-22% Mn	gross ton	82.50	—	85 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00	—	2.50
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-silicon, 50%	gross ton	80.00	-	90 00
Ferro-silicon, 75%	gross ton	150.00		160 00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	80	—	'0
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7 00	—	
Ferro-vanadium, 30-40% per lb of contained V	lb.	6 50		8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Item	Unit	Price		Price
Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20½% silica, not more than 11% moisture	gross ton	$10 00		$11 00
Chrome ore, Calif. concentrates, 50% min., Cr_2O_3	unit	.70		.75
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	75	—	.85
*Coke, foundry, f.o.b. ovens	net ton		—	18 00
*Coke, furnace, f.o.b. ovens	net ton	16.50	—	17 00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00		
Fluor spar, lump, f o b. Tonuco, New Mexico	net ton	17.50	-	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	80 00		100 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	85 02
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	60	—	70
Manganese ore, chemical (MnO_2)	gross ton	70 00	-	80 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N Y	lb.	65	—	70
Monazite, per unit of ThO_2	unit	42 00		...
Pyrites, Spanish, fines, c i.f., Atlantic seaport	unit	12	—	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	—	
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	12	—	14
Pyrites, domestic, fines	unit	.12	—	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	-	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00		
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	4 .0		5.00
Uranium Ore (Carnotite) per lb of U_3O_8	lb	2 75	-	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb	2.75	-	3 00
Vanadium pentoxide, 99%	lb.	12.00	—	14 00
Vanadium Ore, per lb of V_2O_5 contained	lb.	1.25	—	1.50
Zircon, washed, iron free	lb	.05	—	....

*Nominal

Non-Ferrous Metals

New York Markets

Item	Cents per Lb.
Copper, electrolytic	16.50
Aluminum, 98 to 99 per cent	33 00
Antimony, wholesale lots, Chinese and Japanese	6.50@7 00
Nickel, ordinary (Ingot)	43 00
Nickel, electrolytic	45.00
Tin, 5-ton lots	39 50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	8.00
Zinc, spot, New York	8 50
Zinc, spot, E. St. Louis	7.50@7.70

OTHER METALS

Item	Unit	Price
Silver (Commercial)	oz.	$0.91½
Cadmium	lb.	1 40@1.50
Bismuth (500 lb. lots)	lb.	2 55
Cobalt	lb	6 00
Magnesium (f.o b. Niagara Falls)	lb	1 75
Platinum	oz.	95.00@105 00
Iridium	oz	400.00@450 00
Palladium	oz	95.00@100.00
Mercury	75 lb.	70 00

FINISHED METAL PRODUCTS

Item	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	31.50
Copper bottoms	36.00
Copper rods	30.00@35 00
High brass wire and sheets	29 25
High brass rods	25.00
Low brass wire and sheets	31.25
Low brass rods	27 00
Brazed brass tubing	38.25
Brazed bronze tubing	43 00
Seamless copper tubing	31 00@32 00
Seamless high brass tubing	30 00@31 00

OLD METALS The following are the dealers' purchasing prices in cents per pound

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	13 50	17 00	12 00	13 50
Copper, heavy and wire	13 00	16 00	11 75	12 50
Copper, light and bottoms	11 00	14 00	10 00	11 00
Lead, heavy	5 50	4 75	5 50	6 00
Lead, tea	4 50	3 75	3 75	5 00
Brass, heavy	7 00	10 50	8 00	12 50
Brass, light	5 50	7 50	5 00	6 50
No. 1 yellow brass turnings	7 00	10 00	6 00	6 75
Zinc	4 50	5 00	3 75	5 00

Structural Material

The following base prices per 100 lb are for structural shapes 3 in by ¼ in and larger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.30	$4 47	$3 47	$3 44	$3 37	$4 08	$3 47
Soft steel bars	4 75	4 62	3 37	3 84	3.27	3 98	3 37
Soft steel bar shapes	4 75	4.62	3 37	3 84	3 27	3 98	3 37
Soft steel bands	6 43	6 32	4 07	6 25			
Plates, ¼ to 1 in thick	4 50	4 67	3 67	3 64	3 57	4.28	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Conners Steel Co., Brown Marx Bldg., will build a 1-story, 77x400-ft. steel building for a steel mill, on 51st Pl. and Powell Ave. Estimated cost, $50,000. Work will be done by day labor.

Colorado

LAFAYETTE—The Grand Valley Sugar Corp. plans to build a 600-ton mill. Equipment will be installed in same. Estimated cost, $100,000.

STERLING—The Great Western Sugar Co., Sugar Bldg., Denver, will build a sugar factory to have a 1,200-ton capacity near here. Estimated cost, $2,000,000. Work will be done by day labor.

Connecticut

NEW HAVEN—The Connecticut Adamant Plaster Co., River St., has awarded the contract for the construction of a 2-story, 120x160-ft. plaster factory to the Sperry Eng. Co., 82 Church St. Estimated cost, $150,000. Noted Oct. 13.

Florida

LEESBURG—The Grass Fibre Pulp & Paper Corp. is building 3 paper pulp mills. Estimated cost, $75,000. C. T. Logan, 1228 Crittenden, N. W., Washington, D. C., engr.

Illinois

EAST MOLINE—The Moline Pressed Steel Co. plans to build a 50x150-ft. enameling room and install an oven at its plant here.

Indiana

ANDERSON—The Lynch Glass Co. has awarded the contract for the construction of a 1-story, 50x-120-ft. addition to its factory to the H. K. Ferguson Co., 6521 Euclid Ave., Cleveland, O. Estimated cost, $60,000.

Iowa

GILMORE CITY—The city has awarded the contract for the construction of a sewage disposal plant to Phelps & Sons, Knoxville. Estimated cost, $27,300.

Kansas

GALENA—The Eagle Picher Lead Co., Smelter Hill, Joplin, Mo., is having plans prepared for the construction of a 1-story smelter building on Milter St. here. Estimated cost, $75,000. J. E. Webb, mgr.

Maine

FAIRFIELD—The Keyes Fibre Co., Waterville, has awarded the contract for the construction of a 1- and 2-story pulp mill to the Aberthaw Constr. Co., 27 School St., Boston, Mass. Estimated cost, $125,000.

Maryland

BALTIMORE—A. Weiskittel & Son Co., 12th and Lombard Sts., plans to build a 1-story foundry, etc. Estimated cost, $6,000.

Massachusetts

WESTFIELD—The Vitrified Wheel Co., Emery St., has awarded the contract for the construction of a 2-story, 45x100-ft. addition to its plant to P. J. Mahoney, 16 Orange St. Estimated cost, $10,000. Noted Oct. 20.

Minnesota

AITKIN—The Bd. Educ. is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $400,000. A Casey, clk. K. T. Snyder, 738 Plymouth Bldg., Minneapolis, and H. Swanson, Crosby, engrs.

MINNEAPOLIS—The Bd. Educ. will receive bids about Nov. 25 for the construction of a 4-story, 220x300-ft. senior high school on 20th Ave., N. E. and Quincy St. A chemical and physical laboratory will be installed in same. Estimated cost, $700,000. E. Enger, 305 City Hall, archt. Noted July 20.

MINNEAPOLIS—The State Bd. of Control, Capitol, St. Paul, has awarded the general contract for the construction of a 3-story addition to the chemistry building on the State University Campus here to J. and W. A. Elliott, 906 Lumber Exch. Estimated cost, $239,416. Noted July 28.

NORTHFIELD—Carleton College plans to build 11 college buildings to cost $3,150,000. Plans include the construction of a chemistry building to cost $300,000. D. J. Cowling, pres.

ST. PAUL—The city has received bids for 30,000 lb. liquid chlorine for treating city water in 100-lb. cylinders, from Noyes & Bros. & Butler, 6th and Sibley Sts., $0.09 per lb., Electro Bleaching Gas Co., 18 East 41st St., New York City, $0.0925 per lb., Hooker Electro Chemical Co., 25 Vine St., New York City, $0.1089. Noted Oct. 5.

New Jersey

FLORENCE—The Florence Foundry Co. will soon award the contract for the construction of a 2-story, 50x100-ft. factory. Estimated cost, $50,000. J. W. Levin, Liberty Bldg., Philadelphia, Pa., archt.

North Carolina

CANTON—The Champion Fibre Co. will build a 60x350-ft. pulp and paper mill. Work will be done by day labor.

North Dakota

HANKINSON—The city has awarded the contract for the construction of a sewer system to John O'Connor Co., Fargo. A septic tank and sludge bed will be installed in same. Estimated cost, $82,000.

Ohio

CHAGRIN FALLS—The Adams Bag Co. has awarded the contract for the construction of a 1-story paper mill addition to the Myers-Kuhn Constr. Co., Metropolitan Bldg., Cleveland, O. Estimated cost, $50,000. Noted Sept. 15

CLEVELAND—The Atlas Fdry. Co., Shaw Ave., is having plans prepared for the construction of a 1-story, 50x100-ft. addition to its foundry on West 69th St. Estimated cost, $40,000. J. E. Moore, 1900 Euclid Ave., archt. and engr.

Pennsylvania

FERNWOOD—The Eastern Fdry. & Machine Co., Ambler, has awarded the contract for the construction of a 1-story, 85x115-ft. manufacturing building here to C. R. Davis & Son, 15th and Ellsworth Sts., Philadelphia. Estimated cost, $20,000.

PHILADELPHIA—The Sleight Metallic Ink Co., 5907 Market St., has awarded the contract for altering the present 2-story building at 538 North 3d St., to the F. Mark Constr. Co., 2820 North 21st St. Estimated cost, $10,000.

STATE COLLEGE—The Pennsylvania State College has awarded the contract for the construction of a 2-story, 60x160-ft. steel laboratory to the Austin Co., Bulletin Bldg., Philadelphia. Estimated cost, $75,000.

South Carolina

UNION—The City Gas Co. plans to build a gas plant. Estimated cost, $150,000. T. McNally, pres.

Tennessee

CHATTANOOGA—The Mutual Enamel Wks. Co. has awarded the contract for the construction of a foundry and plant to D. P. Robinson, 125 East 46th St., New York City. Estimated cost, $800,000.

Wisconsin

DEPERE—St. Norberts College, Boyle Hall, is having plans prepared for the construction of a 3-story, 80x260-ft. science hall. A chemical laboratory will be installed in same. Estimated cost, $400,000. W. E. Reynolds, 113 South Roosevelt St., Green Bay, archt.

KENOSHA—The Wisconsin Oxygen Hydrogen Co., Marion Ave. along the tracks of the Chicago & Northwestern R.R., is building a 45x109-ft. building. Estimated cost, $60,000. White, White, White & Co., 411-415 Pub. Servc. Bldg., archts.

MILWAUKEE—H. A. Poppert, 505 Cedar St., is in the market for brass foundry equipment, including blowers.

MILWAUKEE—The Shope Brick Co., 831 M. & M. Bldg., has awarded the contract for the construction of a 1-story, 90x115-ft. brick plant on State St., to the Amer. Contg. Co., 198 Milwaukee St. Estimated cost, $25,000.

TOMAHAWK—The Tomahawk Pulp & Paper Co. is having plans prepared for the construction of several buildings to include a 50x231-ft. machine room, etc. V. E. Labbe, secy.

Wyoming

CASPER—The city plans an election on Nov. 2 to vote on $250,000 bonds to construct sewers. Flushtanks will be installed in same. F. S. Knittle, City Engr.

Ontario

ALMONTE—The city engaged A. F. Macallum, engr., City Hall, Ottawa, to prepare plans and submit estimates for a waterworks system to include filters, reservoir, distribution system, etc. Estimated cost, $263,695.

COOKSVILLE—The Shale Brick Co. of Canada, Crown Office Bldg., Toronto, plans to make repairs to present brick plant. Estimated cost, $30,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY, will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 5, Society of Chemical Industry; Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry, and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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Considerations on Dye Licensing

ACCORDING to our British contemporary *The Chemical Age*, the question of regulating dye imports in that country has had the benefit of wide discussion, and it resolves itself into four possible methods from which to choose. These are: First, free imports—which means no restriction, and this is generally regarded as inadmissible despite free trade traditions. National safety requires that there be a well-developed organic chemical industry at home. Secondly, protection by tariff is not feasible owing to the low value of marks, and because the German dye producers are past masters in getting around tariff restrictions. Thirdly, subsidy, which has been tried but has been discontinued. This always brings trouble in a democratic government. The fourth is the prohibition of dye imports except under license. This method will probably be adopted.

Now the calico printers have a very strong organization in England, and they speak with authority for their whole trade. They also appear to be in accord—which is more than we can say of American manufacturers. They would of course prefer free trade, so far as their own business is concerned, but they have declared themselves ready to accept the license system provided four stipulations which they make are agreed to. These are:

That the licensing committee shall consist of practical men with technical knowledge.

The color-consuming trade shall be consulted as to the licensing machinery employed.

The onus of proof as to the suitability of the British color to meet the needs of the trade must lie on the color maker and not on the color consumer.

The licensing system must be limited to a definite period.

What our British cousins mean by "a practical man with technical knowledge" would seem to be expressed in the words themselves, but over here the expression would need definition of the subject of technical training. Years of adherence to the rule of thumb in many industries have almost demanded of the practical man that he shall not even be familiar with the theory of his profession. We should be very much concerned if a commission to pass on the need of imports of dyes were made up of practical dyers of the type that has flourished for over a generation in a large number of dye houses and textile mills. They don't know enough of chemistry, both theoretical and applied, or of the materials to be considered, and besides this they have itching palms. The idea is sound to require men of technical training and experience, but it is equally important that they be men of character and understanding who are appointed to the posts. The records of more than a few practical dyers would disqualify them.

The second requirement that the color-consuming trade be consulted as to the licensing machinery employed may also work well in England, but here again we see trouble in America. The vindictive action during the last Congress of Senator MOSES of New Hampshire, for instance, who is likely to be returned to the Senate this year, in killing the dye bill with the jawbones of Senators THOMAS and KENYON, is significant. The influence of local corporations on some of our representatives in the House and in the Senate is unfortunate, but we must count on it. The present Mayor of Philadelphia, J. HAMPDEN MOORE, is another example who, while in Congress, was blinded to the country's welfare by the interests of one or two local mills. What such men think is not important, but the influence of German agents in the mill in their respective districts and the resolution of their directors to kill any American industry that stands in the way of cheapest dyes for their use are serious hazards. The act of CLAUDE KITCHIN while chairman of the Ways and Means Committee in Congress in discriminating against indigo and most vat dyes is another example. What Mr. KITCHIN thought was not important, but what the owners of some North Carolina mills thought was reflected in his deeds.

That the system of license be limited in the period of its duration is also fair. No industry is entitled to such permanent preference. The trouble is, however, that the duration of research cannot be predicted. We are still short of anthracene in the United States, and of vat dyes made from it, and while it would be unfair to give this situation an indefinite warrant for continuance, it would be doubly unfortunate to cut off protection too soon. The only hope seems to be in the synthesis of anthraquinone from some other intermediate than anthracene, because after the anthracene is extracted from tar the pitch seems unavailable for roofing or road making. The briquetting industry in which such pitch is available is not developed here.

The users of dyes are entitled to a voice in the matter. They are the interested parties, and they have the right, from the services they render, to very earnest consideration. But some users of dyes are in sore need to see a greater light. There is no reason at all why a large mill in New Hampshire should destroy the chance of the country to enjoy military protection, as one did in the last session of Congress. We are in full accord with the idea that the onus of proof of the need—or the lack of need—of a dye should rest on the color makers, but there must be provided a tribunal at once competent and impartial to render judgment. It would

be no less than a farce if the commission were to consist of agents of recalcitrant mills who are resolved to buy German dyes no matter what else happens, whether these men be in the Senate or in the House or otherwise appointed.

The textile industry in this country is a great institution. The point we want to make is that among them there are some who are too much interested in their own profits to consider national welfare. They should be set apart in a class by themselves, and participate only in separate hearings.

Extent and Duration Of "Readjustment"

A GREAT guessing contest is on—how far the "readjustment" in markets and in industries generally will extend, and how much time the operation will require. Predictions are numerous but usually lack definiteness. Then there are differences in viewpoint, or in the precise thing about which the prediction is made. Thus, in the iron and steel industry there are predictions that price declines will be over and buying will begin to revive by next April, while there are bankers who predict that the readjustment will require two or three years. The predictions do not refer to the same thing. The prediction in the steel trade is simply as to the next "buying movement" in steel products, while the banker is thinking of when it will be safe and profitable to make investments of the most permanent character, those that must depend on the long future for a return of the capital, with suitable earnings meanwhile. One case involves commodities that are to be bought and liquidated or consumed, the other involves property that must continue indefinitely to be worth its purchase price.

The comparison suggests that there are two distinct things. One, pertaining to commodity markets, is merely a market movement. The other, pertaining to the whole complicated relationship between property values, values of securities, interest rates and the value of the dollar generally, is in its essence a readjustment from war-time conditions and the strained conditions that curiously sprang into being upon the war's ending. By a free interpretation of the word "readjustment" it could be used to connote what occurs in a commodity market when that market rises or falls, but before the war the word was not commonly used in connection with market movements, and the meaning commonly attached to the word since the signing of the Armistice, translated into the vernacular, is in substance "getting over the war."

If we can "get over the war" in three years' more time, making five years in all, we shall do well enough. Meanwhile commodity markets will have their declines and advances at recurrent intervals according to the circumstances involved in the particular commodity, for some commodities have different wave lengths of fluctuation from others.

There is no reason at this time for anyone to fear readjustment, or to look upon the development as something that should not be welcomed. We must get over the war some time, and if the operation is delayed troubles will be piled up. That is what occurred after our Civil War. Either because our currency was fictitious, not being based on gold or any other definite thing, or because we were young, thoughtless and extravagant, we had a period of eight years of inflation and reckless expansion that ended in a grand collapse, requiring five years of severe industrial depression to correct. That depression was the "readjustment" after the Civil War. We need have no fears regarding a readjustment after the World War that comes at this time, for we have builded too little rather than too much. We want industry and finance to get on a basis such as will make building wise, profitable and safe. The only danger is of the readjustment not being complete.

Already some far-sighted men have become hopeful that we are about to enter a new age in the history of American industry, an age that will be characterized by the absence of the industrial depressions that have marked our past and have been largely peculiar to the United States. The idea is that business will be conducted so conservatively that severe depressions will not be invited. These recurrent spells are natural to a young and growing country, so large a proportion of the "jobs" being in construction work that if building receives a chill the men thrown out of employment in the building trades cannot make work for themselves elsewhere.

Speculations on Sub-Atomic Energy

WE HAVE no less an authority than Professor A. S. EDDINGTON for the opinion that the source of a star's heat cannot be explained by the energy of gravitational attraction, but that it is rather to be accounted for by sub-atomic energy set free within the star. It is recorded in his address before the British Association for the Advancement of Science and published in the October number of *The Scientific Monthly*. Now the development of energy and the use of power from changes in state of sub-atomic particles is the substance of our hope for the continuance and development of civilization after the coal is gone, and it is also a proper basis for our fears for the future if the progress of research is too rapid.

Professor SODDY says, in effect, in "Science and Life" that if we could force the disintegration of radioactive substances so as to control the velocity of disintegration, we should obtain as much energy from one pound of such material as would be developed by burning 150 tons of coal, or that the same pound of material could be made to do the work of 150 tons of dynamite. We doubt if the world is quite ready for such efficiency as yet. Indeed, we offer this as an argument why we need development in the art of living and in human understanding and in character along with the study of science.

The same authority (SODDY) informs us that "Small as is the proportion of uranium and thorium in the rocks of the earth, the energy they evoke is estimated to be far more than the earth loses to outer space if the surface composition of the rocks is maintained uniformly throughout the core. Unless this is not the case, or unless the energy they evoke is being utilized in unknown ways, the conclusion follows that the interior of the globe must be getting hotter instead of colder. The uncomfortable prediction of the ultimate destruction of the world by fire is now at least as possible as the former fate pictured by science that the world must be steadily cooling and that it was only a matter of time before it became lifeless and dead."

The sub-atomic changes which Professor EDDINGTON

has in mind are not wholly atomic disintegrations. Normally we should say that energy is required for the synthesis of atoms, and is given off on their disintegration. But Professor EDDINGTON follows F. W. ASTON in his conclusion that all elements are constituted out of hydrogen bound together with electrons. By this hypothesis he says that "the nucleus of the helium atom is built up of four hydrogen atoms and two electrons," although the mass of the helium atom is less than the sum of the masses of the four hydrogen atoms which enter into it. But since mass cannot be annihilated, the deficit can represent only the mass of electrical energy set free in the transmutation. "We can therefore," he continues, "calculate the quantity of energy liberated when helium is made out of hydrogen. If 5 per cent of a star's mass consists originally of hydrogen atoms which are being gradually combined to form the more complex elements, the total heat liberated will more than suffice for our demands and we need look no further for the source of a star's energy."

This is contrary to our cheerful generalization in regard to the requirement of energy for atomic synthesis and its liberation when atoms disintegrate. Professor EDDINGTON admits that the synthesis of radioactive elements must be endothermic, although he claims that of helium to be exothermic. The rule would seem to work both ways or rather to be no rule at all in regard to the elements. But whether ASTON is right that all atoms are made up of hydrogen plus electrons, or HARKINS is right and they are composed of hydrogen and helium, or LANGMUIR is right and the electrons dance a quadrille in pairs and octets, or BOHR is right and they waltz forever, we have a present question in the integration or compounding of atoms just as we have in their disintegration. All authorities agree that in the presence of positive charges there exists a great, unknown code of behavior among electrons. They organize and arrange themselves under rules that are not yet clear, but in which the Quantum Theory may be involved. And electrons are not to be despised. They are very small, but only by comparison with atoms. In the picture of an atom, magnified to the diameter of a mile, which Dr. IRVING LANGMUIR described when he received the Nichols medal at the Chemists Club, the electrons had a diameter of five feet, whereas the nucleus was no bigger than a walnut.

That imaginary electron, five feet in diameter, is endowed with energy. Compared with the nucleus of the atom, which may contain anywhere from one to ninety-two positive charges, it is very big indeed. To call electrons atoms of electricity does not explain them. We might as well call them John or James or Warren Gamaliel. It is merely a name. They are replete with energy of an electro-negative character. And as for the nucleus or nut at the center, the electro-positive energy is still more concentrated.

We have no recognized aggregations of positive charges set free as positive electricity, but who shall say that there is no such thing? The single positive charges which Sir ERNEST RUTHERFORD drove out from an atmosphere of nitrogen which became first hydrogen ions, and then hydrogen atoms, may have come pretty close to being a positive electric discharge. Suppose, then, a vast number of such hydrogen ions should meet with a vast number of electrons, would anything happen? Might conditions be found under which the single positive charges would aggregate themselves into the nuclei of more complex elements? If such conditions were brought about, what would happen to those of us who were conducting the operation? Should we undergo a transformation similar to that which would be brought about by the explosion of 150 tons of dynamite in our presence? Or would the passion of electrons when confronted with positive charges to organize themselves into pairs and octets, or whirling rings or whatever their habit is, demand, require and take so much energy as to reduce the temperature to -273 deg. C. and thus to repeat the legend—provided only we had a fair maid in the laboratory of The Sleeping Beauty? Or would it be hot infinitely beyond life or cold beyond death, according to the element produced?

A Suggestion To Western Chemists

AN INFLUENCE that will have an important effect upon the industrial development of the West is the success of the co-operative associations whose object is to obtain favorable economic conditions for the financing, handling and marketing of agricultural and other products. The California Associated Raisin Co. and the California Fruit Growers' Exchange, to mention but two, are nationally known through the extensive advertising of their products, "Sunmaid Raisins" and "Sun-Kissed Oranges." These and other co-operative associations are managed by keen business men, and it is not surprising to find that they have employed engineers and chemists to help solve some of their producduction problems, such as the drying of raisins and the utilization of byproducts. Thus the Exchange By-products Co., operated for the benefit of the citrus fruit growers, with a plant at Corona, Cal., is producing 3,000 pounds of citric acid daily, also lemon and orange oil, from cull fruit. Alcohol, edible oil and fuel have been made from the capstems and seeds of raisins. Such associations, the outgrowth of unity of interest, have brought about a degree of development, particularly in the utilization of byproducts, that could not otherwise have been attained. They have, therefore, effectively stimulated a co-operative spirit through the western section of the country.

This spirit has permeated the electrical industry—the power companies, the dealers, and, through the "self-interest" appeal, men in other lines of business—and all are co-operating in the problem of raising the seventy-five or more million dollars that will be needed yearly if development in the electrical industry is to keep pace with the demand that will be placed upon it. The future market for electric power has been accurately estimated through the co-operation of the power companies.

Industrial development in the West will be rapid during the next few years and there will necessarily be an increase in the consumption of chemical products. This demand, together with that which can be developed in the Orient, will be sufficient to create the beginnings of a well-rounded chemical industry on the Pacific Coast. Although the manufacturing chemist has, as a rule, been secretive and self-sufficient, it may be that the apparent advantages of co-operation in the agricultural and electrical industries will not escape the observation of Western chemical manufacturers; at least it is hoped that they will profit by the example set by the industries cited.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, Oct. 13, 1920.

WHILE the threat of a coal strike persists the condition of chemical markets and of the industry generally remains very unsettled. Buyers are still satisfying only their most pressing requirements and as a result prices show a general decline aggravated by increasing Continental and American competition and difficulties due to the exchange situation. On the other hand, business is certain to be brisk as soon as the depression has passed, as stocks are very low, and although the falling off in the textile markets is an adverse factor, good business, especially on export account, is expected by the end of the year.

SULPHUR AND SULPHATE FROM GYPSUM

The high price of sulphur has revived interest in the problem of utilizing the sulphur contained in British gypsum deposits and in those located in British colonies. It was reported shortly after the armistice that in Germany the Farbenfabriken Bayer had roasted gypsum with silica and powdered coal in a rotary cement kiln, passing the sulphur dioxide produced into its contact acid plant and utilizing the residue for the manufacture of cement. This process appears to have been abandoned owing to difficulties in the contact acid plant. On the other hand, Wride, in the *Chemical Age* (London) of Jan. 3, refers to various patents and a new process of making sulphate of ammonia by the interaction of gypsum with ammonia and carbon dioxide, and this process is likely to be tried on a semi-commercial scale in the near future. A third method of utilizing the gypsum is the manufacture of sulphuretted hydrogen gas via calcium sulphide and in this way it would be possible actually to manufacture sulphur at a low cost by burning the sulphuretted hydrogen in a Claus kiln or alternatively completing the combustion to sulphur dioxide and passing that gas into a chamber or contact plant. The cost of the coal or other fuel required in these processes is lower in many of the British colonies than in this country and such a process is therefore of greater importance in the colonies where the cost of American or other imported sulphur is increased by freight charges, and the development of the processes should therefore be of particular interest to American exporters.

"DIRECT" PROCESSES FOR SULPHATE OF AMMONIA

Sulphur economics are also reflected in the various processes which are being devised to utilize directly the sulphur and ammonia in coal and to eliminate the use of sulphuric acid as such in the manufacture of ammonium sulphate. In July, 1914, the writer had the opportunity of inspecting at the Gutehofnungshütte one of the first Feld plants in which the crude coal gas was treated with ammonium polythionate with subsequent formation of sulphate of ammonia, free sulphur and sulphur dioxide, the latter being used again in a cyclic process. This plant had a capacity of two tons per day of sulphate of ammonia and the writer was greatly impressed at the time by the excellence of the chemical engineering work and the general efficiency shown by the designers. In spite of this, the Feld process seems to have proved too complicated in practice, and the most likely successor is that now being worked out under the direction of Prof. J. W. Cobb, of Leeds University. A plant having a capacity of one ton of ammonium sulphate per day is now in operation, the process consisting in treating the coal gas with a solution of zinc sulphate to produce ammonium sulphate and zinc sulphide. The zinc sulphide is roasted and the sulphur dioxide used again to regenerate zinc sulphate from the zinc oxide obtained in a previous roasting. The sulphuretted hydrogen and ammonia in the coal gas are thus utilized, and it is understood that the process is now technically successful.

Other investigators are turning their attention to the manufacture of ammonium sulphite from gas liquor, and using sulphur dioxide gas obtained from spent oxide or any other convenient source. It has been found that under suitable conditions ammonium sulphite can be oxidized with reasonable rapidity to ammonium sulphite, the latter being present to the extent of over 90 per cent after a few days and the remainder of the ammonium sulphite being almost completely oxidized during storage. In this way the cost of manufacturing the sulphuric acid usually required is avoided, but in the case of a market so conservative as fertilizers considerable time must elapse before users can be expected to take up large quantities of a product containing small quantities of ammonium sulphite. This is not surprising in view of the fact that while in some quarters experiments have shown that ammonium sulphite is just as good a fertilizer as the sulphate, other experts have adhered to the opinion that the sulphite is to some extent a plant poison. It would seem that further work on this method should lead to valuable results and substantial economies.

AMALGAMATION OF TRADERS' ASSOCIATIONS

Reference has already been made in these notes to the rival organizations representing chemical merchants (see CHEM. & MET. ENG., July 7, p. 33, and Aug. 4, p. 181). Under pressure of the Board of Trade, which was naturally disinclined to treat with more than one such body, it is now probable that the British Chemical Trade Association and the Chemical and Dyestuff Traders Association will be able to compose their differences and amalgamate into a completely representative body. Meanwhile the latter body has been doing good work by outspoken criticism of the forthcoming imports restriction bill, under which it is intended to allow dyestuffs to be imported only under license.

It is probable that there will be a long and bitter controversy on this and kindred matters when the bill is introduced into Parliament.

PROGRESS OF CHEMICAL INDUSTRY CLUB

The second annual dinner of the Chemical Industry Club is to be held at the Connaught Rooms on Nov. 19, and Sir William Pope is to take the chair on this occasion. Sir William Pope is the president of the Federal Council of Learned and Scientific Societies and that body has recently expressed sympathy with the objects of the club and three of the members of the council have been co-opted on to the club committee. The club now has 750 members and its future prospects are very bright. Reciprocal membership has been arranged with the Chemists' Club of New York.

The Chemistry of Cellulose and Its Compounds From the Colloidal Standpoint*

A Concise Descriptive Summary on Structure, Electrical and General Chemical Properties, Hydration, Oxycellulose—Action of Sulphuric Acid, Zinc Chloride, Ammoniacal Copper Oxide, Carbon Disulphide and Caustic Soda, Nitric Acid and Acetic Acid — Dope Solutions

BY GUSTAVUS J. ESSELEN, JR.

CELLULOSE is one of the common materials of nature. It forms the structural basis of the vegetable world. If we consider the ultimate unit —that is, the cell—cellulose forms the cell wall, and is therefore to be distinguished from the rest of the plant, which is made up of the contents of these cells. It may be isolated in the laboratory by alternate treatments with chlorine and a weak alkali like sodium sulphite. The chlorine treatment decomposes the lignocellulose to water-soluble materials and the alkali hydrolyzes pectic bodies and dissolves the non-cellulose products from the preceding treatment.

STRUCTURE

The physical structure of cellulose varies widely, and a detailed discussion of this property is beyond the scope of this paper. In any consideration of cellulose, however, one should constantly keep in mind the fact that all its modifications have one common characteristic, viz., their colloidal character. It will be recalled that the two chief characteristics of colloidal substances are first, that they are heterogeneous, and second, that the ratio of surface to mass is a high one. As an example of the first of these, it may be noted that cotton fibers, when viewed under a microscope by polarized light, are seen to be physically non-homogeneous, and are of extremely fine structure.

As the typical cellulose and probably the purest form which occurs in nature, it is of interest to consider briefly the structure of the cotton fiber. These fibers, under the microscope, are seen to be flat, ribbon-like bands which are somewhat twisted and subjected to certain internal strains. These strains are probably longitudinal tensions which can be released by the action of solvents. Harrison, in the *Transactions* of the National Association of Cotton Manufacturers (1916), has pointed out that the cotton fiber is made up of four parts:

(1) The outside membrane, which is not soluble in Schweitzer's reagent.

(2) True cellulose.

(3) Spiral fibers, all close to the outside membrane; these are not readily soluble in Schweitzer's reagent.

(4) Insoluble matter occupying the core of the fiber.

It seems probable that those portions other than the main bulk of the fiber are cellulose in a different colloidal state. In other words, cotton fiber consists of a complex structure of cellulose in different physical states, and contains fatty, protein and mineral matter, partly in the central canal and partly dispersed throughout the fibers. Cellulose from wood is a mixture of this typical cellulose with other celluloses less stable and less resistant to reagents.

ELECTRICAL PROPERTIES

When cellulose is immersed in water it assumes a negative charge. This probably is to be explained by the existence of a positive residual valency in the cellulose. As it is bombarded by hydrogen and hydroxyl ions the positive hydrogen ions are repelled, but the negative hydroxyl ions condense on the surface. These quickly rebound, but, as Langmuir has pointed out, owing to the fact that there is necessarily a time lag between the striking of the fiber and the rebounding, there is a higher concentration of these hydroxyl ions on the surface than in the main body of the liquid. In other words, hydroxyl ions are adsorbed. An illustration of this is seen in the fact that after a very dilute solution of sodium chloride is filtered through absorbent bleached cotton the filtrate is found to be a dilute solution of hydrochloric acid. In other words, the hydroxyl ions adsorbed on the cellulose have sufficient residual affinity to attract positive sodium ions from the solution and hold them in the vicinity of the cellulose fiber. A similar effect is observed when a very dilute sodium hydroxide solution is filtered through absorbent bleached cotton. In this case the filtrate is pure water. There will be frequent occasion to refer to these electrical properties in the explanation of the chemical behavior of cellulose.

GENERAL CHEMICAL PROPERTIES

Cellulose has the empirical composition $C_6H_{10}O_5$ and belongs, therefore, to the class of carbohydrates. Its molecular weight has never been determined, and accordingly the number of $C_6H_{10}O_5$ aggregates in a molecule is not known. The simplest point of view, as regards molecular weight, seems to be the modern one of Langmuir, which would regard the whole colloidal cellulose particle as a *colloid molecule*, consisting of large aggregates of atoms or group molecules held together by secondary valence.

The property of cellulose on which its greatest usefulness depends is its general chemical inertness. Modern theory explains this by the difficulty in making it take on or give up an electron. Under certain conditions, however, it does react, and then behaves like an amphoteric compound, exhibiting the property of a weak acid and a still weaker base. This behavior is generally explained on the ground of the mutual effect of the hydroxyl groups on the -CO and -CH_2 groups which are not far removed in the molecule. In view of the general inertness of cellulose, an almost paradoxical

*A paper presented at the Seminar of A. D. Little, Inc., Cambridge, Mass.

behavior has recently been noted by Cross and Bevan, who showed by subsequent acetylation that two samples of cellulose, identical except for the fact that one had been boiled in distilled water for two hours and then dried, exhibited markedly different chemical characteristics. Besides this there is additional evidence pointing toward the conclusion that any treatment to which cellulose is subjected, either physical or chemical, modifies its chemical activity.

When treated with dilute aqueous acids or alkalis at room temperature, cellulose adsorbs the acid or alkali from the solution, accompanied by a very slight rise in temperature. It also readily adsorbs barium hydroxide from solution, as well as basic oxides from solutions of lead, zinc, copper, tin, aluminum, iron and chromium salts. The action of mineral acids at higher temperatures and concentrations will be taken up later under the heads of hydration and hydrolysis. The explanation of these varied chemical phenomena has already been referred to in the consideration of the electrical properties of cellulose. In this connection it is well to keep constantly in mind the fact that these electrical phenomena are exhibited at the surface, and are, accordingly, more pronounced in a colloidal material, such as cellulose.

Hydration

When cellulose is acted upon by acids a change occurs which is generally referred to as hydration. Its exact nature, however, has not been established. There are certain interesting experimental facts which may be noted before considering the theoretical aspects of the matter. It is a general phenomenon that when cellulose is treated with mineral acids the strength of the cellulose is greatly impaired. Very often, also, its affinity for basic dyes is greatly increased. For example, after treating with 1 per cent sulphuric or phosphoric acids and subsequent drying at 100 deg. C. for ten minutes, the treated portions develop a considerable affinity for methylene blue, which is a typical basic color. On the other hand, after the same treatment with hydrochloric acid, although the strength is considerably impaired, the affinity for basic dye is decreased. Accordingly the substance formed when cellulose is "tendered" by acid is not the same as the substance which causes an increased affinity for methylene blue. However, it has been experimentally demonstrated that this latter material is produced from the former by the further action of acids. The material having the affinity for basic colors is not oxycellulose, but a derivative of hydrocellulose. Harrison's opinion is that it is analogous to the material produced when cellulose is parchmentized and that it is a peptized form of cellulose —that is, a form in a higher degree of dispersion, which probably adsorbs substances of a sugar-like reducing character, formed by hydrolysis. The reducing power of these substances is usually considered to be dependent upon the latent activity of the -CO group being brought into play.

On this basis, the increased affinity for basic colors is to be accounted for by the increased surface. The non-dyeing modification formed by hydrochloric acid is sometimes referred to as a dehydration product, but it seems more reasonable to explain it on the basis of pectization, with a possible resulting lessened adsorption of hydroxyl ions. It will be noted that this observation of the two forms of hydrocellulose casts some doubt on one of the methods of distinguishing between hydrocellulose and oxycellulose, inasmuch as the affinity for basic colors was always considered to be a characteristic of oxycellulose.

Hydration of cellulose is not limited to treatment with dilute acids, but is generally observed when cellulose remains in contact with water for any length of time, particularly if, at the same time, it is mechanically agitated. In the beater, in the process of paper making, hydration is accompanied by some hydrolysis, but the latter proceeds more slowly. Dr. Minor, of the Hamersley Manufacturing Co., has pointed out that there is a big difference between pulp which has been hydrated by long beating and pulp which has been brought to the same degree of hydration by a short beating, followed by cutting in the Jordan. In the former case there is plenty of chance for the production of mucilaginous substances by hydrolysis, the presence of which might account for the grease-proof properties of artificial parchment paper. Dr. Minor has further pointed out that there is botanical evidence for the formation of such mucilaginous substances by the hydrolysis of the cellulose.

A complete discussion of the many examples of hydration of cellulose would require a long paper devoted to nothing else. All that can be done here is to point out that hydration follows different courses, dependent upon the physical and chemical forces which are brought to bear upon it.

Oxycellulose

The name oxycellulose is applied to all products formed by the action of oxidizing agents on cellulose. Oxycellulose is even formed by the action of light in air, together with acid substances, soluble in water, which have strong reducing power. Like hydrocellulose, oxycellulose is also produced in the beater in the process of paper making, the rate at which it is formed depending upon the rate at which fresh surfaces are exposed by the cutting of the fibers. Hydration, on the other hand, proceeds at a much slower rate.

Oxycellulose reduces Fehling's solution and readily adsorbs methylene blue. It may be considered as a peptized form of cellulose in which the adsorbed substances have greater reducing power than those present in hydrocellulose. In the formation of hydrocellulose the acid used converts part of the cellulose into a pectized state, part into a peptized state and hydrolyzes a part. This is entirely analogous to the action of acid on starch. One gets, therefore, compounds formed by the adsorption of hydrolization products by cellulose in different colloidal states. The reducing properties of hydrocellulose and oxycellulose are mainly due to the adsorbed products; the dyeing properties are due to the colloidal state of the true cellulose portion.

Mercerization

When cellulose is treated with caustic soda solution, its degree of dispersion is increased in much the same manner that gelatine swells in water. As has already been pointed out, cellulose under these conditions adsorbs hydroxyl ions from the solution, forming adsorption compounds accompanied by changes in physical state at certain concentrations of alkali. Tolman and Stearn have suggested that the swelling is due to the repulsive force acting between the adsorbed ions, forcing the cell walls farther apart. At the same time the sodium ions are held in close

proximity to the adsorbed hydroxyl ions and thus form a second layer near the surface. As the swelling proceeds, the ions tend to arrange themselves in such a way as to neutralize the original electrostatic repulsion, and finally the swelling ceases to increase. It is conceivable that the environment might be so changed, as by the addition of salts, that the swelling might either decrease or increase still further.

At the same time that the swelling is taking place a decided shrinkage is noticeable, and also an untwisting of the fiber. The shrinkage is probably due to the strains to which reference has previously been made and which exist in the natural fiber. These become active when the fiber is softened. The untwisting is probably to be accounted for on the ground that the strains are distributed, partly at least, in spiral form.

Many colloidal substances react with iodine to give products of varied colors, the color combinations varying with the degree of dispersion. A low degree of dispersion gives a yellow color; as the degree of dispersion increases the color changes through orange, red, violet, to blue. By means of this test, mercerized cotton is shown to be cellulose in a more highly dispersed state than ordinary cellulose. This observation is checked by the ultra-microscope.

It is a well-known fact that cotton mercerized under tension develops a luster. A number of theories have been suggested to account for this luster, but it has now apparently been demonstrated that it is due to the smoothness of the surface of the fiber, as compared with the surface of cotton unmercerized, or mercerized without tension. Furthermore, cotton mercerized under tension possesses a regular structure, whereas the two others do not. Fibers mercerized without tension appear darker than unmercerized fibers, when both are dyed with the same percentage of dye, owing to the fact that the round section of a fiber mercerized without tension gives no internal reflection.

Action of Sulphuric Acid on Cellulose

While the decomposition of cellulose by sulphuric acid has usually been referred to as a solution process, Dr. Minor has recently pointed out that it really is not solution but adsorption, followed by peptization and a subsequent entire alteration of atomic affinities. One of the earliest observations of the action of sulphuric acid on cellulose was in the manufacture of parchment paper. In this operation the first effect is the adsorption of sulphuric acid by the cellulose to form a series of adsorption compounds, accompanied by swelling and peptization. In making parchment this process is stopped by plunging the product into water, which decomposes the sulphuric acid adsorption compounds and gives a gelatinous hydrate. It is probable that whatever concentration of sulphuric acid is used a series of adsorption compounds is formed, accompanied by both hydration and hydrolysis, which result respectively in an increase of the reducing power of the cellulose and in molecular disintegration. If the aqueous solution of these adsorption compounds is boiled, glucose and sulphuric acid are produced. With less drastic treatment, however, it has been found possible to obtain a very considerable amount of molecular degradation without freeing the -CO groups. When wood cellulose is used. in which the -CO group is more reactive, the reaction with sulphuric acid is more complicated, and yields furfural and condensation products of the latter.

When cellulose is immersed in a concentrated aqueous solution of zinc chloride, swelling is also observed. In this case the swelling is due to the adsorption of zinc oxide. That zinc oxide is adsorbed is proved by the fact that, when precipitated in water, the resulting cellulose hydrate retains 18 to 25 per cent zinc oxide, which is removable only by acid. Dr. Minor has suggested that the adsorbed zinc oxide or zinc hydroxide weakens the bonds which hold the colloid cellulose molecule together. In other words, a certain peptization is accomplished. In confirmation of this theory, it may be noted that sodium hydroxide does not effect the solution of normal cellulose, but does dissolve cellulose hydrate precipitated from its solution in zinc or copper compounds. After the initial swelling in zinc chloride solution, gentle heat is required to bring about final solution. This also is regarded by Dr. Minor as confirmatory of her idea that it is necessary to break the bonds of the cellulose gel before solution is effected. If a hydrochloric acid solution of zinc chloride is used, the cellulose dissolves at room temperature, but the solution is then accompanied by a gradual molecular breakdown. The solution is a rather unstable one, being broken up by mere dilution with water.

Schweitzer's Reagent

When treated with an ammoniacal solution of copper oxide, cellulose is rapidly attacked in the cold, forming a series of gelatinous hydrates, which pass into solution. The action is again due to the initial adsorption of copper oxide, and the explanation is probably the same as in the case of zinc chloride. The solutions are not very stable, being readily precipitated by alcohol, sodium chloride or sugar.

If the cellulose is allowed to remain in contact with the cuprammonium solution for a long time, some oxycellulose is formed and also a considerable quantity of nitrite. In other words, oxidation takes place slowly. As regards hydrolysis, cotton cellulose is not hydrolized by the process, but some forms of cellulose are.

Viscose

There is a well-known reaction by which carbon disulphide reacts with alcoholic sodium hydroxide to yield a xanthate having the general formula (XO)C : S(SNa), where X represents the hydrocarbon radical of an alcohol. Cellulose is enough of an alcohol to respond to this reaction. In carrying out the reaction in practice, cellulose is soaked in an aqueous sodium hydroxide solution of about 15 to 20 per cent strength for several hours. This is preferably done out of contact with the atmosphere to avoid oxycellulose formation. The surplus liquid is then removed in a centrifuge or press, the cellulose usually retaining about three times its weight of solution. It is then broken up into small pieces and treated with carbon disulphide in a closed container, the amount of carbon disulphide used being one-half the weight of the original cellulose. After standing several hours in a cool place, water is added to the mixture, and the solid is allowed to swell. On stirring, a smooth colloidal solution may be obtained which is yellow in color, due to the presence of colored by-products. In consists essentially of cellulose xanthate. The cellulose xanthate may be precipitated with alcohol or brine and redissolved in water. One or two such precipitations yield a product dissolving in water to a colorless solution.

From the standpoint of colloid chemistry, the process proceeds in several distinct steps. The initial treatment with caustic soda is similar to that which takes place on mercerization—that is, the cellulose adsorbs sodium hydroxide and swells, the swelling being accompanied by an increase in the degree of dispersion. The resulting hydration and increased surface renders the cellulose more reactive. Then the carbon disulphide is added and a metathetical reaction occurs. Cross and Bevan have shown that the best proportions of reagents are two molecules of sodium hydroxide and one of disulphide to each $C_6H_{10}O_5$ aggregate. The usual reaction between carbon disulphide and an alcoholic alkali requires only one molecule of the alkali, so that the second molecule of sodium hydroxide apparently necessary for the reaction must remain held to the cellulose by adsorption. The product is really, therefore, an alkali cellulose xanthate. Only one of the three hydroxyl groups of cellulose seems to be concerned in the reaction. After from twelve to twenty-four hours, Cross and Bevan have shown, the proportion of cellulose to xanthate radical corresponds to one xanthate radical to two $C_6H_{10}O_5$ aggregates, and this compound passes continuously to one in which there are four $C_6H_{10}O_5$ aggregates to each xanthate radical. This latter compound represents the material which spontaneously gels from a viscose solution, as will be explained below. It is, however, soluble in aqueous alkalis.

The solution of viscose is probably to be explained as a colloidal dispersion of the alkali cellulose xanthate in water. This dispersion is not stable; it breaks up again on standing at normal temperatures. This behavior gives an excellent example of hysteresis. The viscose first forms a continuous phase—or in other words gels—and then the gel shrinks symmetrically with exudation of solvent. The material possesses remarkable power to absorb water, as will be seen when it is pointed out that as little as 1 per cent viscose in solution will form a gel, and solutions containing 12 to 15 per cent no longer shrink spontaneously.

Viscose solution may be precipitated by alcohol or brine. If the precipitate is redissolved and again precipitated it is found that the percentage of Na_2O and sulphur in the compound gradually diminishes as the process is repeated, no break being observed in the curve between the original xanthate and the cellulose hydrate, which is the limiting product. Cross and Bevan explain this by saying that the size of the cellulose aggregate gradually increases—in other words, the degree of dispersion decreases. In view of our general knowledge of the behavior of colloidal materials in general and cellulose in particular it seems hardly reasonable to suppose that the cellulose molecule increases in size in the course of such treatment. It is a general property of colloid solutions that, with mechanical treatment, the size of the molecular aggregate decreases rather than increases. Furthermore, in the case of cellulose acetate and cellulose nitrate there is evidence that the molecule is gradually broken down by repeated solution and reprecipitation. Accordingly it seems more reasonable to assume that the degree of dispersion of the cellulose is increased in the case of viscose also and to look elsewhere for the explanation of the increased ratio of cellulose to carbon disulphide and alkali.

At first sight it might seem that it could be explained on the ground that we were dealing with an adsorption compound, but those who know most about viscose state that there is very strong evidence that the combination is much stronger than that. The only way that a true chemical compound can be assumed, in view of the gradual change in composition, would be that the molecule was so large that the removal of one molecule of sodium hydroxide would effect such a small proportional change in the total amount present as to escape detection by the ordinary analytical methods. Since we do not find it reasonable to assume a decrease in the degree of dispersion, it seem that the most reasonable explanation is to assume a very large molecule from which the splitting off of one or two molecules of sodium hydroxide would not produce an appreciable percentage change. Such behavior would seem to find an explanation if it be assumed that the cellulose aggregate formed one large molecule which, because of its colloidal nature, presented a very large surface. It would contain a large number of $C_6H_{10}O_5$ aggregates and the molecules of sodium hydroxide to which these were connected could be gradually eliminated one by one or even in larger numbers at a time and still give us what appeared like an unbroken curve. This explanation avoids any necessity of considering a decrease in the degree of dispersion on the one hand, or any consideration of the compound as merely an adsorption one on the other hand.

Another way of coagulating viscose is by heat. When evaporated at a low temperature a solution of viscose gives a water-soluble residue. If heated to 80 or 90 deg. C. a viscose solution coagulates, and if dried at this temperature gives a residue which is not soluble in water. In either case an analysis indicates that more water is adsorbed by such residues than by the original cellulose. This seems to indicate an increase rather than a decrease in the degree of dispersion. That it really is an increase in the degree of dispersion is further indicated by the fact that the product dyes more readily, is more easily acetylated than normal cellulose and also adsorbs a larger amount of sodium hydroxide from solution.

Cellulose Nitrate

When cellulose is treated with concentrated nitric acid a true nitric acid ester is formed. Since the cellulose remains solid during the treatment, one of the factors determining the degree of nitration is the surface exposed. Probably the most common way of modifying the amount of surface is to add concentrated sulphuric acid, which is adsorbed by the fiber, and not only aids the reaction by increasing the degree of dispersion of the cellulose but also acts as a direct catalyst of the esterification. The highest nitrate known is the one containing three nitrate groups for each $C_6H_{10}O_5$ aggregate. This is usually referred to as the hexa-nitrate, and is the one used as an explosive. There seems to be an unbroken series of compounds with steadily but gradually decreasing amounts of combined nitric acid from this point down to hydrocellulose. As just mentioned, the compounds with the highest nitrogen content are among our best explosives. Those with an intermediate amount form the basis of the nitrocellulose plastic industry, while those with the lowest nitrogen have no particular commercial significance.

From the colloidal standpoint, the most interesting nitrates are those of an intermediate nitrogen content, which serve as raw material in the manufacture of celluloid. This industry affords as fine an example of applied colloid chemistry as there is to be found.

There are two general methods of making celluloid. n the first pyroxylin is combined with an alcoholic lution of camphor by working under heated rolls. A nsiderable amount of alcohol has to be used and the lvent loss is high. In the other method, which is the ore usual American process, the moist pyroxylin is timately ground with about one-quarter its weight of mphor. The water is then expelled by pressure and fter the resulting cake has been broken up it is slowly prayed with denatured alcohol and thoroughly stirred at the same time. Alcohol amounting to about 10 per ent of the weight of the pyroxylin is ordinarily used. The resulting mixture is allowed to stand for some hours to allow for proper impregnation by the alcohol and is then worked on warm rolls until translucent, when it is pressed into slabs and sheeted or given some other form. It is finally seasoned in driers at 50 deg. C. to remove any volatile solvent which may remain. From the colloid point of view, the finished product is a true colloidal gel.

Action of Anti-Acids in Celluloid

One of the difficulties of the celluloid industry is that there are present, unless great care is taken, unstable compounds formed during the nitration. These have a tendency to decompose and set free acid, which, in turn, tends to act catalytically to decompose the main body of the material. To counteract this tendency organic compounds of a basic nature are added. They usually have some slight solvent action on the nitrocellulose, and therefore are presumably dispersed throughout the mass. As they are substances usually thought of as crystalloids it is possible that they may be present in a molecular degree of dispersion, although it seems more probable that they will be in a colloidal degree of dispersion.

Schwarz makes the statement that an anti-acid is the more effective the larger its particles are and the more colloidal its character. From our knowledge of colloid materials in general it would seem that his statement was contrary to the general conception, because the larger the particles the less the surface, and where, as in a gel, diffusion is slow the effectiveness of the anti-acid would have to depend upon the amount of surface exposed. In other words, in gels where the rate of diffusion is slow we have to depend much more on proximity for a chemical action than in true liquid solutions where diffusion is comparatively rapid and where mechanical agitation is readily possible.

Some basic organic materials have a tendency to crystallize in the gel. These, of course, would not be expected to be so effective as materials which remained in the colloidal or molecular state of dispersion. Contrary to Schwarz, it would seem more reasonable to expect an anti-acid to be more effective the finer its particles and the greater its degree of dispersion.

Cellulose Acetate

An acetic acid ester of cellulose results when cellulose is treated with acetic anhydride in the presence of a catalyst such as zinc chloride, sulphuric acid, methylamine sulphate, etc. There are two general methods of producing cellulose acetate, both of which have a number of variations. One results in a fibrous cellulose acetate resembling in outward appearance the original cotton used as raw material; the other gives a granular product. Both have this in common, that the catalyst is adsorbed on the fiber and presumably facilitates the reaction not only because of its true catalytic effect, as exhibited in any esterification, but also because it causes a swelling and probably an increase in the degree of dispersion of the cellulose. Very frequently, in practice, time is allowed for this adsorption of catalyst and resulting swelling before the acetic anhydride is added. That the degree of dispersion of the cellulose is really modified by the reaction is indicated by the fact that the longer the preliminary treatment the more rapid the reaction when the anhydride is added and the less viscous the solutions of the product.

In making the granular form of cellulose acetate, cellulose, usually in the form of cotton, is treated with a mixture of acetic acid, acetic anhydride and a suitable catalyst. The acetic acid acts merely as a carrier and takes no part in the reaction. As mentioned above, the catalyst dissolved in acetic acid is frequently mixed with the cellulose some time before the anhydride is added, although in other cases all are added together. Since cellulose acetate is soluble in acetic acid, the cellulose dissolves as the esterification proceeds. Samples are taken from time to time and when the desired solubility has been attained the reaction is stopped by adding an excess of water, which destroys any remaining anhydride and precipitates the cellulose acetate.

In the earlier processes the acetate thus formed was the tri-acetate, which corresponds to the hexa-nitrate. It later developed that, owing to their wider range of solubility, the acetates of most technical usefulness were those with a somewhat lower acetyl content than would correspond to a hexa-acetate on the C_{12} basis, but higher than would correspond to a tetra-acetate. These were at first prepared by adding small and carefully regulated amounts of water and sulphuric acid to the solution of cellulose acetate. As before, when the desired solubility was attained, the product was isolated by precipitation with water. While, outwardly, this secondary treatment is one of partial saponification, actually it is much more intimately connected with the colloid properties of the cellulose acetate. The reason for this is that an equivalent degree of saponification obtained by methods not involving the solution of the acetate does not give a product with the same wide range of solubilities. The effect may very possibly be connected with the opening up of the molecule in such a way as to make the -CO group more reactive, because it results in a greatly increased solubility in acetone.

In preparing cellulose acetate in fibrous form it is given a preliminary treatment with sulphuric acid dissolved in glacial acetic acid, this step being similar to the one for preparing granular cellulose acetate. During this treatment the cellulose adsorbs sulphuric acid to such a degree that the amount adsorbed has to be taken into account in making up the bath for the following run. After removing the surplus preliminary bath in a centrifuge or press the cellulose is immersed in a mixture of acetic acid, acetic anhydride and some non-solvent hydrocarbon. The sulphuric acid catalyst, being adsorbed directly on the fiber, is in a particularly favorable position to hasten the reaction. While the proportion of non-solvent is so regulated that the cellulose acetate does not dissolve, the conversion is accompanied by a marked swelling and by a noticeable change in the index of refraction. When the product has reached the desired degree of solubility the surplus liquid is removed, usually in a centrifuge, and the residue is thoroughly washed with water. The product is cellulose

tri-acetate, and in order to render it soluble in acetone it is subjected to a partial saponification, as in the case of the granular form described above.

Solutions

When cellulose acetate is dissolved in an organic solvent a colloidal solution is obtained in which the cellulose compound is dispersed in the solvent in the form of a lyophile colloid. In common with all lyophile solutions, it is noticed that the viscosity of any given solution increases at a very much more rapid rate than the concentration of the solution. Furthermore, in common with all lyophile solutions, the viscosity of these solutions gradually decreases when they are subjected to mechanical treatment, such as shaking or pressing through capillary tubes.

This is sometimes explained as indicating a sort of structure even in the liquid and as being connected with liquid membranes which surround the colloidal particle. That it really also affects the substance which is in the dispersed phase is indicated by the fact that when a given sample of cellulose acetate is dissolved, which necessarily involves a certain amount of mechanical treatment in the way of stirring, and is then recovered from the solution in some manner, either by evaporating the solvent or by precipitation in a non-solvent and drying, the recovered cellulose acetates give solutions of a lower viscosity than solutions of similar concentration made from the original acetate.

Furthermore, in common with other lyophile colloids, cellulose acetate solutions show rapid changes in viscosity with variations in temperature, and the viscosity of the solution is influenced by its thermal history. It is very interesting to note that in making up lacquers or other solutions in which gums are included as well as a cellulose ester it makes a decided difference in the finished solution whether the cellulose ester is added to the solvent first or whether the gum is added before the cellulose ester. Sometimes the effect is so marked that if the gum is added to the solvent first the cellulose ester will not dissolve in the resulting mixture, but if the cellulose ester is added first the gum can be readily dissolved afterward. In other words, the cellulose ester is not soluble in the colloidal dispersion of the gum in the solvent, although the gum may be dispersed in the solution of cellulose ester. From this it would appear as if the cellulose ester and solvent formed the dispersion medium, and the gum the dispersed phase, and that it was not possible under the conditions cited to obtain a mixture in which the solvent, plus gum, was the dispersion medium with the cellulose ester as dispersed phase.

The colloid chemistry of cellulose acetate plastics is the same in its essential principles as that of celluloid, and accordingly need not be considered further at this point. It may be of interest, however, to consider briefly what happens when a solution of cellulose acetate evaporates, as for example in the drying of lacquer or airplane dope, or in the manufacture of continuous films such as are used for photographic purposes. In the simplest case the cellulose acetate is dispersed in the solvent. As this is spread out on a surface to dry the solvent gradually evaporates, and finally at a certain concentration a gel is formed—i.e., the dispersed phase and the dispersion medium both form continuous phases. The solvent continues to evaporate, until finally we reach a condition where the solvent becomes the dispersed phase and the cellulose acetate the dispersion medium. This may very well be the situation in films which have become brittle.

If, on the other hand, we were to start with a cellulose ester solution containing, in addition to the cellulose ester and solvent, some material analogous to camphor which, though solid, was still a solvent of the cellulose ester, then on continued evaporation of the liquid solvent from the gel the solid and non-volatile solvent would still remain, and we would still have a true gel with two continuous phases, which presumably would not be brittle.

In selecting such a solid non-solvent it is desirable to select a material which is miscible with the cellulose ester over a wide range of proportions, for certain such materials are known which, although acting as camphor substitutes in certain concentrations, still, if these concentrations are materially increased, tend to form a crystalline deposit which, of course, renders the combination unfit for practical purposes.

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Production of Gum Turpentine and Gum Rosin

The Bureau of Chemistry makes public the following figures showing the production of gum turpentine and gum rosin during the 1919-20 season by states. The unit for turpentine is the cask of 50 gal.; for rosin, the round or still barrel of approximately 500 lb. gross weight.

State	Turpentine Production, Casks	Per Cent	Rosin Production, Round bbl.	Per Ce
Alabama	38,100	10.4	126,000	10 2
Florida	136,900	37.4	457,500	37.0
Georgia	73,900	20.3	250,600	20.3
Louisiana	68,700	18.8	232,000	18.7
Mississippi	29,500	8.0	102,800	8.3
North Carolina	600	....	2,200	.
South Carolina	1,100	0.5	3,400	0 5
Texas	17,200	4.7	62,500	5.0
	366,000	100.0	1,237,000	100.0

The total production for the 1918-19 season was 341,000 casks of gum turpentine and 1,115,000 round barrels of gum rosin.

Watch Oil From Petroleum

The K. & J. Oil Co., of Canton, Ohio, has begun the manufacture of watch oil from crude petroleum of the Mecca field. The process was devised by Dr. C. F. Mabery, of Cleveland, Ohio, and affords a product which is said to be entirely satisfactory for chronometric lubrication. Hitherto watch oil has been prepared from the maxillary fat accumulations of the porpoise, and has sold for approximately $250 per gal.

The Blast-Furnace Hearth*

A Wide Hearth Permits Steeper Bosh and Flatter Stack Lines With Many Resulting Economies, Especially for Smelting Mesaba Ores—Operating Data, Construction Details and Theoretical Considerations Point to Its Definite Superiority

BY WALTHER MATHESIUS†

ON THE theory of the blast-furnace process and its chemical reactions our technical literature contains many able contributions, but little has been said for years about the scientific factors pertaining to furnace design. Perhaps the statement was made occasionally that a blast furnace must afford the opportunity for a uniformly intimate contact between the iron-bearing materials of the descending stock column and the furnace gases rising from the hearth. Just how this was to be accomplished, however, what specific features should be embodied in the furnace lines to attain this end, has so far been left almost entirely to the practical furnace man to find out. Thus blast-furnace design has to date been a rather exclusively empirical development. To the practical furnace operator belongs the credit for the accomplishments in this respect as obtained by departing from the older standards, to which the engineer, as a rule, was wont to cling.

However, with a number of examples in successful operation for a period of years, theory may now safely come to the front and demonstrate that its laws were violated in the past, or that the successful development is logical and correct, its accomplishment scientifically permissible. In this manner I shall attempt to show the development of larger furnace hearths to be a logical advancement of the art in its endeavor to design furnaces which will offer the least possible resistance to a rapid and uniformly regular descent of the stock, and which at the same time will permit the furnace gases to rise through this stock column with equally regular and uniform velocity and distribution.

HEARTH ORIGINALLY A RECEPTACLE FOR IRON

Going back in history, we find that the earliest types of blast furnaces, used in charcoal practice with cold blast, were built with comparatively small hearths. On furnaces with 8 or 9 ft. bosh diameter they seldom exceeded 3 ft. in width. It is apparent that the principal and probably only consideration determining the size of the hearth in those days was to provide sufficient storage space below the melting zone for the liquid products of the operation, so as to enable their withdrawal at convenient intervals. In view of the small output of these furnaces such hearth dimensions were apparently ample. Considering the slow rate of driving, the low blast pressures and small wind volumes used, the distance of the tuyeres from the furnace center and the resultant height and slope of bosh were evidently minor considerations. Thus it may be stated that in these early days the hearth dimensions had little or no effect on the working of the furnace proper and, therefore, the design of the latter above the tuyeres was not influenced to any extent by the size of the hearth.

Since then, and right up to our own days, the size of the blast-furnace hearth has been very largely controlled by these same considerations of providing sufficient storage capacity for the molten iron and slag. With greatly increased productive capacity and faster driving on the one hand and steadily rising difficulties of raw materials on the other, the effect of small hearth diameters in conjunction with the resultant flat or high boshes on the working and economy of our furnaces became, however, more and more apparent. Yet tendencies toward radical departures from well-established standards were for years most effectively offset by the decided aversion of furnace men, well founded on sad experiences with "hearth trouble" in the form of breakouts, to store in their furnaces more than the necessary quantities of molten materials.

This conservative policy was strengthened through the quite popular assumption that gas distribution in the stack could be controlled by maintaining the proper "blast penetration" in the hearth, and that this was largely a question of selecting the proper length and size of tuyeres. Such belief and the failure connected therewith, of recognizing the condition of raw materials in the furnace, dependent upon method of charging and furnace lines, as the principal factor governing gas distribution, has only recently been dealt with by J. A. Mohr, in his paper presented before this Institute in May, 1919.

SUPPORT OF STOCK COLUMN BY BOSH

Lastly there remained the theory that a bosh with sufficient bearing surface was needed to properly support the stock column and to prevent the premature descent of the charges into the tuyere zone, thus avoiding compression and clogging there due to the weight to be carried. This supposition was, I think, definitely controverted by H. A. Brassert, in his paper read before this Institute in May, 1914, where he termed the furnace bosh of that day the chief impediment to a free travel of the stock. Since then it has been the basic idea governing the development of the large hearth, to design, with its aid, a furnace bosh of such steepness and so short as to avoid interference with the stock movement.

Why the evolution of such designs was naturally and logically linked with the desire to use higher percentages of fine Mesaba ores may readily be understood on the basis of the following theoretical considerations:

SHRINKAGE OF STOCK VOLUME

As long as the shrinkage of the stock volume taking place during its descent from the top of the bosh to the tuyeres is such as to result in a contraction of

*A paper read before the Eighteenth General Meeting, American Iron and Steel Institute, Oct. 22, 1920.

†Superintendent Blast Furnaces, Illinois Steel Co.

TABLE I. DATA CONCERNING THE PERFORMANCE OF NO. 6 BLAST FURNACE AT SOUTH WORKS, ILLINOIS STEEL COMPANY

		Pounds per Ton							Average Blast			Iron Analysis		
Date	Product (Gross T[ons])	Total Ore, Scale, C[inder], Etc.	Coke	Stone	Scrap Used Over P[ro]duced	Flue Dust [Pro]duced	Flue Dust	Per cent Mesaba Ore Mi[xture]	Cu.ft. of [Wind] per Mi[nute] Engines	Temperat[ure]	Pressure a[t] Engines	Si %	S %	Actual Yi[eld] Metallic Mixture
1918														
Oct *	485	4,900	2,126	972	35		21	94 2	40,870	1,194	17 0	1 49	0 029	46 29
Nov	568	4,678	1,964	868	38	278	77	100 0	44,400	1,242	18.0	1 49	0 037	48 55
Dec	583	4,692	1,993	797	18	254	96	100 0	44,613	1,147	17.6	1 54	0.040	48 05
Ave	544	4,659	2,016	873	29	184	67	98 1	43,254	1,204	17 5	1 50	0 035	47 61
1919														
Jan.	606	4,679	1,980	693	30	277	99	100 0	43,840	1,136	17 1	1 56	0 040	48 38
Feb	602	4,594	1,956	694	21	303	153	100 0	44,286	1,152	16 9	1 48	0 045	49 12
Mar	607	4,781	1,933	698	49	298	170	100 0	44,323	1,062	16 6	1 27	0 039	48 30
Apr	625	5,043	1,888	666	48	336	170	100 0	45,689	1,086	16 8	0 90	0 040	45 23
May	590	4,732	1,949	742	64	258	156	100 0	44,613	1,138	16 9	0 90	0 043	48 45
June	600	4,622	2,035	678	42	308	180	100 0	47,839	1,163	16 4	1 02	0.035	49 23
July	600	4,590	1,981	659	39	240	173	100 0	48,322	1,196	16 2	0 91	0.039	49.50
Aug	605	4,631	1,955	628	42	186	187	100 0	47,645	1,190	16 7	0 85	0 035	49.11
Sept ‖	612	4,572	1,988	544	41	251	175	100 0	47,433	1,026	15 3	1 08	0.031	49 73
Oct †	361	5,293	2,398	872	73	251		100 0	36,000	926	15 4	1 56	0.057	43 48
Nov	597	4,440	1,942	627	77	152	136	100 0	43,840	1,045	16 1	1 17	0 033	51 90
Dec	597	4,538	2,052	718	73	247	173	100 0	42,903	1,092	16 7	1 32	0 039	50 71
Ave	600	4,661	1,972	673	48	257	159	100 0	44,726	1,114	16 4	1 17	0.040	48 91
1920														
Jan	625	4,603	1,890	611	56	229	105	100 0	42,871	1,107	17 7	1 01	0 039	49 68
Feb	618	4,575	1,976	618	49	235	78	100 0	42,552	1,079	17 5	1 12	0 039	49 84
Mar	632	4,510	1,891	686	53	237	92	100 0	44,387	1,070	17 9	1 10	0 038	50 64
Apr §	563	4,536	1,883	709	49	211	82	100 0	43,542	1,034	17 2	1 06	0 034	50 25
May¶	608	4,565	1,983	748	55	216	105	100 0	43,633	1,099	17 5	0 96	0 036	50 05
June	608	4,384	1,988	753	43	227	171	99 1	44,666	1,087	18 1	0 95	0 038	51 91
July	598	4,461	1,923	671	42	254	171	97 3	48,933	1,045	18 0	1 01	0 036	50 96
Aug	611	4,384	1,962	698	51	236	169	97 1	47,839	1,067	17 5	1 01	0.041	52 01
	615	4,509	1,937	685	49	231	122	99 2	44,803	1,074	17 6	1 03	0 038	50 67

To[tal] produced on lining to Sept 1, 1920 392,594

*Blown in Oct. 1, 1918
‖ Banked Sept. 21, 1919
† Resumed operation Oct [illegible] 1919
§ Banked from April 7 to 9 [a]nd from April 25 to May 3, 1920.
¶ Resumed operation May 3, 1920

the total bulk greater than the reduction of the furnace area prescribed by the bosh angle between the two points mentioned, we may assume that the furnace bosh does not impede the stock movement.

Such shrinkage of the stock volume may be due to one of two causes. The first of these, supposedly existent in every blast-furnace operation, is the gradual consumption, above the tuyeres, of the coke by the oxygen of the blast and such metallic oxides as may still be unreduced at this point. This shrinkage will, of course, be greater with a higher coke rate and will begin at an earlier stage, which means a higher furnace level, the farther the melting zone extends upward above the tuyeres. A flat or high bosh may, therefore, be expected to interfere with the stock movement, particularly on furnaces making low-silicon iron on a low coke rate. Attempts to use high blast heats, which, of course, would aim at a concentration of the melting zone, would no doubt aggravate matters under these conditions.

The second cause of shrinkage of the stock volume in the bosh is the gradual melting of the ore and the formation of slag, which enables the liquid particles to make their way into the furnace hearth ahead of the burning coke. It may readily be seen that this shrinkage can take place to an appreciable extent only in furnaces where all or a large part of the burden consists of lumpy material, which does not disintegrate in the furnace stack but retains its shape until it reaches the melting zone. Material of this character occupies, of course, a considerable part of the furnace volume and its melting in the bosh makes this volume available for other solid materials, especially coke.

If, on the other hand, all or a large part of the burden consists of fine materials, the voids existing in the coke charge will offer sufficient volume to receive it, so that, as the stock column descends, the space occupied by ore and coke is practically no greater than that of the coke charge alone. Consequently the melting of the ore in the bosh cannot bring about any shrinkage of the stock column. Now modern Mesaba practice with high blast heats and low fuel rates will be seen, from this purely mechanical point of view, to present all of the above-mentioned conditions which tend to minimize the shrinkage of the stock in the bosh and to retard its beginning. Thus, Mesaba practice, more than other operations, was evidently in need of lower and steeper boshes, and practical experience has shown that their adoption has in every case resulted in improved quality of product, increased tonnage, lower fuel consumption and better use of hot blast temperatures, as stated and proved by James G. West, in his paper read before this Institute in May, 1918.

One of the incidental yet not negligible advantages of the larger hearth is its greater accessibility. With increased diameter, greater peripheral distances result for arranging feed and discharge pipes for cooling water, more working space is available around the tuyeres, blow stocks and the columns, as well as between the iron and cinder runners near the furnace, so that, on the whole, the cast-house work and also the mechanical maintenance becomes easier and simpler.

Present Hearth Dimensions at South Chicago

In order to illustrate the extent to which hearth dimensions have grown in recent years, I might mention that the average hearth diameter of all 22-ft. bosh furnaces at the South Chicago plant of the Illinois Steel Co. was increased from 16 ft. 6 in. in 1911 to 18 ft. 6 in. in 1919, and that the best average monthly production of these same furnaces equaled 512 tons per furnace-day in December, 1911, as against 556 tons in

May, 1920. For this increased output the adoption of larger hearths is primarily responsible, no enlargement of the furnaces or important changes of lines above the bosh having been made. During the same time our fuel conditions have developed no permanent improvement, but rather have experienced a decided change for the worse. The fuel consumption per ton of iron for the two periods cited above were 2,053 lb. in December, 1911, and 2,037 lb. in May, 1920.

In this connection I wish to point out that with this development of hearth dimensions the old practice of comparing furnace performances on the basis of their daily pig iron output per sq.ft. of hearth area is no longer applicable. It will readily be understood that this method of calculating furnace ratings, while capable of furnishing reasonably equitable data where hearth sizes bore the same relation to furnace dimensions as a whole, must naturally cease to be of value as soon as hearth diameters are increased beyond the customary proportion.

Effect on Stack Lines

So far this discussion has dealt with changes of hearth and bosh dimensions which did not contemplate or entail any changes in the upper or stack part of the furnace. Lately, however, larger hearths have also enabled modifications of the stack lines which were not practicable before, although their desirability had been felt for some time. Particularly for operations where soft, easily reduced ores are used which are known to have a tendency to swell under the influence of the reducing furnace gases, the suggestion had been made that the uniform descent of the stock might be facilitated by increasing the batter of the stack lining, thereby reducing any "jamming" tendencies as well as friction. One way to obtain this would seem to require merely a decrease in the diameter of the stock line. This, however, did not appear to be permissible on modern fast-driven furnaces using a large percentage of fine ores, since the gas velocity at the stock line, which, all other things being equal, must necessarily be determined by the available area, was known to be so high in many cases as to keep the surface of the charge in more or less constant agitation. Thus the limit would be closely approached beyond which dust losses would rapidly grow to excessive proportions. The diameter of the bosh, on the other hand, appeared to be definitely controlled by the limits of hearth dimensions and bosh angles. The only means remaining, then, of obtaining at least a slight increase in the stack batter was to carry the straight stock line section down lower into the furnace and thereby reserve the relief offered by a greater outward slope of the furnace walls for that part of the travel in which the swelling of the ore and consequently the friction was thought to be most prominent.

With the removal of the assumed limitations of hearth dimensions the situation has changed. Hearth diameters of 20 ft. and larger are in satisfactory operation and the opportunity is now here to increase the bosh diameter over the rather commonly accepted 22-ft. standard without sacrificing anything in suitability of bosh angle or height. The result to be expected from such designs should, of course, be a freer working of the furnace—that is, regular descent of the charges—and, other conditions being equal, a lower blast pressure.

Operating Details No. 6 Furnace

Practical results appear to verify this theoretical analysis, since, for instance, No. 6 blast furnace at the South Works, of the Illinois Steel Co., which was designed along such lines of reasoning and has now been in operation for about two years, has consistently worked with a more regular and uniformly lower blast pressure than the other furnaces at this plant under

TABLE II. DATA CONCERNING THE AVERAGE PERFORMANCE OF BLAST FURNACES AT SOUTH WORKS, ILLINOIS STEEL COMPANY
(Excluding No. 6 Blast Furnace)

Date	Average Production (Gross)	Pounds per Ton: Total Ore, Scale, C, Etc.	Coke	Stone	Scrap Used Over Produced	Flue Dust Produced	Flue Dust Used	Per cent Mesabas in Ore Mixture	Cu.ft. of Wind per Min. at Engines	Average Blast: Temperature	Pressure at Engines	Iron Analysis: Si	S	Actual Yield Metallic Mixture	Number of Furnaces Operating
1918															
Oct.	528	4,475	2,072	886	+16	270	176	72 3	43,570	1,062	17 8	1 29	0 044	49 66	9 0
Nov.	506	4,471	2,130	837	+28	283	211	82 2	46,719	1,066	17 4	1 39	0 043	50 37	9 0
Dec.	526	4,480	2,055	822	+17	247	178	85 5	42,120	1,074	17 4	1 39	0 039	49 89	9 0
Ave.	520	4,473	2,084	848	+20	266	188	80 0	44,136	1,067	17 5	1 36	0 042	49 97	9 0
1919															
Jan.	524	4,420	2,055	778	+50	282	190	85 2	41,523	1,062	*17 6	1 37	0 040	49 75	8 6
Feb.	520	4,470	2,039	838	+26	295	232	87 5	41,258	1,069	17 4	1 25	0 042	49 64	9 0
Mar.	538	4,400	1,992	819	+27	239	226	85 4	41,907	1,070	17 2	1 27	0 039	50 56	*9 2
Apr.	556	4,330	1,885	721	+39	289	179	89 6	41,690	1,065	16 7	1 20	0 035	50 71	5 3
May	543	4,470	1,984	776	+26	268	100	88 5	42,983	1,050	16 7	1 28	0 040	48 81	4 5
June	542	4,558	2,079	724	+21	267	114	90 1	43,516	1,006	16 6	1 40	0 034	49 73	4 4
July	522	4,552	2,111	793	+32	258	125	87 3	41,390	1,107	16 0	1 44	0 037	49 27	5 0
Aug.	518	4,395	2,048	779	+ 7	160	64	91 0	41,494	1,092	16 2	1 32	0 040	48 85	5 6
Sept.	518	4,442	2,046	774	+19	224	123	86 8	41,396	1,045	16 5	1 38	0 037	49 36	6 7
Oct.	484	4,664	2,091	863	- 62	293	11	90 5	40,451	982	16 6	1 30	0 040	48 78	4 4
Nov.	516	4,320	1,970	746	+49	145	82	89 9	40,831	1,039	17 3	1 44	0 045	49 75	6 2
Dec.	516	4,299	2,030	835	+86	174	108	89 9	39,150	1,086	17 3	1 29	0 047	50 54	4 3
Ave.	523	4,413	2,038	788	+24	241	130	88 5	41,466	1,056	16 9	1 33	0 040	48 81	6 0
1920															
Jan.	537	4,429	2,025	776	+28	203	82	85 9	40,000	1,048	17,5	1 29	0 042	50 98	7 3
Feb.	552	4,360	1,992	745	+23	222	128	83 5	41,044	1,060	17 5	1 38	0 041	50 99	6 4
Mar.	562	4,382	1,953	781	+11	204	116	89 0	42,323	1,082	17 2	1 35	0 037	50 99	7 2
Apr.	525	4,365	1,999	800	+36	184	115	90 4	40,965	966	16 8	1 43	0 039	50 74	5 4
May	565	4,355	2,002	819	+27	210	129	91 7	43,783	1,072	17 4	1 33	0 039	50 59	6 5
June	549	4,345	2,033	845	+15	214	122	88 3	43,008	1,062	17 2	1 33	0 040	51 39	6 3
July	551	4,320	2,001	837	+ 7	222	132	78 1	44,194	1,065	18 1	1 33	0 039	51 83	5 6
Aug.	530	4,300	2,017	852	- 8	222	112	73 5	41,161	1,053	16 6	1 37	0 039	51 84	5 7
Ave.	547	4,362	2,002	805	+20	210	117	85 1	42,052	1,051	17 3	1 35	0 040	51 17	6 3

Average tons produced on linings of furnaces in blast Sept. 1, 1920 — 316,775.

comparative conditions. The principal dimensions of this furnace are given in Fig. 1, and data illustrating its performance are shown in Table I.

In order to afford a basis for comparison the average performance of all other South Works furnaces for the same period of time is given herewith in Table II. It should be noted that No. 6 furnace was operated for the entire period on practically 100 per cent Mesaba ores and that no scrap of any kind was charged. Beyond this the data presented are believed to require no special comment, except to point out that the fuel consumption was inferior to that of former years. This is due exclusively to the inadequacy, irregularity and inferior quality of our fuel supply. The fuel question, however, besides having been dwelt upon of late on several occasions, is not believed to be of primary interest in the scope of this paper; also, there appears to be little hope that further discussions by blast-furnace operators may produce beneficial results. Although the number of large furnace hearths installed throughout the country has increased by leaps and bounds during recent years, some furnace men are still maintaining a rather skeptical attitude and are occasionally voicing their objections with more or less substantial arguments. It may, therefore, be interesting to discuss here some of the points brought forth on the subject.

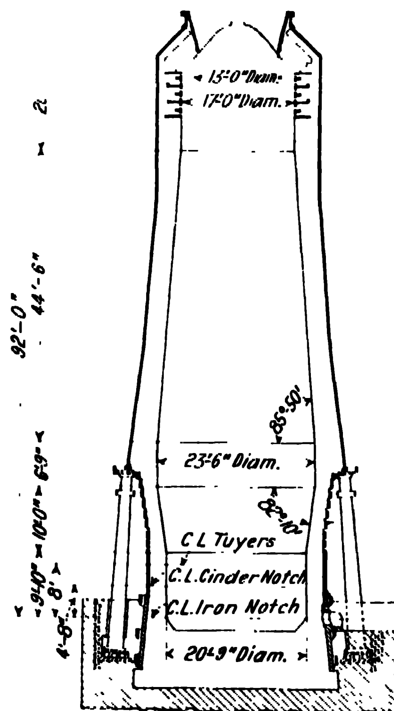


FIG. 1. PRINCIPAL DIMENSIONS OF FURNACE NO. 6, SOUTH WORKS, ILLINOIS STEEL CO.

Reputed "Jetting" in Wide Furnaces

One of the most frequently heard assertions is that the large hearth furnaces must necessarily suffer from lack of penetration and that this ailment can be alleviated only by either considerably overblowing or by reducing the tuyere size to such small dimensions as to create a pronounced "jetting" action.

Advocates of this theory are, in my opinion, laboring under a wrong assumption with regard to the actual pressure drop through the tuyeres of a blast furnace. Calculations based on authoritative tests concerning the flow of air through orifices show that under average conditions of Mesaba practice this pressure drop is less than 10 per cent of the total blast pressure, and this figure has been repeatedly verified by taking pressure readings on furnaces in operation. Since it is also a scientific fact that the energy of the air flow through an orifice—that is, its ability to overcome resistance, or to penetrate—varies directly as the difference in pressure before and after the orifice, it will be readily seen that, other things being equal, a doubling of the penetrating ability would require only a small increase in total blast pressure. However, practice on our largest hearth furnace in South Chicago has, I believe, conclusively demonstrated that no such additional penetrating energy is required. Based on an equal volume of wind blown, it was found best to use a slightly larger tuyere area than on other furnaces with smaller hearths. The only possible explanation for this seems to be that the materials are not packed as tightly in the large hearth and actually offer less resistance to the blast. The latter, therefore, with the same energy, is able to penetrate for a greater radial distance than was formerly possible.

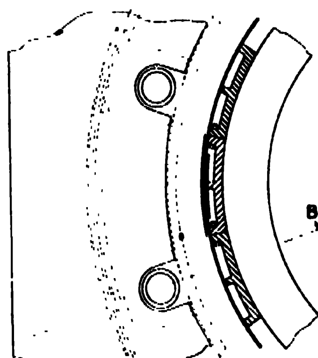
Tuyere Dimensions

Another point which has been raised as indicating the fallacy of the large hearth design is the fact that on many large hearth furnaces the tuyeres, extending from 9 to 12 in. into the furnace proper, are longer than those in use at other plants. The assertion has even been made that the "jetting" action as discussed before, together with the long tuyeres, produces "phantom" boshes, the actual working lines of the furnace having a much flatter bosh angle and smaller hearth than those provided in the design. I feel justified on the basis of our experience at South Chicago to say that we are able to use longer tuyeres to good advantage, and do so on furnaces with hearth diameters ranging from 17 ft. 8 in. to 20 ft. 9 in., largely on account of our steep and low boshes. Without these, shorter tuyeres would have to be used in an attempt to keep the bosh clean and prevent the formation of accumulations, the periodical building up and sliding off of which was formerly a source of continuous trouble at a good many plants. How the use of such short tuyeres in numerous instances resulted in "working too close to the bosh," cutting out the brickwork between the bosh cooling plates and leaving the latter sticking out into the furnace, is no doubt well known to many furnace men. A bosh in this condition becomes, of course, still harder to keep clean, as the erosion has produced a series of shelves which have justly been called "ideal lodging places for scaffold formations."

Troubles resulting therefrom have at times been charged to overcooling of the bosh, and warning notes have been voiced against the disadvantages of this evil. While I fully believe that overcooling is disadvantageous, I do not think that a decrease in the number of bosh plates used and a corresponding increase in the size of the unprotected areas between such plates is the proper remedy. We are using, at South Chicago, a closer spacing of bosh plates than is customary at many plants. With this construction we have eliminated to a large extent the above-mentioned shelf formation due to erosion, as well as the evils of overcooling, simply by not "working too close to the bosh." This we believe to have accomplished by the use of longer tuyeres.

We have had the opportunity of late to inspect during the repairing of several of our furnaces the bosh linings after successful campaigns and blowing out on account of business conditions. The evidence as found came up to our expectations. It was clearly apparent that all the cooling plates had been completely coated during the operation of the furnace; erosion was practically absent, so that the interior of the bosh presented a uniformly smooth surface which could offer little or no

resistance to the travel of the stock. The same inspections have in my opinion also furnished ample proof that the "phantom boshes" and "automatically reduced hearth dimensions" which have been theorized about do not exist in our furnaces. It has further been asserted that with an increase in hearth diameter it would be necessary to add to the number of tuyeres in order to avoid too great a distance between the same, since this would lead to the formation of pilasters of inactive material and an undesirable reduction of hearth area. In reply to this I can only state that on four of our furnaces at South Chicago, where the distance between the centers of adjoining tuyeres, measured on the periphery of the hearth, was 4 ft. 7¾ in., 4 ft. 11¾ in., 5 ft. 9¾ in. and 5 ft. 10⅝ in., inspection after blowing out did not show any such formations. On our No. 6 furnace, where with 20 ft. 9 in. hearth diameter and ten tuyeres the distance between tuyeres amounts to 6 ft. 6¼ in., we do not expect to have an opportunity for inspection for some time to come. I feel justified, however, in stating that the operation of this furnace does not reveal any indications of forming such accumulations between tuyeres.



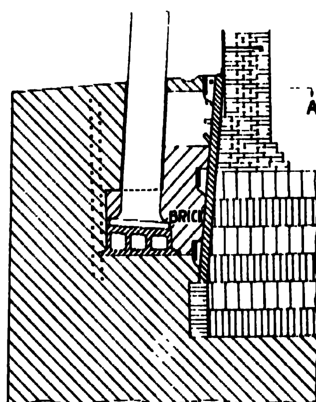


FIG. 2. REINFORCED CONCRETE GIRDLE ENCLOSING FURNACE HEARTH

WIDE HEARTH DEFINITELY SUPERIOR TO NARROW

Another statement which has been made in literature is that large hearths are not capable of maximum heat concentration and that for this reason a poor quality of fuel would here be more likely to give serious trouble through building up in the bottom than would be the case with smaller hearth dimensions. For the same reason large hearths were said to be not as well suited for the manufacture of foundry iron and other high-silicon grades. So far I have not been able to find a satisfactory explanation or theory as to how a small hearth favors maximum heat concentration, and am, therefore, unable to discuss this question.

As to the ability to operate under adverse conditions of raw materials I feel that little can be added to the statements made in Mr. West's paper and the discussions presented therewith before this Institute in May, 1918, except to say that furnace operations since have only furnished additional proof of the assertions made on that occasion. The same is true regarding the question of manufacturing foundry iron, which at that time was fully covered by G. L. Collord.

In summing up these arguments I do not intend to deny that conditions may exist in this country—and they are well known to predominate abroad—where in normal operations furnaces with high or flat boshes and small hearth dimensions work entirely satisfactorily and compare well in results with those accomplished in Mesaba practice by furnaces with larger hearths. The fact remains, however, that in a great number of instances and under different conditions of raw materials, practice and products the larger hearth has been the means of obtaining improvements in output and economy which were not realized before.

CONSTRUCTION DETAILS

Concerning the constructive features involved in the design of large furnace hearths it may be said that few departures have so far been made from former standards. On the contrary, it should be emphasized that the enlargement has not imposed additional or increased stresses and duties, while in some respects the demands upon the strength and wearing qualities of the construction have actually lessened. The volume for storing the molten iron and slag being larger, the maximum height to which these latter will rise above the low level prevailing at the end of the cast must for a given production necessarily be lower. Thus less pressure is exerted per sq.ft. of bottom and hearth walls, and there is less danger of metal reaching the level of the cinder notch or of slag interfering with the combustion of coke at the tuyere level. Such advantages are distinctly to the credit of the large hearth, as they could not have been obtained by increasing the vertical distances between the iron and cinder notches and the tuyere level. These dimensions must necessarily be kept below a well defined maximum, otherwise the metal bath, being removed too far from the zone of highest temperature, becomes the cause of producing physically cold iron, which is the source of many evils and worries in steel works as well as in blast-furnace practice.

Having made provisions for storing larger quantities of molten metal in the furnace and having reduced the number of casts per day accordingly, it becomes naturally of utmost importance to leave nothing undone toward minimizing the danger of iron breakouts. To obviate this most hated of all furnace troubles requires—aside from highest quality of building materials and first-class workmanship—uninterrupted, effective water-cooling and ample mechanical strength. The latter should preferably be pro-



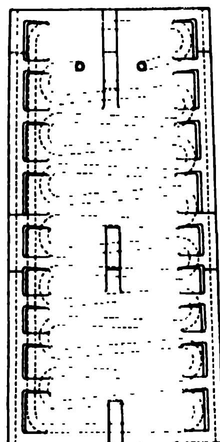


FIG. 3. CONVENTIONAL DESIGN OF HEARTH JACKET

vided in such a way that a possible failure of the former at any one point, with resultant local heating and perhaps an incipient breakout, will not at the same time reduce the strength of the mechanical bond. It is apparent that this might readily be the case where cast iron watercooled staves are placed immediately inside of a steel hearth jacket, or where watercooled hearth jacket sections are encircled by bands placed directly on the jacket itself. To eliminate this risk we have at South Chicago developed a design which has now been in use for several years and consists mainly of a circular beam of reinforced concrete placed at some distance from the watercooled cast iron hearth jacket, as shown in Fig. 2. The space between this concrete reinforcement and the hearth jacket is bricked up with firebrick, so that any radial pressure exerted on the hearth jacket, or expansion stresses of the latter, are directly transmitted to the concrete girdle. Provision is made by allowing clearance on the furnace side of each column so that no side thrust can be transmitted to them.

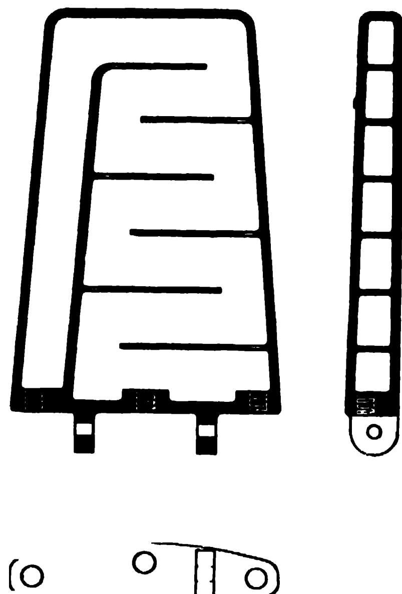
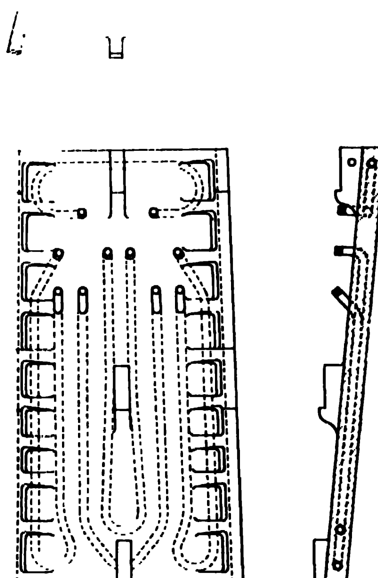


FIG. 5. CONVENTIONAL BOSH PLATE



I. REVISED DESIGN OF HEARTH JACKET

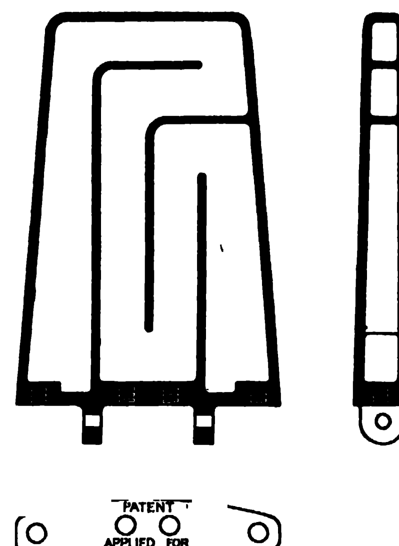


FIG. 6. REVISED DESIGN OF BOSH PLATE

Hearth Jacket and Bosh Plates

In order to reduce the chances of interruption in the watercooling of the hearth jacket segments, we have abandoned the rather conventional design as shown in Fig. 3, because it was found impossible at times to remove obstructions, carried in with the water, from the many bends and angles of the cast-in cooling pipes. In its place we are now installing the construction illustrated in Fig. 4. It will be seen that only simple hairpin loops of pipe are used in this design, so that in case of stoppage each pipe is accessible from the outside for practically its entire length. Also, should it be found impossible to remove an obstruction from one of the loops, it is no longer necessary, as before, to discontinue cooling the entire section.

Following similar lines of reasoning, we are replacing the bosh plate design as shown in Fig. 5 by that illustrated in Fig. 6. As may be seen, this type of plate is readily accessible for cleaning out, when required, by simply taking out the pipe plugs provided for this purpose. Accumulations of solid matter, which if permitted to remain would interfere with the cooling effect and eventually lead to the destruction of such plates, may readily be removed during operation. Furthermore, these plates have the advantage of a positively controlled flow of water, no core holes being required in the baffle plates such as are generally found in the older designs, where they permit of bypassing the water around the outside edge of the plate and of depositing solid matter in the remaining passages in which the flow of water is decreased correspondingly.

It should also be noted that in the new design the baffling of the plate is arranged parallel to instead of at right angles to the line of withdrawal from the brickwork. Furnace operators who on account of adverse water conditions encounter the necessity of frequent bosh plate changes will appreciate this feature, as it effectively supports the arched surface and prevents indentations, which formerly interfered with the removal of the plates from the brickwork.

Conclusion

In conclusion I take pleasure in pointing out that the successful development of the large hearth blast furnace, unhampered, as far as I am aware, by any sacrifice of former advantages, is an exclusively American accomplishment, which today is evoking the keenest interest of our competitors abroad.

The results obtained so far justify the belief that permanent progress has been achieved to the lasting benefit of the American iron and steel industry.

Standardization of Sieves by the U. S. Bureau of Standards

During October the problem of standardization of sand sieves has been taken up by the Bureau of Standards with the object of preparing standard samples for their testing. The bureau at present maintains standard cement samples for checking 200-mesh sieves and these samples may be used for the determination of correction factors for such sieves, thus comparing them with the standards kept at the bureau.

The Manufacture of Lime for Chemical and Metallurgical Purposes*—II

A Description of the Applications of the Rotary Limekiln in Burning Stone and Recovering Spent Lime —Advantages in Capacity, Low Labor and Operation Costs and Utilization of Spalls†

BY RICHARD K. MEADE

THE rotary kiln which has been so universally adopted for cement plants is now being employed to a growing extent for burning lime for chemical and metallurgical purposes. For burning lime to be so used it has many points of advantage over the shaft kiln, chief of which are the low labor and fuel cost of operating and the uniformity and thoroughness with which the lime may be burned.

There has always been considerable objection to the use of the rotary kiln for the production of building lime. This prejudice is to some degree due to ignorance on the part of the builder. Fine lime is generally the result of air slaking, and as air-slaked lime is partly reverted to the carbonate, it is natural that the builder should demand lime in lumps. The product obtained by the rotary kiln ranges in size from 2 in. to dust and is indeed often much finer than this. On being supplied with this fine lime, the builder supposes that it is air-slaked lime and refuses it.

At one or two plants producing rotary-kiln lime, the lime is hydrated and sold to builders in the form of hydrate. The hydrate made from this lime differs very little, if any, from that made from the ordinary grades of shaft-kiln lime.

Where the lime is desired for chemical and metallurgical purposes, such as in the manufacture of soda ash, wood pulp, carbide, cyanamide, calcium acetate, bleaching powder, bichromates, sugar, glass, ammonia, etc., for causticizing and furnace linings and flux—in short, where lump lime is not necessary—the rotary kiln will prove superior to the shaft kiln provided the quantity of lime justifies the outlay.

The first definite proposal to use a rotary kiln for burning lime appeared in a patent which was granted to Henry Mathey of New York in 1885 (U. S. Patent 330,603) on a process of making lime which consisted in first crushing the stone to a suitable degree of fineness to pass a No. 4 or No. 6 mesh screen, then burning in a revolving furnace which he invented (U. S. Patent 325,259). This consisted of a rotary cylinder somewhat similar to the present day kiln except that the center line of the kiln was horizontal, while the kiln itself was made slightly cone shape, this latter serving just as does the inclination of the straight cylinder to work the material through as the furnace revolved.

The John G. Jones patent (U. S. Patent 832,485), taken out in 1906, specifies the use of the present-day kiln, but covers the burning of lime in a "granular condition with granules of such size as will readily pass a 1-in. mesh screen," and this phrase occurs in all his claims. In view of the fact that the use of an apparatus cannot be patented and that Mathey had previously suggested the burning of limestone in a granular condition, it is not at all surprising that Jones, so far as I know, has never made any serious attempt to sustain his patent.

Some experiments were also made in the early days of the cement industry on burning lime in rotary kilns. About 1905 the New York Lime Co. started to burn lime at Natural Bridge, N. Y., in a rotary kiln and shortly after this rotary limekiln plants were built by both the Union Carbide Co. and the Aluminum Ore Co. There are now in operation quite a number of rotary-kiln lime plants supplying lime for chemical and metallurgical purposes.

The Eastern Potash Co. is now installing at New Brunswick, N. J., a rotary-kiln lime plant equipped with ten rotary kilns, each 8 ft. x 125 ft. This plant when completed will have a capacity of 1,000 tons of lime per day and will be the largest lime plant in the world.

The Air Nitrates Works at Muscle Shoals, Ala., is also equipped with a rotary-kiln lime plant which contains seven kilns of the above size.

The Union Carbide Co. has two rotary-kiln lime plants and no other kiln compares with the rotary one for burning lime for carbide, because of the thoroughness with which this type of kiln burns the lime. Any unburned stone in lime for this purpose not only must be decomposed with a great expenditure of power in the electric furnace but the carbon dioxide liberated destroys the carbon electrodes.

The rotary kiln is now being quite extensively used also for burning dolomite for furnace lining. For this latter purpose much harder burning is necessary than can be obtained easily in a shaft kiln. The rotary kiln is also pretty generally used for calcining magnesite in California.

LIME RECOVERY

An application of rotary kilns for burning lime of particular interest in the chemical industry is the employment of these for burning lime from the waste carbonate of lime, or "lime sludge," obtained from the manufacture of caustic soda by the action of lime on soda ash and in sugar refining. Large quantities of this waste are produced by paper pulp mills, caustic soda works and beet sugar manufactories. The rotary kiln is now being employed for converting this waste into lime in all of these industries.

The attempt to burn the waste in a rotary kiln began about 1900, when the kiln was employed in connection with driers. This combination had already been tried on wet materials in the cement industry and proved a failure. The use of driers in recovering waste was soon abandoned and the employment of long kilns, following

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.
†For Part I see CHEM. & MET. ENG., vol. 23, No. 17, Oct. 27, 1920, p. 841.

the cement practice on wet materials, was substituted. This, in connection with various schemes for thickening the waste sludge so as to reduce the water to be evaporated, has made the burning of lime waste commercially profitable.

The waste is usually received in the form of very thin sludge or slurry and it is necessary to dewater this by passing it through filter presses. The first presses employed were of the intermittent type, Recently, however, the continuous type presses have been found more satisfactory. The rotary presses are particularly convenient, as the cake may be scraped from the latter directly into the kiln. As fed to the kiln under these conditions, the material usually contains from 45 to 55 per cent water. It is desirable to reduce the quantity of water as far as possible in order to reduce the work of evaporating this water in the kiln.

Generally, producer gas is used for burning lime sludge. Where available and cheap, however, natural gas or fuel oil would be superior fuels. Pulverized coal is not entirely satisfactory, as the amount of ash introduced is considerable, due to the much greater quantity of fuel required to burn the wet sludge. The wet sludge in the upper part of the kiln serves to catch and retain a large part of the ash which in burning limestone would pass out of the stack.

The capacity of a rotary kiln burning alkali waste will vary very largely with the water content of the waste when fed to the kiln. If properly installed a kiln burning lime waste will have about 60 per cent of the capacity of the same kiln burning limestone—the actual amount depending to a large extent on how much water remains in the sludge.

The fuel requirements also vary with the amount of water in the sludge, but with a sludge containing 50 per cent water the amount of coal required per ton of lime will be from 800 to 1,000 lb. The amount of natural gas will range between 11,000 and 14,000 cu.ft., while the oil will range between 72 and 90 gal. The labor, power, repairs, etc., required to operate a lime-recovery plant will be about the same as are required to operate a plant burning limestone, with the addition of a man to watch the filter presses.

In many of the newer plants mechanical filters are a part of the causticizing equipment and the operation of these would be considered as part of the causticizing plant. If possible, these filters should be located so that they can feed the cake directly into the kiln, but where it is less convenient to do this the material can be carried from the press to the kiln on a belt conveyor. Recovered lime consists of small, slightly oval lumps ranging in size from that of a walnut down to dust. The color is slightly yellowish or greenish. The lumps slake quite a bit slower than rock lime and consequently causticize somewhat slower. On the other hand, the resulting precipitated carbonate of lime usually settles much more quickly. The lime will slake much more rapidly if the lumps are crushed before being added to the solutions to be causticized.

The lime will gradually pick up impurities from the process and also from the kiln lining, so that it is not possible to burn the same sludge over and over indefinitely. Instead of starting with an entire fresh lot of lime, therefore, it is the general practice to introduce a small quantity of rock lime into the system at regular intervals and to sell a corresponding amount of recovered lime or discard the equivalent amount of sludge. This loss is usually made up by adding ground limestone to the kiln along with the lime sludge. The amount of lime necessary to replace losses usually amounts to about 5 to 10 per cent. The recovered lime, if burned at all skillfully, will contain as much caustic lime as the best lump lime made from limestone. Lime sludge usually contains a certain small amount of caustic soda and the reburned lime of course contains this soda which is so recovered, adding to the saving to be effected by the process.

The kiln used for recovering lime waste may also be used to burn lime from limestone provided the latter is crushed and there are suitable means at hand for feeding it to the kiln.

A lime-recovery plant will cost approximately $1,500 per ton of lime recovered. This figure includes filter press, gas producer and buildings.

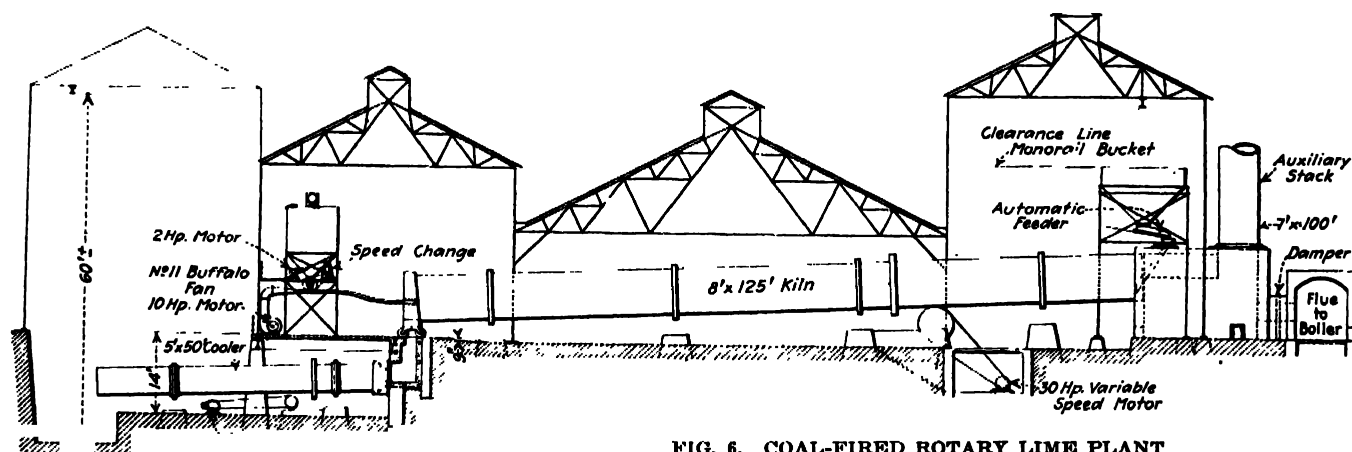


FIG. 6. COAL-FIRED ROTARY LIME PLANT

Description of Rotary Kiln

The rotary kiln as used for burning lime does not differ in any particular from that used in the cement industry. It consists of an inclined cylinder from 6 to 8 ft. in diameter and from 60 to 125 ft. long. This cylinder is lined with firebrick and is supported on two or more steel tires which revolve on rollers. Power is received by means of a girt gear and supplied by a train of gears. The cylinder is slightly inclined from the horizontal, usually from ½ to ¾ in. to the foot. The limestone is fed in at the upper end of the kiln and a jet of burning fuel is introduced at the lower. The limestone works its way through the furnace as the latter revolves and is burned by the gases passing

through the latter, falling out at the lower end of the kiln.[1]

Fig. 6 illustrates a rotary-kiln lime plant. The stone is held in a large bin and is fed from this automatically and continuously into the kiln. The latter is heated in this case by pulverized coal. The lime falls out of the kiln into a cooler, which reduces its temperature to the point where it can be conveniently handled.

The capacity of various size kilns is given in the accompanying table.

CAPACITY OF ROTARY KILNS BURNING LIME FROM LIMESTONE

Diameter Unlined Shell, Ft.	Length of Shell, Ft.	Capacity per Day of 24 Hr., Tons	Approximate Horsepower Required*
5	60	18-20	4
6	60	25-30	
6	100	40-50	7½
7	80	55-60	10
7	100	70-80	12½
8	125	90-100	17

* NOTE—Motors should of course be larger, as this is actual average horsepower required.

Spalls Used in Rotary Kiln

The advantages of the rotary kiln begin with the quarry. With the old shaft kiln, whether of the most improved type or not, it is necessary to feed the kiln with stone of a certain size. If the stone is too big, the heat cannot penetrate to the center of the lump and consequently there will be a core or center of unburned limestone. If the stone is too small, the small pieces will work their way into the crevices between the larger stone and will choke the draft of the kiln, not only decreasing very materially the output of the latter but also causing irregular burning of the stone, due to the fact that the gases are forced to seek the path of least resistance and will probably avoid the central portion of the kiln in which the fine stone is more apt to lie.

As a general rule, the stone for the shaft kiln should be brought down to a size ranging between 2 and 8 in. Where the stone breaks up in the form of slabs, these latter can be quite long provided their least dimension is not greater than 8 in.

The necessity of having the stone of this size increases very materially not only the labor but also the waste in the quarry. Where the small stone or spalls can be sent to a crushing plant or other use can be found for them, the item of waste is not so great, but where they must be thrown away, the loss from this source is considerable. Quite a number of lime manufacturers have installed rotary kilns in connection with their vertical kilns with the express idea of burning up these small stones.

The saving of labor in the quarry is very considerable. The sledging of the stone to proper size and the hand sorting and forking add much to the cost of this. Anyone with experience in such matters will appreciate the fact that stone can be crushed to 2 in. by a stone crusher much more cheaply than it can be crushed to 8 in. by hand. "Cup grease" is much cheaper now than "elbow grease."

There are also numerous limestones which do not burn very satisfactorily in a shaft kiln owing to the fact that when the heat strikes them they decrepitate and fall into small pieces. In some cases this action is very marked, the stone being almost reduced to dust. A very good example of this is the highly crystalline limestone found in the neighborhood of Franklin Furnace, N. J., some of the purest ledges of which have never been successfully burned in a shaft kiln due to this very action. Another limestone which is difficult to burn in a vertical kiln but which can be burned in a rotary kiln is the soft, chalky limestone of central Florida.

The saving effected in the quarry by a rotary kiln depends very largely on the size of the plant. If the plant is large enough, the fact that the quarrying can be done with steam shovels will appeal to even the layman as a great saving over the process of carefully breaking down all stone to proper size by means of sledges[2] and then loading by hand on cars.

The earlier rotary-kiln plants nearly all reduced their stone to quite fine material—passing the 1-in. screen, or about ¾ in. and under. In the writer's opinion this is unnecessary and good results are now being obtained with stone crushed to pass a 2-in. screen. This has the advantage of saving power and simplifying the outfit required.

The power required to crush the limestone may be safely figured at about 1¼ hp.-hr. per ton of limestone crushed, which is equivalent to 2½ hp.-hr. per ton of lime produced (1.87 kw.-hr.).

In small plants which would naturally employ hand labor for quarrying, a small gyratory crusher with smooth concaves and head may be used, setting this to 2-in. screening and returning the oversize to the crusher for recrushing.

As a general rule, better results can be obtained by screening out the dust from the coarse rock before burning. This increases somewhat the capacity of the kiln. This dust also contains a large part of the dirt which finds its way into the quarry, so that the writer has found its removal is of advantage in increasing the purity of the lime. In localities where water is abundant there would be no objection to washing the limestone to free it from dirt, as the wet stone would not affect materially the operation of the kiln.

Probably most chemical manufacturers will purchase their stone. In this event a good specification would be "to pass a screen with round perforations 2 in. in diameter and be retained on a screen with round perforations ½ in. in diameter."

Part III, dealing with Operation, will appear in a subsequent issue.

Search for Sodium Sulphate

Active prospecting for sodium sulphate has begun in the West and the Bureau of Mines is receiving numerous inquiries regarding its occurrence and its characteristics as found in nature. The bureau's chemists are at a loss to explain this sudden interest in sodium sulphate prospecting. Heretofore practically the entire supply has been the manufactured product, a considerable portion of which is a byproduct of hydrochloric acid making. Large deposits of sodium sulphate occur in Wyoming, Nevada and Utah—the "white alkali" of the semi-arid regions.

[1]The construction of the kiln and its history and use in various industries was described in detail in the *Transactions* of the American Institute of Chemical Engineers, vol. 7, p. 153, and in the *Journal of Industrial and Engineering Chemistry* of September, 1914, p. 754.

[2]If the shaft kiln plant is large enough to justify the cost of the installation of very large crushers the steam shovel can be used here also and the limestone crushed in such crushers and sized by screens as is done by the Solvay Process Co. at Jamesville, N. Y. The waste in such a plant is large, however.

The Expansion of Glass at High Temperatures

BY W. B. PIETENPOL

THE problems met in the manufacture of optical and commercial glass have necessitated extended investigations concerning methods for determining the proper procedure and treatment of the glass during the productive stage. Relative to such research the solution of the means of determining a suitable annealing temperature is of importance depending upon the purpose for which the glass is to be used. In the manufacture of optical glass the greatest care must be exercised throughout every stage of the process in order that the glass may be homogeneous and free from strain.

Methods of determining the annealing range have been investigated by observing the disappearance of double refraction, the region of heat absorption and the rate of deformation of loaded rods. The relation of the rate of thermal expansion to the annealing temperature has also been pointed out, but without due emphasis upon the importance with which the determination of the rate of expansion bears upon the manufacture of glass. With a view of determining more definitely this relation and extending the temperature range through which the expansion of glass has been investigated, the author has carried out a series of experiments by a simpler and a more direct method than has heretofore been used.

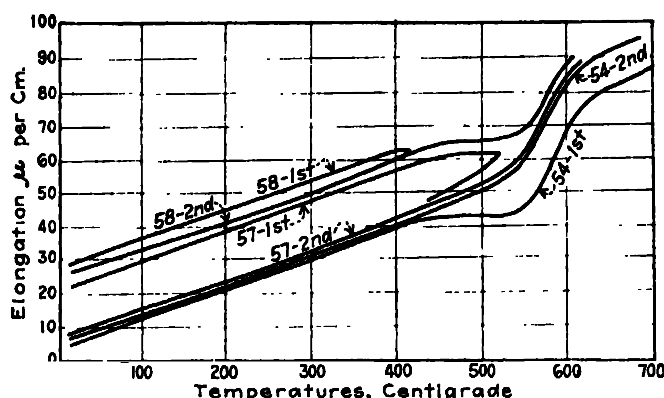
To the engineer and industrial concern, laboratory results depending upon the measurement of minute quantities are not as acceptable as the results of experiments upon bodies comparable in dimensions with those found in the industries. Though acknowledging the refined laboratory technique of the physicist in measuring the change in dimensions of a centimeter of material in terms of the wave-length of light—i. e., of the order of one two-thousandths of a millimeter—in general there is some hesitancy in applying the results of such delicate measurements to the commercial process. This was considered sufficient reason for adopting a method by which the thermal expansion of relatively large samples of glass could be examined. The accuracy of measurement was thereby increased and the results not so dependent upon the homogeneity of the sample in question.

An electric furnace, 100 cm. in length and 6 cm. in diameter, was constructed with small openings about 12 cm. from the ends, through which specially designed microscopes were focused upon the samples of glass. The strips of glass were about 76 cm. long and rested upon a flat piece of asbestos rigidly supported within the furnace. By the use of auxiliary heating coils in parallel with resistances the temperature was kept uniform. As measured by thermocouples, the temperature in different parts of the furnace varied by less than 1 deg. C. during the observations. The microscopes were focused upon diamond scratches on the glass and upon small platinum particles resting upon the surface of the glass strip. By this means the temperature at which the glass began to soften could be very closely determined. The microscopes were supported upon a heavy steel frame which was kept at constant temperature during the observations.

The expansion of optical and other glass was measured from room temperature to 750 deg. C. The rate of expansion of annealed glass is nearly linear until temperatures of 450 to 550 deg. C. depending upon the kind of glass. The rate of expansion then increases by four to six times through a temperature range of 60 to 100 deg. C. This is in agreement with the expansion determined by C. G. Peters of the Bureau of Standards by an interference method.

Measurements have been extended to higher temperatures. After the rapid increase in expansion the rate of expansion again becomes nearly linear, in general being slightly greater than at low temperatures. When the softening point is reached the rate of expansion gradually decreases and the length of the strip remains constant. At this point the glass loses its form and no linear expansion can be measured.

With unannealed glass the rate of expansion in general decreases from 50 to 150 deg. before the rapid ex-



THERMAL EXPANSION CURVES OF UNANNEALED LIGHT BARIUM CROWN, BUREAU OF STANDARDS, MELT 404

pansion takes place. This decreased rate may continue through a temperature range of 100 to 150 deg. depending upon the strain in the glass. In some instances the expansion through a range of 100 deg. is practically zero. Upon cooling, the strip of glass is shorter by a definite amount which is proportional to the strain which has been relieved. If the observations are carried to a sufficiently high temperature and the glass is slowly cooled, it becomes well annealed. A second set of measurements then taken upon the same strip of glass does not show this decrease in rate of expansion, but a nearly linear rate until the temperature of rapid expansion is reached.

This is shown graphically in the figure, which shows the thermal expansion curves of unannealed light barium crown, Bureau of Standards, Melt 404. The two curves referred to are marked 54-1st and 54-2nd. When an unannealed sample of the same melt of glass is heated to a point just below the temperature at which the rapid expansion begins (57-1st), the strain disappears entirely. The curve shows observations taken for about a hundred degrees upon cooling and the final point to which the strip of glass contracted at room temperature. Without moving the glass in the furnace, a second run was made with results as indicated by curve 57-2nd. The observations coincide with those of the previously indicated strip of annealed glass (54-2nd), showing that the annealing temperature had been reached. Curves 58-1st and 58-2nd show the results of heating the glass to a temperature below the annealing point. Thus a determination of the rate of thermal expansion may be used as a very exact method of finding the proper annealing temperature.

During the investigations which were made on the

thermal expansion of different kinds of glass, it was noted that a certain strip of glass underwent a rapid contraction soon after the rapid expansion took place. This occurred at a temperature above 620 deg. C., when the glass rested on asbestos board which had not previously been heated. Such asbestos contracts very greatly at high temperatures. This may have caused a compression in the glass sufficient to shorten the strip when in the plastic state.

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What Constitutes Unfair Trade Practice?

By an Interested Observer

THE abstract of an address by William B. Colver of the Federal Trade Commission which appears in CHEMICAL & METALLURGICAL ENGINEERING of Aug. 4 (p. 191), coming at the time it did, presented an interesting coincidence, since Mr. Colver's speech gives the sanction of a member of the Federal Trade Commission to just such a line of investigation as that which Minerals Separation, Ltd., sought to exclude from the testimony of Theodore J. Hoover in the recent San Francisco hearing before the Federal Trade Commission.

Among those practices which Mr. Colver enumerates as being "unfair methods against competitors" is given "false claims to patents or misrepresenting the *scope* [italics mine] of patents. Statements of this character have been at times sufficiently broad to give claimant a monopoly of an industry."

Here is stated just such a case as Mr. Hoover perceives to be that of Minerals Separation, in its attempt so to construe its patents and so to broaden their claims as to bring within their scope the process of the porous bottom cell.

When Mr. Hoover learned from his reading of the testimony being given in patent litigations just what a broad monopoly Minerals Separation was attempting to establish before the United States court, and when he realized how absolutely at variance these present claims are from any conception of the process which one would gain from the reading of a manuscript treatise which had been written by two of the inventors shortly after the invention of the process and which had been handed by one of them to Mr. Hoover at the time he was manager of Minerals Separation, for his instruction as to the process, he felt it to be his duty to divulge these gross discrepancies of statement.

The fact of Mr. Hoover's possession of the manuscript was disclosed in an affidavit made by him in certain court proceedings in connection with the Miami infringement suit. The existence of the manuscript and the inconsistencies which it reveals had thus become public knowledge.

Three fellow engineers, to whom the question was submitted, recognizing, as they did, how absolutely convinced Mr. Hoover was that he had found in the conflicting statements as contained in the Sulman and Picard manuscript and the statements now made by Minerals Separation in prosecuting its infringement suits a palpable attempt upon its part to perpetrate a fraud upon the United States court, could have arrived at no other conclusion than that it was ethical, under the circumstances, for him to divulge the contents of the manuscript. More than this, however, Mr. Hoover was himself impelled by the spirit of most enlightened ethics, in keeping with the modern trend of thought, in which the interest of the individual, as well as that of his employer, is subordinated to the general welfare. This idea is well illustrated in Article 3 of the code of ethics proposed by the American Society of Mechanical Engineers, which reads:

> He should consider the protection of his client's or employer's interests in professional matters his essential obligation, *provided these interests do not conflict with the public welfare.* [Italics mine.] CHEM. & MET. ENG., June 2, p. 1042.

This code, framed to conform to modern conceptions, was drawn up by eminent engineers from San Francisco, Minneapolis, Atlanta, Boston and Baltimore and may therefore well be presumed to express a broad spirit. In its preamble and the twelve articles of the code itself the underlying principle is enunciated that the benefit of the public must come first, that of the employer second, and that of the individual engineer last.

It was indeed by the spirit of this code that Mr. Hoover was actuated, that not only the interest of the mining public, but that of the whole United States should be considered before that of his former employer, or his own personal disinclination to enter into such a controversy.

"Misrepresenting the scope of patents," says Mr. Colver, is one of the "unfair methods against a competitor," statements of such a character as would give claimant "a monopoly."

Now this would certainly appear to be just what Minerals Separation is attempting in its efforts so to broaden the scope of the claims of its patents as to include within the agitation of these patents such agitation as is incident upon the introduction of the air through the porous bottom of the cell in the pneumatic process, an agitation which the U. S. Circuit Court of Appeals says, in its Miami decision, "is not even approximately of the violence and the duration of the agitation of the patent" (*E. and M. J.*, Dec. 1, 1917, p. 956).

We have, however, in this manuscript which Mr. Hoover has brought forward statements by two of the patentees of the process which show most conclusively what was the idea of these two inventors of the process as to the agitation of their process and just what it was that their discovery had added to the art, and that was simply the manner in which the "supersaturation" of the pulp was attained by a rapid rotary agitation of such violence that the gas [air] was "whipped into the ore pulp in minute bubbles."

This manuscript is particularly important because written at a time immediately following the invention, and because it was written in a purely scientific vein and was not influenced by any such spirit of mental reservation as that which subsequently led to the entire suppression of so purely scientific a treatise.

It was natural, under the circumstances, that in pressing the case before the Federal Trade Commission against Minerals Separation it was sought to introduce this manuscript, and also natural that Minerals Separation should "object" to its introduction as "incompetent, irrelevant and immaterial."

The arguments as to the introduction of this document and as to Mr. Hoover's interpretation of it are not of moment in this connection except in so far as

Minerals Separation objected to the introduction of the manuscript on the ground that it was improper for the Federal Trade Commission, as it was expressed, "to try out patent litigations."

Such an interpretation of the situation as this by Minerals Separation is simply a play upon words. The Federal Trade Commission was making no attempt whatever to try a patent case, but simply to establish such an attempted broadening of the patent claims as is shown by Mr. Colver to constitute objectionable practice, the establishment of which fact comes well within the province of the Federal Trade Commission.

That it is the duty of the Federal Trade Commission to determine whether among other improper practices, if there are such, Minerals Separation is also attempting improperly to enlarge the scope of its patents with a view to obtaining a monopoly is clearly pointed out by Mr. Colver in his speech.

If one turns to the pages of the Sulman-Picard manuscript treatise which were cited by Mr. Hoover in his testimony before the Federal Trade Commission in San Francisco, and compares statements found upon these pages with testimony presented by Minerals Separation in the United States courts, one may well believe that Mr. Hoover had every reason to feel himself impelled to disclose the suppressed manuscript.

Limited space precludes the quotation of more than two or three examples.

On page 6 of the manuscript, in a classified list of processes, we find this classification:

> (d) Dependent on the use of more or less minute quantities of oil to "cement" gas or air bubbles to the particles so covered with an indefinitely thin film of oil:
> Froment.
> Sulman and Picard.
> Sulman, Picard and Ballot.
> Elmore (vacuum process).

On page 83 we find the following:

> The second type of process, dependent on the flotation of oil particles by means of air or other gas, introduced in such a manner as to bring about a state of supersaturation in the solution, was discovered almost simultaneously by one of the authors in England and Mr. Froment in Italy, though published first by the latter.
>
> In the Sulman, Picard and Ballot "frothing" process the same result is achieved without the employment of decomposable carbonates and acid or other gas-producing mixture; the necessary gas is supplied by means of air, which is whipped into the ore pulp in minute bubbles by means of rapid rotary agitation.

On page 94, referring to Froment and Minerals Separation "frothing" process, Sulman and Picard say:

> Both these processes not only recover finely divided or slime sulphide mineral, but actually demand the presence of the same for the production of a coherent froth. The minute amount of oil added forms a film coating on the mineral which to all intents and purposes becomes part and parcel of the particle.

We have, on the other hand, the following as an illustration of Minerals Separation's interpretation of the Froment process, as presented in the United States District Court in Wilmington, Del., in which for their "thinnest possible layer" of an "ordinary oil" they chose an oil of such viscosity that it gave 13 per cent of oil upon the ore used, instead of an amount so small as to become "part and parcel of the particle," notwithstanding that Froment's instructions which had been given to Minerals Separation gave 1 per cent of oil as an example.

As to the resulting product of the Froment process, Minerals Separation testified as follows (Miami Appeal Record, vol. 2, p. 1,455, Dr. Adolf Liebman's answer to question 472):

> When you come to a scientific definition, we call froth air bubbles, collected on the surface of water or liquid. I should call the results as obtained in this way (Froment process) an emulsion, an emulsion produced by oil, some air bubbles, some mineral and some water. It may quite correctly be termed a magma, but a magma is not as definite as an emulsion. It is not a froth. When it comes to a strict definition it is not a froth.

These and many other statements, both as to the classification and description of their own and other processes, which are contained in the Sulman and Picard suppressed manuscript are found to be absolutely at variance with the entire contention of Minerals Separation in its litigation before the U. S. courts.

Moreover, the statements in the Sulman and Picard manuscript so evidently present the true knowledge and sincere convictions of these two inventors as to their own "frothing" process, as well as to the Froment and others, having been written down by them immediately following the invention, there would seem to be no question as to what any honorable engineer should do upon whom circumstances had thrust the knowledge of so monstrous a discrepancy.

Belgian Chemical Company Developments

A number of important developments and extensions in connection with the chemical and allied industries of Belgium, where, by the way, the process of reconstruction is proceeding more rapidly and infinitely more orderly than anywhere else in Europe, have to be recorded.

La Société Chimique de l'Escaut has been established, with headquarters in Brussels, to carry on the manufacture and sale of chemical products and also the sale of raw materials for use in chemical manufacture. The capital of the concern is 4,500,000 fr., the principal shareholders being La Société Anonyme des Verreries des Hamendes and La Société Anonyme Cuivres Métaux et Produits Chimiques d'Hemixen. Another new undertaking, the Belgoleum Compagnie Industrielle et Commerciale des Produits Oléagineaux du Congo, has been registered at Brussels with a capital of 9,000,000 fr. At a meeting held in Brussels at the end of last month it was decided to increase the capital of the Société Générale des Produits Chimiques by the issue of new shares to the value of 6,500,000 fr.—*Chemical Trade Journal.*

Fuel of the Future

Prof. W. M. Thornton, in a presidential address to the Newcastle branch of the Institute of Junior Engineers, said that, with regard to heat, development must be looked for along the lines of new fuels. The coal age was passing, and the future of fuel was with the chemists. He referred to the possibility of tapping the earth's underground heat, and, turning to electricity and magnetism, said it was now known that all matter was made up of electrons, and the problem, at present barely conceivable, was to tap that source of electricity without going through the inefficient process of heat. The science of electrochemistry was gradually indicating lines of attack, and, if electricity could be obtained at high pressure from coal, oil or alcohol without burning, an immense advance would have been made.—*Chemical Trade Journal.*

New Deoxidizers for Steel Manufacture

Report of a Co-operative Investigation Sponsored by the National Research Council on the Function and Action of Deoxidizers, Together With Experimental Work to Find Low-Melting Mixtures of Scavenging Oxides

By J. R. CAIN*

A CO-OPERATIVE investigation was started in June, 1918, to select, according to a systematic procedure, some new experimental deoxidizing alloys for trial in steel manufacture. The original and primary motive was to contribute toward conservation of manganese in this industry, since manganese shortage was being experienced by American steel manufacturers at that time. This particular motive for the research became less urgent as time went on. Nevertheless, a knowledge of deoxidizers for steel manufacture which could, if necessary, contribute toward reducing the amount of manganese needed still seems of great importance. Many careful investigations made during the war showed that there is not available within the United States sufficient high-grade manganese ore for the needs of the steel industry, although there is a fair amount of ore suitable for making deoxidizers leaner than the 80 per cent ferromanganese which steel manufacturers prefer.

Action of Deoxidizer

In order to give a proper perspective, it seems well first to consider briefly the mode of action of a steel deoxidizer, some of the problems which must be solved in a complete deoxidizer investigation, and, finally, some simplified investigations which could give most of the information needed by manufacturers and practical men, without requiring too great an expenditure of time and labor.

In general, a deoxidizer is added to steel to make the metal sound. In order to do this the following results have to be accomplished: Gaseous impurities must be eliminated or rendered incapable of causing blowholes and cavities; non-gaseous oxides must be reduced to metal, caused to separate as such from the bath, or made to combine with the deoxidizer or its reaction products to yield substances which can free themselves readily from the molten metal—i.e., presumably in fusible and fluid slags.

Considering somewhat more in detail the mode of action of the deoxidizer, it may be stated:

First, as to its effect on the gas content of the metal, there is little exact knowledge. In an empirical way it is known, for instance, that additions of ferrosilicon, ferromanganese or aluminum to molten steel before tapping remove the harmful effects of gases in causing blowholes. Just what happens to the gases—whether the deoxidizer combines with them and fluxes them off, whether they are given off as gas wholly or in part, or whether addition of the deoxidizer merely enables the metal to hold more gas in solution—these are important questions not yet adequately answered.

Second, considering a deoxidizer (ferro-alloy) with two or more reactive constituents (e.g., Mn: C, Al: Si, Mn: Ti, Mn: Si: Ti alloys, the iron in the ferro-alloy being regarded as inert) in respect to its chemical action on solid oxide impurities in carbon steel, the following cases may arise:

a. The active elements in the deoxidizer may, and probably will, be consumed at unequal rates in reacting with the impurities—e.g., aluminum, being more reactive than manganese, may be consumed faster, hence

b. The deoxidation slags produced by such differential consumption of the deoxidizing element will vary correspondingly, and, in general, will be different for each different alloy of the same active elements.

c. For any given impurity a condition may be reached such that when the impurity has entirely consumed one of the active elements in the deoxidizer, there is no further action on what remains of the other active elements; these may then alloy with the steel.

d. The reaction products (deoxidation slags) will tend to free themselves from the metal bath in proportion to their fusibility, fluidity and insolubility in the molten metal, and in general these properties of the products will be different for each combination of deoxidizing elements.

e. The deoxidizer may not reduce or flux off completely the foreign oxides, some of which may remain in the bath.

f. Usually the deoxidation period is too short for the establishment of equilibrium in the physicochemical sense of the word.

Third, considering the deoxidizer in relation to its possible action on carbides, phosphides and sulphides, it can be seen that for each of these there are the same possibilities as for oxide impurities. It can also be seen that the deoxidizer may, and probably will, react to some extent with all classes of non-gaseous impurities at the same time, and that, accordingly, extremely complex chemical reactions may take place.

Fourth, considering the action of the deoxidizer with respect to variables of a physical nature as contrasted with the chemical variables heretofore discussed, it is evident that the mode of action of each deoxidizer and the resulting deoxidation products will be affected by such factors among others as:

a. Temperature of the molten steel.

b. The manner of adding the deoxidizer—whether molten or solid.

c. The amount of the deoxidizer added.

d. The time allowed for action of the deoxidizer.

e. The use of two or more deoxidizers successively added.

f. The concentration of the active element in the deoxidizer.

To summarize, it would seem that there is small possibility of obtaining with any reasonable expenditure of effort or time accurate and complete information concerning each individual deoxidizer in respect even

*Bureau of Standards, Washington, D. C.

of the few variables which have been mentioned. Consequently, it is necessary to consider various experimental short-cuts that will approximate to a complete solution.

Value of Information on Fusibility

Conforming to this idea, it was suggested by Dr. H. M. Howe that one of the most important functions of the steel deoxidizer is removal of the solid oxides contaminating the molten metal, which removal is usually believed to be accomplished by the formation of deoxidation slags which fuse and float to the surface of the metal and are usually skimmed off or poured off before tapping. Accordingly, the most fusible deoxidation slags are the most desirable ones, and a simple way to select new deoxidizers would be to choose such alloys of the active deoxidizing chemical elements as would yield very fusible combinations of the oxides of these elements. Such fusible combinations of oxides could be found by experimentally determining the melting points of a series of mixtures of the oxides. Once the most fusible oxide combinations were found experimentally by such procedure the calculation of the composition of the corresponding deoxidizing alloy is simple.

It is recognized, of course, that this view of the mode of action of the deoxidizer is a simplified one, and that it leaves out of consideration many of the factors of possible or known influence. However, this investigation constitutes but the first phase of a more extended research which has been begun at the Bureau of Standards consisting of the following parts:

1. A systematic selection of some new deoxidizing alloys—the present investigation.
2. The selection or production of the most practicable of these alloys to manufacture.
3. The use of the selected alloys for making steel experimentally under a variety of conditions.
4. Physical and chemical tests of the steels so made to determine useful properties, and particularly the determination of the gas content of the steels before and after deoxidation.

Organization and Plan of the Research

A committee composed of Henry M. Howe, R. B. Sosman of the Geophysical Laboratory and the author recommended to the National Research Council that it enlist the co-operation of certain research organizations. After some correspondence and many changes in personnel of the group, the melting points included herein were determined by the institutions noted below. After a suitable selection of co-operating laboratories had been made the results were obtained very promptly, but very serious delays were incurred on account of those laboratories which originally volunteered for the work failing, after several months' efforts, to produce results. These remarks are not made in any spirit of criticism of the laboratories which withdrew, but merely for the purpose of giving some information as to how a co-operative research of this character, involving several groups of workers, actually progressed.

After much consideration, it was decided to limit this work to oxides of the more commonly used deoxidizing elements—manganese, silicon, aluminum and titanium. On account of the large amount of labor which might otherwise be necessary, it was thought the work should be confined to binary and ternary systems. In order still further to limit the field these oxides were combined according to an arbitrary plan, which, nevertheless, seems to represent the path along which possible new deoxidation practices might be developed. For this purpose it was assumed that the slags resulting from deoxidation would be of the following types: silicates, titanates and aluminates in the binary systems and silico-aluminates, alumino-silicates, alumino-titanates and titano-aluminates in the ternary systems.

The investigation of the system Al_2O_3-SiO_2 was omitted at the suggestion of Dr. Sosman, since work already done shows that combinations of these two oxides all melt above 1,500 deg. C. Experimental work on all mixtures of MnO and Al_2O_3 also showed them to melt above 1,500 deg. C.

While it would seem desirable to have ferrous oxide present in all the mixtures investigated, since it is always found in steel deoxidation slags, this was not done, because of the greater complexity which the investigation would then assume. It is believed, however, that the effects of such amounts of ferrous oxide as would probably be present in deoxidation slags would be in all cases to lower melting points, so that any desirable mixtures of low fusing point found by this investigation could be assumed to be still more desirable because of probable presence of ferrous oxide.

Methods for Determining the Melting Points

In general, it was thought that the choice of the method could be left to the laboratory doing the work, depending on its equipment in the way of furnaces, pyrometers, etc. It was, however, considered necessary that the melting point determinations should be made in a non-oxidizing atmosphere, since the deoxidizer in a steel bath usually does its work under such conditions. It was recommended by the committee that electrically heated furnaces be used, either of the vacuum type (Arsem) or furnaces which permit the circulation over the mixture of a non-oxidizing gas. Very convenient crucibles were devised for the work and were used by several of the laboratories. These were made of "Armco" iron, supplied by the American Rolling Mill Co., and were pressed out of this material in the thimble-manufacturing machines at the Scovill Mfg. Co.'s plant. The melting point of the "Armco" iron, on account of its freedom from impurities, approximates that of pure iron (1,530 deg. C.); it was thought that any slags melting higher than such crucibles would be of no value in the steel industry; consequently, if during an experiment the crucibles showed signs of fusion before the contents (oxide mixtures), the experiment was carried no further.

The mixtures were made at the Bureau of Standards from the following materials: As a source of manganese oxide, c.p. manganese carbonate was used, since this dissociates at the temperatures used to MnO and CO_2. For the aluminum oxide c.p. calcined Al_2O_3 was used. For silica a good grade of quartz was ground to 200-mesh, digested for several hours with hydrochloric acid and then washed free of chlorides. For titanium oxide the best commercial grade of rutile concentrate carrying 97 per cent TiO_2 was used (3 per cent silica). In making the mixtures containing the TiO_2, correction was made for the silica impurity.

These various substances were thoroughly dried and mixtures were then prepared by weighing the components and mingling them thoroughly by turning over several times on a sheet of paper with a large spatula;

after this they were passed through an 80-mesh sieve several times in order to insure a still more homogeneous mixture. Fifty-gram portions of each mixture were then placed in sealed manila envelopes and these were sent out by the National Research Council as directed. Many mixtures had to be returned to Washington and redistributed because of changes in the co-operators.

Reference Work at Bureau

As a check on the accuracy of the method used by each co-operating laboratory the melting point of one of the mixtures (No. 89, with 25 per cent Al_2O_3, 20 per cent MnO and 55 per cent TiO_2, melting point 1,370 deg. C.) was determined at the Bureau of Standards by R. G. Waltenberg, and portions of this were distributed to each co-operating laboratory, which reported its fusion point as determined by their method. The method used by the bureau for this determination was as follows:

The finely ground materials were moistened with water and molded into cylinders 1 cm. in diameter by 1.5 cm. long. These were air dried at least one day before use.

The melting points were determined by direct observation in an Arsem vacuum furnace.[1] The cylinders of oxide mixture were placed in "Armco" iron crucibles (these were scoured until free from internal surface oxide) and the latter placed in a magnesia holder supported on a graphite stand. The crucibles were placed slightly below the hottest part of the furnace so that any change in shape of the material was visible through the observation window of the Arsem furnace. The temperature was raised gradually until evidence of softening or melting appeared. Then the temperature was determined with an optical pyrometer. The melting point was taken as the temperature at which the material would flow. The gaseous pressure in the furnace was about 1 mm. mercury throughout the work. The mixtures contained manganese as carbonate from which carbon dioxide was liberated as the temperature was raised. Considerable shrinkage of the cylinders took place during this stage.

It was found that the temperature of initial softening was not much lower than the temperature at which the material would flow. This was verified by removing some of the samples from the furnace after heating just below and a little above the melting point. On one of the samples the melting point was determined on material which had previously been melted. This melting point did not differ materially from the first determination.

The method used by each co-operating laboratory is briefly described below.

General Electric Co., work in charge of W. E. Ruder: The method used was practically that employed at the Bureau of Standards in determining the melting point of the "standard mixture." Result, 1,370 to 1,380 deg. C.

Westinghouse Electric Co., work in charge of P. G. Nutting: The method used was that used at the Bureau of Standards. Result, 1,368 deg. C.

National Lamp Works of General Electric Co., work in charge of E. C. Bain: Cones of the materials shaped like standard pyrometric cones were heated electrically in a tungsten-wound furnace. Hydrogen was on the outside of the heated tube containing the cones and a current of nitrogen was passed through the interior of the tube. The cones were supported on alundum boats. The temperature observations were taken with a Holborn-Kurlbaum optical pyrometer. Result, 1,400 deg. C.

[1]See Scientific Paper 212.

TABLE I. MANGANESE OXIDE: SILICA, AND MANGANESE OXIDE: TITANIUM OXIDE SERIES

Per Cent MnO	Melting Pt., Deg. C. MnO:SiO_2 Mixtures	Melting Pt., Deg. C. MnO:TiO_2 Mixtures
5	Above 1500	1320
10	Above 1500	1160
15	Above 1500	1250
20	Above 1500	1200
25	Above 1500	1250
30	Above 1500	1180
35	Above 1500	1160
40	Above 1500	1200
45	Above 1500	1300
50	1268	1280
55	1264	1350
60	1255	1420
65	1228	1425
70	1258	1457
75	1287	1420
80	1282	1455
85	1284	1485
90	Above 1500	Above 1500
95	Above 1500	Above 1500

TABLE II. MANGANESE OXIDE: SILICA: ALUMINA SERIES

Per Cent MnO	Per Cent SiO_2	Per Cent Al_2O_3	Melting Pt., Deg. C.
70	15	15	1245
60	25	15	1179
50	35	15	1138
40	45	15	1121
30	55	15	114[illegible] 1163
20	65	15	1435
60	15	25	1327
50	25	25	1223
40	35	25	1215
30	45	25	1149 1115 1124
20	55	25	1171
50	15	35	1448
40	25	35	1223
30	35	35	1138
20	45	35	1174 1163
40	15	45	1458
30	25	45	1285
20	35	45	1245
30	15	55	1494
20	25	55	1469 1477
20	15	65	1538

TABLE III. MANGANESE OXIDE: SILICA: TITANIUM OXIDE SERIES

Per Cent MnO	Per Cent SiO_2	Per Cent TiO_2	Melting Pt., Deg. C.
70	15	15	1260
60	15	25	1224
50	15	35	115[illegible]
40	15	45	11[illegible]4
30	15	55	1187
20	15	65	1185
60	25	15	1170
50	25	25	1140
40	25	35	1140 1160
30	25	45	1190
20	25	55	1190
50	35	15	1160
40	35	25	1130 1160
30	35	35	1190 1200
20	35	45	Above 1500
40	45	15	1200 1180
30	45	25	Above 1500
20	45	35	Above 1500
30	55	15	Above 1500
20	55	25	Above 1500
20	65	15	Above 1500

TABLE IV. MANGANESE OXIDE: ALUMINA: TITANIUM OXIDE SERIES

Per Cent MnO	Per Cent Al_2O_3	Per Cent TiO_2	Melting Pt., Deg. C.
70	15	15	1388
60	15	25	1366
50	15	35	1329 1350
40	15	45	1320
30	15	55	1328
20	15	65	1354
60	25	15	1392
50	25	25	1403
40	25	35	1381
30	25	45	1348
20	25	55	1367
50	35	15	Above 1527
40	35	25	Above 1527
30	35	35	1428
20	35	45	1348
40	45	15	Above 1500
30	45	25	Above 1500
20	45	35	Above 144[illegible]
30	55	15	Above 1500
20	55	25	Above [illegible]
20	65	15	Above 1500

The Norton Co., Niagara Falls, N. Y., work in charge of R. H. White: A horizontal, electrically-heated carbon tube furnace was used. Cones of the material 1 in. high were placed in the uniform-temperature part of the tube, two or more cones for each mixture, and the melting point checked by two observers. Nitrogen was introduced into the furnace by a fused quartz tube extending within 6 in. of the cones. Temperatures were observed with a Leeds & Northrup optical pyrometer. Result, 1,406 deg. C.

The FitzGerald Laboratories, Niagara Falls, N. Y., work in charge of F. A. J. FitzGerald: Cones of the materials were placed near standard Seger cones in a carbon tube imbedded in granular carbon heated by an electric current. The point determined was where the oxide mixture softened and bent over completely. Result, 1,380 deg. C.

Bureau of Mines, Pittsburgh, Pa., work in charge of A. C. Fieldner: Cones of the material were tested by the gas furnace method for determining fusibility of coal ash, as described in Bureau of Mines Bulletin 129, pp. 111-114. Result 1,388 deg. C.

The accompanying tables give the results of the various determinations.

Conclusions

Seventy-three deoxidizing alloys, all of possible value to steel makers, have thus been shown to have melting points, when oxidized, somewhat below the melting point of pure iron—some of them considerably below. The relative or actual value of these can be determined by carrying out the other phases of the complete investigation mentioned in this paper.

The only basis this investigation furnishes for judging the relative merits of the deoxidizers is comparative fusing points of the slags. It may be expected that a deoxidizer which gives the deoxidation slag of lowest fusing point will be the best. Of the new oxidizers the most fusible are as follows:

Composition	Melting Point of Mixed Oxides Deg. C.
75 per cent Mn, 24 per cent Si	1228
41 per cent Mn, 59 per cent Ti	1160
49 per cent Mn, 18 per cent Ti, 33 per cent Si	1130
13 per cent Al, 52 per cent Mn, 35 per cent Si	1121
12 per cent Al, 47 per cent Mn, 41 per cent Ti	1320

Industrial Wastes in Relation to Water Supplies*

INDUSTRIAL pollution of water, like sewage pollution, is an unfortunate accompaniment of civilization. It is estimated that not less than 40 per cent of the population of the United States is supplied with water obtained from surface sources, and it is therefore evident that the preservation of the purity of the streams and lakes of the country is important. The effect of industrial wastes on public water supply is generally manifested in one or more of the following ways:

(1) Disagreeable odors or tastes.

(2) Foreign substances which make the water unsightly and unsuitable for use or else interfere with the proper functioning of the purification works.

(3) Chemical substances in solution which, though not objectionable to the sight or taste, may cause actual damage to waterworks structure, render the water less fit for domestic or industrial use on account of hardness or other chemical properties and may or may not be detrimental to health.

Some of the instances of pollution having particular reference to the chemical industry are discussed. The more important are:

In recent years the increase of the byproduct coke works has added materially to the problems of water supply in those districts in which the works are located. The wastes vary in composition depending upon the process and the degree to which the products are worked up for the market. A complex group of substances referred to as "phenols" and its derivatives persist in the waste products from the works by reason of the relative solubility in water and give rise to the greatest offence to water supplies. Phenol will form substitution products with chlorine gas and calcium hypochlorite, in use generally for water sterilization, forming the intensely aromatic trichlorphenol.

The trouble arising from the wastes from wood distillation industries are more frequently those arising from the destructive distillation of hard woods, although some trouble has been reported from plants using resinous wood. Spent still liquors and sludges, all of which have a penetrating odor and "smoky" taste peculiar to wood creosote, are the cause of most of the trouble. Unlike coal "phenols," the wood "phenols" are little affected by the chlorination process used in sterilization. No method has been found which is effective in removing objectionable tastes and odors caused by these substances.

The wastes from tanneries are objectionable from the fact that they cause additional expense in the proper purification of the water into which they are added as well as being unsightly.

The wastes from the paper and pulp industries have been the cause of litigation in those states where the waste from mills is run into streams.

It can hardly be denied that the prosperity of a nation is fairly measured by its industrial development. It is obvious therefore that the proper solution of the problem of industrial pollution does not lie in the forbidding of industry, but in a sane regulation whereby industries may flourish without detriment to the resources of the country. It is proper that the burden of preventing stream pollution should be placed on the industrial plants themselves. There has been too much carelessness by manufacturers in allowing obnoxious wastes to enter streams and too much disregard of the rights of the public, particularly in the use of streams. The manufacturers can often with little expense prevent the pollution of streams, and repeatedly it has been found that the unwilling adoption of a process for waste disposal has resulted in a clear profit to the manufacturer from the recovery of byproducts. On the other hand, it is apparent that the necessities of the public water supply have sometimes borne down rather heavily upon industries when remedies were at hand for offsetting the effects complained of. It must be admitted that water purification plants are very much stereotyped in design and fitted for handling the older problems of removing sewage effects. In this matter it would seem that "rule of reason" might often be put into effect, although it must be admitted that the structure of American law is not inclined much to the principle of "balance of conveniences."

*Abstract of a paper presented by Wellington Donaldson at the San Francisco meeting American Public Health Association.

Experiments in Manufacturing No. 12 Alloy

No. 12 Alloy May Be Conveniently and Economically Prepared by Charging Aluminum Ingot, No. 12 Ingot and Scrap and a Copper-Rich Alloy Into the Melting Furnace, and There Is No Advantage in Any Other Procedure[1]

By ROBERT J. ANDERSON*

FOR the purpose of securing comparative data with regard to the manufacture of light aluminum : copper alloys by the various methods in use, a number of experiments were carried out at the Gloekler Foundry Co., Pittsburgh, Pa. In these experiments No. 12 alloy heats were made up by the use of copper, 33: 67 alloy, 50: 50 alloy, and 60: 40 alloy.

Method of Experiment and Materials

In all of the experimental heats, the endeavor was made to keep the conditions the same so far as possible, and the variables included time, temperature, and method of introducing the copper. The various heats were melted in plumbago crucibles in a gas-fired melting furnace, and sand castings were poured from each heat. Chemical compositions of the materials employed are given in Table I. No. 12 alloy scrap was used in some of the heats so as to approximate foundry practice more closely. Pouring temperatures were taken with a Wilson-Maeulen "pyod." Table II gives a summary of the experiments, and they are described in detail below. Chemical analyses of some of the sand castings poured in the various heats are given in Table III. The initial temperature of the hot crucible into which the materials were charged was taken as 600 deg. C., but this was somewhat variable—that is to say, between 400 and 700 deg. C.

Use of Solid Copper

In the experiments carried out in the preparation of No. 12 alloy by alloying solid copper and liquid aluminum, the aluminum was melted in the crucible, and the copper added later. Two experiments in particular were carried out in order to observe the effect of agitation. In experiment G-1 the copper was added and allowed to sink to the bottom; no stirring was done, and the metal was poured into castings after standing for 30.0 minutes. In experiment G-2, the copper was added as in experiment G-1, but the melt was thoroughly stirred every few minutes. The melt was held in the furnace for 30.0 minutes, and was again well stirred before pouring into castings. The detailed data are given below.

Experiment G-1. In this experiment solid copper was added to liquid aluminum without stirring.

Charged aluminum into a hot crucible at 600 deg., lb	23.0
Time required to melt aluminum, min	23.0
Gas consumption, cu.ft	2,415
Temperature of the aluminum at the time copper was added, deg. C	697
Charged copper, lb	2.0
Highest observed temperature of the resultant alloy, deg. C	765
Total gas consumption, cu.ft	2,940
Final temperature, deg. C	740
Pouring temperature of castings, deg. C	732
Weight of ingots and castings poured, lb	24.90
Weight of dross recovered, lb	0.20
Shrinkage, lb	+0.10
Loss due to oxidation and shrinkage, per cent	0.40

[1] Published by permission of the Director, U. S. Bureau of Mines.

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Experiment G-2. Here, solid copper was added to liquid aluminum with thorough stirring.

Charged aluminum into a hot crucible at 600 deg. C., lb	23 0
Time required to melt the aluminum, min	28 0
Gas consumption, cu.ft	2,940
Temperature of the aluminum at the time copper was added, deg. C	685
Charged copper, lb	2.0
Highest observed temperature of the resultant alloy, deg. C	765
Total gas consumption, cu.ft	3,465
Final temperature, deg C	750
Pouring temperature of castings, deg. C	744
Weight of castings and ingots poured, lb	24 70
Weight of dross recovered, lb	0.20
Shrinkage, lb	0.20
Loss due to oxidation and shrinkage, per cent	1.20

Some additional foundry experiments were made in the preparation of No. 12 alloy by adding copper directly. In one experiment, the copper was melted first and the aluminum added later; in the other, the aluminum was melted first and the copper added later, but the temperature of the aluminum in this experiment was considerably higher than was the temperature in experiments G-1 and G-2. These additional experiments are described below.

Experiment G-3. In this experiment, the copper was melted first and the aluminum added later.

Charged copper into a hot crucible at 600 deg. C, lb	2 0
Time required to melt the copper, min	23 0
Gas consumption, cu ft	2,415
Temperature of the copper at the time the first aluminum addition was made, deg. C	1,128
Charged aluminum in small amounts every few minutes during 35 minutes, lb	23.0
Highest observed temperature, deg. C	1,195
Total gas consumption, cu.ft	4,515
Final temperature, deg C	754
Pouring temperature of castings, deg. C	710
Weight of castings and ingots poured, lb	24.50
Weight of dross recovered, lb	0.50
Shrinkage, lb	0.00
Loss due to oxidation and shrinkage, per cent	2.00

TABLE I. CHEMICAL ANALYSES OF THE MATERIALS USED IN PREPARING No. 12 ALLOY

Material	Elements, per Cent: Cu	Fe	Si	Al(a)
Aluminum	0 25	0 39	0.31	99.05
Light copper (b)	99 89	...	....	.....
Heavy copper (b)	99.92	. .	..	.....
33 : 67 alloy	33 05	0 50	0 36	66 09
50 : 50 alloy	49 24	0 49	0 35	49.92
60 : 40 alloy	59 29	0 53	0 32	39 86
No. 12 alloy	8 38	0 58	0 41	90.63

(a) Aluminum, by difference.
(b) The light copper was used in experiments G-1, G-2, G-4, and the heavy copper in experiment G-3.

Experiment G-4. Here, aluminum was melted first and the copper added later.

Charged aluminum into a hot crucible at 600 deg. C., lb	23.0
Time required to melt the aluminum, min	31.0
Gas consumption, cu ft	3,255
Temperature of the aluminum at the time copper was added, deg. C	715
Charged copper, lb	2 0
Highest observed temperature of the resultant alloy, deg. C	950
Total gas consumption, cu.ft	3,780
Final temperature, deg. C	928
Pouring temperature of castings, deg. C	720
Weight of castings and ingots poured, lb	24.75
Weight of dross recovered, lb	0.35
Shrinkage, lb	+0.10
Loss due to oxidation and shrinkage, per cent	1.00

Use of 33 : 67 Copper : Aluminum Alloy

Heats of No. 12 alloy were made up by using the 33 : 67 alloy for introducing the copper. In foundry

practice, it is customary to charge the rich alloy and the aluminum ingot plus No. 12 scrap at once, and the whole charge is presumed to go down at once. As a matter of fact, the rich alloy, whether 33: 67 or 50: 50, melts first and the aluminum later. In making up No. 12 heats by the use of a rich alloy, it is possible to do this in at least three ways: (1) By charging the rich alloy and the aluminum together; (2) by melting the aluminum first and then adding solid rich alloy; and (3) by melting the rich alloy first and then adding the aluminum later. Also the aluminum and the rich alloy might be melted separately and the one poured into the other. Practically, the two methods used commercially are (1) and (2) above, but data with regard to (3) are also presented for the sake of comparison.

Experiment H-1. In this experiment, the required amounts of rich alloy, aluminum and No. 12 scrap were charged together.

Charged aluminum into a hot crucible at 600 deg. C., lb	9.47
Charged No. 12 scrap, lb	12.50
Charged 33 : 67 alloy, lb	3.03
Time required to melt the charge, min	23.0
Gas consumption, cu.ft	2,415
Highest observed temperature of the resultant alloy, deg. C	700
Total gas consumption, cu.ft	2,415
Final temperature, deg. C	685
Pouring temperature of castings, deg. C	672
Weight of castings and ingots poured, lb	24.70
Weight of dross recovered, lb	0.20
Shrinkage, lb	0.10
Loss due to oxidation and shrinkage, per cent	1.20

Experiment H-2. In this experiment, the aluminum plus No. 12 scrap was melted first, and the 33 : 67 alloy was then added to the liquid melt.

Charged aluminum into a hot crucible at 600 deg. C., lb	9.47
Charged No. 12 scrap, lb	12.50
Time required to melt this charge, min	25.0
Gas consumption, cu.ft	2,625
Temperature of the charge at the time the 33 : 67 alloy was added, deg. C	650
Charged 33 : 67 alloy, lb	3.03
Time required for the rich alloy to go into solution, approximately, min	1.0
Highest observed temperature of the resultant alloy, deg. C	710
Total gas consumption, cu.ft	3,150
Final temperature, deg. C	710
Pouring temperature of castings, deg. C	704
Weight of castings and ingots poured, lb	24.85
Weight of dross recovered, lb	0.15
Shrinkage, lb	0.00
Loss due to oxidation and shrinkage, per cent	0.60

Experiment H-3. The rich alloy was melted first in this experiment, and the aluminum was charged later. No scrap was used.

Charged 33 : 67 alloy into a hot crucible at 600 deg. C., lb	6.06
Time required to melt the alloy, min	12.0
Gas consumption, cu.ft	1,260
Temperature of the alloy at the time the aluminum was added, deg. C.	649
Charged aluminum, lb	18.94
Time required to melt the aluminum, min	20.0
Highest observed temperature of the resultant alloy, deg. C	720
Total gas consumption, cu.ft	3,360
Final temperature, deg. C	720
Pouring temperatures of castings, deg. C	710
Weight of castings and ingots poured, lb	24.60
Weight of dross recovered, lb	0.30
Shrinkage, lb	0.10
Loss due to oxidation and shrinkage, per cent	1.60

50 : 50 Copper : Aluminum Alloy

A number of No. 12 alloy heats were made up where the 50: 50 copper: aluminum was employed for introducing the copper. The methods were practically the same as in experiments H-1 to H-3 where the 33 : 67 alloy was used.

Experiment I-1. In this experiment, the required amounts of aluminum, No. 12 scrap, and rich alloy were charged together.

Charged aluminum into a hot crucible at 600 deg. C., lb	10.5
Charged No. 12 scrap, lb	12.5
Charged 50 : 50 alloy, lb	2.0
Time required to melt the charge, min	30.0
Gas consumption, cu.ft	3,150
Highest observed temperature of the resultant alloy, deg. C	730
Total gas consumption, cu.ft	3,885
Final temperature, deg. C	730
Pouring temperature of castings, deg. C	711
Weight of castings and ingots poured, lb	24.75
Weight of dross recovered, lb	0.15
Shrinkage, lb	0.10
Loss due to oxidation and shrinkage, per cent	1.00

Experiment I-2. In this experiment, aluminum was melted first and 50 : 50 alloy was added to the liquid charge.

Charged aluminum into a hot crucible at 600 deg. C., lb	21.0
Time required to melt the aluminum, min	21.0
Gas consumption, cu.ft	2,205
Temperature of the aluminum at the time the 50 : 50 alloy was added, deg. C	690
Charged 50 : 50 alloy, lb	4.0
Time required (approximately) for the 50 : 50 alloy to go into solution, min	2.5
Highest observed temperature of the resultant alloy, deg. C	780
Total gas consumption, cu.ft	3,255
Final temperature, deg. C	780
Pouring temperature of castings, deg. C.	710
Weight of castings and ingots poured, lb	24.80
Weight of dross recovered, lb.	0.20
Shrinkage, lb	0.00
Loss due to oxidation and shrinkage, per cent	0.80

Experiment I-3. Here, the 50 : 50 alloy was melted first, and the aluminum ingot was added later.

Charged 50 : 50 alloy into a hot crucible at 600 deg. C., lb	4.0
Time required to melt the alloy, min	12.0
Gas consumption, cu.ft	1,260
Temperature of the alloy at the time the aluminum was added, deg. C	608
Charged aluminum, lb	21.0
Time required to melt the aluminum, min	18.0
Highest observed temperature of the resultant alloy, deg. C	715
Total gas consumption, cu.ft	3,675
Final temperature, deg. C	715
Pouring temperature of the castings, deg. C	706
Weight of castings and ingots poured, lb	24.60
Weight of dross recovered, lb.	0.40
Shrinkage, lb	0.00
Loss due to oxidation and shrinkage, per cent	1.60

60 : 40 Copper : Aluminum Alloy

As has been mentioned previously, a 60 : 40 copper : aluminum alloy has not been used in the foundry, so far as is known, for introducing copper into aluminum. Since it is a brittle alloy and melts at approximately the same temperature as aluminum, it was thought to be worthy of trial. Accordingly, a number of heats were made up with this alloy.

Experiment J-1. The rich alloy, aluminum, and No. 12 scrap were melted together in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb	10.84
Charged No. 12 scrap, lb	12.50
Charged 60: 40 alloy, lb.	1.66
Time required to melt this charge, min	30.0
Gas consumption, cu.ft.	3,150
Highest observed temperature, deg. C.	715
Total gas consumption, cu.ft.	3,675
Final temperature, deg. C.	715
Pouring temperature of castings, deg. C	711
Weight of castings and ingots poured, lb	24.80
Weight of dross recovered, lb	0.13
Shrinkage, lb.	0.05
Loss due to oxidation and shrinkage, per cent	0.80

Experiment J-2. In this experiment, the aluminum and No. 12 alloy were melted first, and when liquid the proper addition of 60: 40 alloy was made.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.84
Charged No. 12 scrap, lb	12.50
Time required to melt this charge, min	24.0
Gas consumption, cu.ft	2,520
Temperature of this charge at the time the 60 : 40 addition was made, deg. C.	645
Charged 60 : 40 alloy, lb	1.66
Highest observed temperature of the resultant alloy, deg. C	709
Total gas consumption, cu.ft.	3,045
Final temperature, deg. C	709
Pouring temperature of the castings, deg. C.	699
Weight of castings and ingots poured, lb.	24.90
Weight of dross recovered, lb	0.20
Shrinkage, lb	+0.10
Loss due to oxidation and shrinkage, per cent	0.40

Experiment J-3. In this experiment, the 60: 40 alloy was melted first, and the aluminum was added later. No scrap was used.

Charged 60 : 40 alloy into a hot crucible at 600 deg. C., lb	3.32
Time required to melt the alloy, min	10.0
Gas consumption, cu.ft	1,050
Temperature of the alloy at the time the aluminum was added, deg. C.	700
Charged aluminum, lb	21.68
Time required to melt the aluminum, min	18.0
Highest observed temperature of the resultant alloy, deg. C.	707
Total gas consumption, cu.ft	3,465
Final temperature, deg. C.	707
Pouring temperature of the castings, deg. C.	701
Weight of castings and ingots poured, lb	24.75
Weight of dross recovered, lb.	0.25
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	1.00

Experiment J-4. Aluminum and 60:40 alloy were melted together in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb	21.68
Charged 60:40 alloy, lb.	3.32
Time required to melt the charge, min	26.0
Gas consumption, cu.ft.	2,730
Highest observed temperature, deg. C	730
Total gas consumption, cu.ft	3,465
Final temperature, deg. C.	730
Pouring temperature of castings, deg. C.	710
Weight of castings and ingots poured, lb	24.80
Weight of dross recovered, lb	0.30
Shrinkage, lb	+0.10
Loss due to oxidation and shrinkage, per cent	0.80

Discussion of the Experiments

An inspection of the experimental details and the summary in Table II affords interesting data from which conclusions may be safely drawn. Both dross losses and gas consumption are high in the experiments where either copper or the rich alloys were melted first and the aluminum added later. Both dross losses and gas consumption are low when the entire charge is melted at once, or where the necessary rich alloy (or copper) is added to a liquid bath. There appears to be no advantage gained by adding solid rich alloy or solid copper to liquid aluminum as compared to charging all the materials together. In general, the higher dross losses result from higher temperatures, for example in experiments G-3 and G-4. In experiment G-3 the copper was melted first, and when at a temperature of 1,128 deg. C. aluminum was introduced. In experiment G-4, the temperature of the alloy, after the copper addition, was purposely raised to 950 deg. C., and the dross loss was consequently high. But few apparent anomalies appear in the summarized data, and it will be readily apparent that these may exist without vitiating the results because of the conditions of the experiments. As already explained, the initial charging temperature of the hot crucible was arbitrarily taken as 600 deg. C., but this varied considerably, as shown by temperature measurements. Consequently, gas consumption figures vary, but within reasonable limits. The difficulty of collecting all of the melt, after pouring castings and ingots, and the practical impossibility of cleaning the crucible so as to recover all of the dross and the alloy sticking to the inside will lead to minor errors. Where there is a plus shrinkage, the materials were recovered most completely; the weight of the castings and ingots poured plus the dross should give a total weight greater than the weight of the original charge because of the oxidation of aluminum to Al_2O_3.

In considering the dross and shrinkage losses in Table II, it should be borne in mind that the experiments were carried out on a small scale, 25-lb. charges being used. The relative order of the losses in preparing No. 12 alloy by the different methods is correct, but the actual figures are too high for large-scale practice. Moreover, it should be pointed out that ordinarily the dross is not entirely loss in commercial practice because a considerable recovery of metal would be made by running down the dross and skimmings. These matters should be borne in mind when considering the loss figures.

TABLE III. CHEMICAL ANALYSES OF SOME OF THE CASTINGS POURED IN THE NO. 12 ALLOY EXPERIMENTS

Experiment	Elements, per Cent Cu	Fe	Si	Al (a)
G-1	7.47	0.49	0.33	91.71
G-2	7.66	0.48	0.40	91.46
H-1	8.29	0.61	0.38	90.72
H-2	8.19	0.54	0.38	90.89
I-1	8.23	0.48	0.44	90.85
I-3	8.13	0.42	0.38	91.07
J-1	7.92	0.62	0.42	91.04
J-2	7.94	0.58	0.40	91.08

(a) Aluminum, by difference

Metallography of the Sand Castings

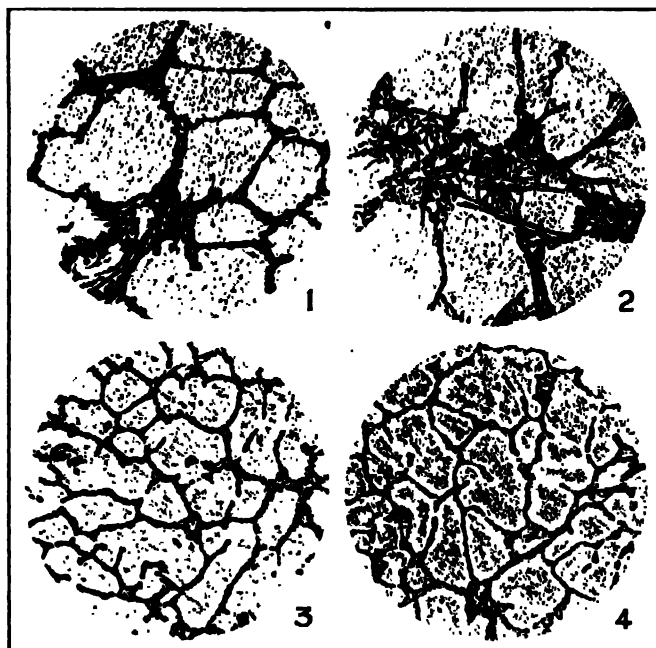
The castings poured from the No. 12 alloy heats described above consisted of thin shells and 1.0-in. square bars, following the practice in the writer's previous experiments on blowholes and unsoundness in aluminum-alloy castings.[1] In connection with the present experiments, microsections were cut from all of

[1] Anderson, R. J., "Unsoundness in Aluminum-Alloy Castings," *The Foundry*, vol. 47, 1919, pp. 579-584.

TABLE II. SUMMARY OF THE NO. 12 ALLOY EXPERIMENTS (a)

Experiment	Wt. Copper, Lb.	Wt. Al., Lb.	Wt. No. 12 Scrap, Lb.	Wt. Rich Alloy, Lb.	Temp. Initial Charge after Melt'g, Deg.C.(b)	Highest Observed Temp., Deg. C. (c)	Final Temp., Deg. C	Castings Poured at Deg. C.	Wt. Castings and Ingots, Lb.	Wt. Dross Recovered, Lb.	Shrinkage, Lb.	Total Loss, per Cent	Metal Oxidized, per Cent (d)	Total Gas Consumption, Cu.Ft. (e)	Cost Gas Used, Dollars (f)	Remarks	Introduced Copper by Means of
G-1	2.00	23.00		.	697	765	740	732	24.90	0.20	+0.10	0.40	0.42	2,940	0.88	Solid copper added to liquid aluminum	Copper
G-2	2.00	23.00	.		686	765	750	744	24.70	0.20	0.10	1.20	0.42	3,465	1.04	Solid copper added to liquid aluminum	Copper
G-3	2.00	23.00	.	.	1,128	1,195	754	710	24.50	0.50	0.00	2.00	1.06	4,515	1.35	Copper melted first, and aluminum added later	Copper
G-4	2.00	23.00			715	950	928	720	24.75	0.35	+0.10	1.00	0.74	3,780	1.13	Solid copper added to liquid aluminum	Copper
H-1	.	9.47	12.50	3.03	...	700	685	672	24.70	0.20	0.10	1.20	0.42	2,415	0.72	Aluminum, No. 12 alloy and 33:67 alloy melted together	33:67 alloy
H-2	.	9.47	12.50	3.03	650	710	710	704	24.85	0.15	0.00	0.60	0.32	3,150	0.95	Aluminum and No. 12 scrap melted first, and 33:67 alloy added later	33:67 alloy
H-3	..	18.94	....	6.06	649	720	720	710	24.60	0.30	0.10	1.60	0.64	3,360	1.01	33:67 alloy melted first, and aluminum added later	33:67 alloy
I-1		10.50	12.50	2.00	...	730	730	711	24.75	0.15	0.10	1.00	0.32	3,885	1.17	Aluminum, No. 12 alloy, and 50:50 alloy melted together	50:50 alloy
I-2	.	21.00	....	4.00	690	780	780	710	24.80	0.20	0.00	0.80	0.42	3,255	0.98	Aluminum melted first, and 50:50 alloy added later	50.50 alloy
I-3	.	21.00	....	4.00	608	715	715	706	24.60	0.40	0.00	1.60	0.84	3,675	1.10	50:50 alloy melted first, and aluminum added later	50.50 alloy
J-1	...	10.84	12.50	1.66	...	715	715	711	24.80	0.15	0.05	0.80	0.32	3,675	1.10	Aluminum, No. 12 alloy and 60.40 alloy melted together	60:40 alloy
J-2		10.84	12.50	1.66	645	709	709	699	24.90	0.20	+0.10	0.40	0.42	3,045	0.91	Aluminum and No. 12 alloy melted first and 60:40 alloy added later	60:40 alloy
J-3		21.68	...	3.32	700	707	707	701	24.75	0.25	0.00	00	0.53	3,465	1.04	60:40 alloy melted first, and aluminum added later	60.40 alloy
J-4	..	21.68	.....	3.32	..	730	730	710	24.80	0.30	+0.10	80	0.64	3,465	1.04	Aluminum and 60:40 alloy melted together	60.40 alloy

(a) See experimental details in the text.
(b) The figures indicate the temperature of a liquid bath at the time of the addition of solid material. All solid additions were at room temperature.
(c) The figures indicate the observed highest temperatures: higher temperatures may have obtained, but they were not observed.
(d) Based on the assumption that dross is equivalent to Al_2O_3, containing about 53.0 per cent aluminum.
(e) Furnace gas consumption was at the average rate of 105 cu.ft. per minute.
(f) Based on gas at \$0.30 per 1,000 cu.ft.



FIGS. 1 TO 4

Fig. 1. Microstructure of section cut from 1.0-in. square bar, cast in Experiment G-2. Fig. 2. Microstructure of section cut from 1.0-in. square bar, cast in Experiment I-3. Fig. 3. Microstructure of section cut from thin shell, cast in Experiment G-2. Fig. 4. Microstructure of section cut from thin shell, cast in Experiment I-3. All etched with NaOH × 135.

the castings poured, and these were examined for general characteristics. Practically no differences with regard to microstructure (distribution of the $CuAl_2$, etc.) were found, but blowholes and porosity appeared to be more numerous and greater in the case of castings poured from melts which, at one time or another during preparation, had attained rather high temperatures. Furthermore, these defects were more pronounced in the castings poured from heats where the dross losses were high, viz., G-3, J-3, and I-3. Typical microstructures of sections cut from the castings are shown in Figs. 1 to 4, inclusive.

Grade of No. 12 Alloy Heats

In papers which have preceded this,[2] it has been shown that the 92 : 8 alumium : copper alloy is prepared by various methods, and there remains to be considered, in a brief way, the various grades of heats used in making this alloy. Ordinarily, pig aluminum alone is not used, but some No. 12 ingot, or foundry scrap, or both, is added to the charge. The proportions of aluminum and No. 12 ingot or scrap in heats for castings may, and do, vary from 0 to 100 per cent. Where both aluminum and No. 12 ingot or scrap are charged, sufficient rich alloy, say 50: 50, is charged at the same time for the purpose of introducing the desired amount of copper. In foundry practice, it is economical, and usually necessary, to charge some No. 12 alloy with the aluminum; the No. 12 scrap charged will be made up of gates, risers, and defective castings from the foundry. Furthermore, if the castings are machined in a shop in conjunction with the foundry, large amounts of No. 12 borings will accumulate, and these must be disposed of. Also, some foundries buy back the borings from their castings in case the castings are sold to outside consumers. The petroleum involved in the economical handling of borings is one which is solved in different ways. Some foundries send the borings to outside refiners or smelters; the refiner will run the borings into No. 12 ingot, and return the resultant ingot for a fee. This ingot is then charged into the melting pots with the aluminum and the rich alloy. Other foundries run down the borings into ingot themselves, while a few charge borings as such into the pots; the latter practice has largely disappeared. The handling of borings has already been dealt with by Gillett and James.[3]

In some places, no attempt is made to preserve uniformity in the matter of relative percentages in successive heats, while in other foundries this is guarded closely. One foundry, for example, uses the following charge: 25 per cent No. 12 scrap (gates, risers, defective and broken castings), 25 per cent No. 12 ingot (run down from borings), 50 per cent aluminum ingot (plus sufficient 50: 50 rich alloy). This charge is used continually unless the scrap losses on the floor mount to unusually high figures, and it becomes necessary to work more of the defectives into the charges.

The kind and quality of the scrap and No. 12 ingot used in foundry charges should be carefully controlled, since much difficulty may arise otherwise. Under Bureau of Aircraft Production specifications for Liberty (and other) motor castings, no No. 12 scrap other than that originating in the manufacturer's plant was allowed in the make-up of charges. The influence of the quality of the melting charge upon the resultant castings is one which is important and interesting to foundrymen, but it cannot be dealt with in this paper.

Summary

The conclusions arrived at from the experiments and foundry experience in the preparation of No. 12 alloy by various methods are these:

First, there is nothing which would lead to the belief that one rich alloy is any better than another, for introducing copper, from the standpoint of dross losses and gas consumption.

Second, small heats of No. 12 alloy may be made conveniently and cheaply by using light gage copper sheet or punchings; the solid copper should be added to the liquid aluminum, whereupon it will alloy at relatively low temperatures.

Third, where the production is large, as in a foundry pouring 25,000 to 50,000 lb. of castings in eight hours, it is safer to employ a rich alloy.

Fourth, the most convenient rich alloy available (taking into consideration brittleness, melting point, and ease of calculation) is the 50: 50 alloy.

Fifth, the most desirable method of making up a heat is to charge all the materials together.

Those foundrymen who hold to the belief that the "most desirable" method of preparing No. 12 alloy is by adding light copper punchings or sheet to liquid aluminum base their arguments largely on the saving arising in not using a rich alloy. The objection has been made that with this method the resultant castings are likely to run "hard" and "soft." The objection is valid, but, as has been shown, this may be overcome provided the melts are thoroughly stirred. Segregation of the $CuAl_2$ is extremely likely when melts are made by this method unless stirring is performed thoroughly and often. "Hard" and "soft" castings are attributed to

[2] "Foundry Methods for Light Aluminum: Copper Alloys," by Robert J. Anderson, CHEM. & MET. ENG., vol. 23, No. 15, p. 735, Oct. 13, 1920.

[3] Gillett, H. W., and James, G. M., "Melting Aluminum Chips," Bull. 108, Mineral Technology 14, Bureau of Mines, 1916.

the fact that the first pour is lean in copper and the last relatively rich. This defect in the method is so serious that it renders the whole scheme undesirable in large foundries, particularly when the production is rushed. Danger of segregation will be greatly minimized if rich alloys are used for introducing the copper. Moreover, with unskilled labor at the melting pots, it is much safer to use a rich alloy. Further than that, there have been difficulties experienced, at times, by some foundries in obtaining a suitable and sufficient supply of copper. It appears that a small foundry can use the direct copper method to advantage, but a large foundry voluntarily puts fetters on itself when it adheres to this method solely. The No. 12 alloy may be conveniently and economically prepared by charging the aluminum ingot, No. 12 ingot and scrap, and rich alloy together into the melting furnace, and there is no advantage in any other procedure.

How to Paint Turpentine Tanks and Cars

Effective methods for painting the inside of turpentine tanks and tank cars have been described by specialists of the Bureau of Chemistry, United States Department of Agriculture, as follows:

When in contact with iron for any length of time, especially if the tank is only partly full, turpentine gradually turns yellow. This is due to the fact that on exposure to air, turpentine slowly absorbs oxygen and becomes slightly acid, causing corrosion of the iron, which goes into solution, causing the formation of the yellow or brown color.

Unless the iron is protected against the action of the acids formed when the tank has been emptied, and is full of air with a thin film of turpentine on the inner surface, tank cars in regular use for transporting turpentine soon become rusty inside. As ordinary paint, made from linseed oil and turpentine, will not resist the solvent action of turpentine, it is necessary to use a paint made from materials which are not affected by turpentine. One made according to the following formula, which makes about 8 gal., enough to give an 8,000-gal. tank two coats, is generally used for this purpose:

Methanol or denatured alcohol, gal.	5
Orange shellac (pure), lb.	24
Dry red lead, lb.	24
Venice turpentine, oz.	28

Dissolve the shellac in the alcohol. This operation, which takes some little time, is best done by putting the two in a can and allowing the mixture to stand, covered, for two or three days, stirring occasionally. After all the shellac has gone into solution, strain the liquid through cheese-cloth to remove any insoluble matter. Then warm the Venice turpentine until it flows freely and stir it into the shellac solution. This is now ready for use in making up the paint. When ready to use the paint, immediately before it is to be applied to the tank, from which all loose rust has been scraped or removed with a wire brush, mix the red lead with the liquid, being sure to stir thoroughly to break up all lumps. Apply with an ordinary paint brush to the thoroughly clean and dry surface. Brush the paint out well to prevent peeling. Allow the first coat to dry hard before applying the second coat.

When painting the inside of a tank with this preparation, or whenever it is necessary for a man to enter a tank which has held turpentine, some arrangement must be made to prevent inhalation of the alcohol or turpentine fumes. A supply of fresh air can be pumped in to the workman through a pipe connected with either an air pump or a small blower like those connected with small portable forges. A gas mask with a container filled with broken pumice stone saturated with concentrated sulphuric acid, through which the air is drawn, may also be used. The absorption chamber must be recharged at least once a day. The pumice, in pieces about the size of a pea, should be steeped in the acid and the excess acid allowed to drain off before being placed in the container. Since concentrated sulphuric acid rapidly absorbs moisture from the air, thus losing its absorptive qualities, the acid supply and the pumice after saturation with the acid must not be exposed to the air any longer than absolutely necessary. A man should not remain in such a tank for more than four hours a day, and should come out sooner if he begins to feel unsteady, or if the muscles become "jerky." Continued work, day after day, in a tank with a methanol paint should be avoided, as the poisonous effects of methanol are cumulative.

Sugar Industry in Brazil

Every state in Brazil produces sugar cane. Reliable statistics, however, are not obtainable, as most of the production is for local consumption, reports Consul-General Haeberle of Rio Janiero. Moderate estimates give the approximate number of bags of sugar produced as follows in 1911, 1914 and 1917: 1911-12, 5,000,000 bags of 60 kilos (132 lb. each bag); 1914-15, 5,196,000 bags; 1917-18, 7,350,000 bags. The States of Pernambuco, Sao Paulo, Sergipe and Bahia lead in the production of sugar in the order named.

The cane is all crushed in the country. In many places in the interior rudimentary appliances, made of hardwood, are still used to crush the cane. These establishments, producing dark-brown cake sugar ("rapadura"), consumed by the laborers on the farm, do not figure in any statistics, and the total production cannot be estimated. It is large, however. Small American crushers with three vertical steel cylinders are often used on farms and in small factories, driven by human or animal power. Some factories have up-to-date machinery; only one factory so far, however, has introduced the diffusion process in Brazil—the Uzina Esther, in Sao Paulo, with a daily capacity of 125 tons of cane.

Most of the production is used for consumption in Brazil; only the surplus is exported. Exports in the years 1914 to 1919, inclusive, were in the following quantities (one metric ton = 2,204.6 lb.):

Kinds	1914 Metric Tons	1915 Metric Tons	1916 Metric Tons	1917 Metric Tons	1918 Metric Tons	1919 Metric Tons
White sugar	1,365	2,833	31,201	98,179	94,720	(a)
Demerara	20,876	22,064	12,974	10,541	8,984	(a)
Brown sugar	9,619	34,178	9,650	22,789	11,930	(a)
Total	31,860	59,075	53,825	131,509	115,634	69,429

(a) Classification not yet available.

Sugar cane in Brazil is not an annual plant; it remains on the fields for several years. Seasons of planting and crushing are governed by weather conditions, wet or dry, varying greatly according to the districts. As a rule sugar cane is planted during the rainy season and crushed when the dry season sets in. These seasons differ widely in the various parts of Brazil.

Legal Notes

By Wellington Gustin

Some Pitfalls of Selling

A broker's right to his commissions is involved in the action of Eugene Suter, a New York broker, against the Farmers' Fertilizer Co., recently decided in the Supreme Court of Ohio. The company had employed the broker to negotiate a contract for the sale of sulphuric acid to be manufactured by the company, the company agreeing with the broker to pay a brokerage of 1 per cent of the amount of the price provided for in such contract, to be paid as payments of the price were received by the company. Under this agreement the broker negotiated a contract between the company and the Aetna Explosives Co., whereupon it was agreed that the defendant company should proceed with the erection of a plant for the manufacture of sulphuric acid and sell and deliver to the Aetna company 600 tons of acid per month, commencing about April, 1916, and continuing thereafter monthly for a period of twelve months, deliveries to be made at defendant's plant, the Aetna company agreeing to pay for the acid on delivery at the rate of $27 per ton of 2,000 lb., f.o.b. defendant's works, Columbus, Ohio. The contract expressly provided that a brokerage of 1 per cent on this sale should be paid by defendant company to the broker as payments were received. The defendant company erected its sulphuric acid plant and made various deliveries to the Aetna company between April and July, 1916, and paid brokerage thereon.

Clients Make New Agreement

However, in October, the defendant company entered into a contract with the Aetna company canceling the former contract and releasing the latter company from the obligations thereof in consideration of the payment by the Aetna company of $45,000 and an agreement on the part of the Aetna company to repay any brokerage the defendant company might be compelled to pay beyond that admitted due on the $45,000 cash settlement. Thereupon the broker was sent check for $450, but this settlement was rejected by him, and this suit was brought to collect 1 per cent brokerage on the full amount of the original contract.

The defendant company contended that according to custom and usage among brokers in New York the plaintiff was entitled to commission or brokerage only upon the moneys received by the defendant under the original contract, and that the broker had been paid his full commissions on the moneys received under said contract.

Insolvency of Buyer Set Up as Defense

Further the defendant company claimed that shortly after it began shipping acid disputes arose with the Aetna company over the contract; that the latter failed to furnish cars for shipments as provided in the contract and refused to pay for the acid delivered; that the Aetna company became financially embarrassed, and in order to save itself and the broker from great loss on acid shipped and not paid for it entered into the cash settlement; that it made every effort to perform the conditions of the contract on its part, but was prevented solely through the failure of the Aetna company and by its threatened and actual insolvency. Then the defendant company denied that it employed the broker to negotiate the contract with the Aetna company.

Upon hearing the evidence the jury was instructed to find a verdict for the defendant, Farmers' Fertilizer Co., and from a judgment against him Suter appealed. The Court of Appeals affirmed the trial court and a further appeal on error was made to the Ohio Supreme Court.

The first question decided was whether the broker had a valid contract of employment. The broker testified that he was employed by Young, general manager of the defendant. The president of the company denied that the general manager had any authority to make such a contract. But there were a number of telegraphic communications between the broker and defendant company on the subject, and thereafter the general manager entered into a written contract with the Aetna company for the sale of the acid. In this contract brokerage is expressly provided to be paid Suter. This contract was signed by the names of the two companies, and thereafter the company ratified this contract made by its general manager by entering upon its performance and by paying Suter certain commissions in accordance with its terms.

Right to Commission Rests on Contract

The Supreme Court said that the right of a broker to recover commissions rests upon contract, express or implied. The burden is upon him to prove that his services were rendered under employment by the principal, or that the latter accepted his agency and his acts under circumstances showing that he knew the services were being rendered on his account and while the agent was relying on the principal's obligation to pay him. If the services are rendered without employment, express or implied, or as a mere volunteer and without acceptance under the circumstances stated, he cannot recover.

Also, where a principal enters into a written contract of sale with a purchaser produced by a broker, in which instrument the principal agrees to pay the broker a specific compensation on "this sale," such action amounts to an acceptance of the services of the broker and ratification of his previous employment, even though such previous employment was made by an officer or agent who was without authority to make it.

On the question of the release of the Aetna company by defendant the rule was stated that where the obligations arising under a contract have attached, and subsequent thereto one party, without the consent of the other, does some act or makes some new arrangement which prevents the carrying out of the contract according to its terms, he cannot avail himself of this conduct to avoid his liability to the other party.

It appeared that the defendant company entered into the contract with the purchaser relying on its own investigations and knowledge of the ability of the Aetna company to carry out the contract, and because it was satisfied with the purchaser procured by the broker. Under such circumstances the release of the Aetna company from further performance of the contract on its part for the consideration named would entitle the broker to the immediate payment of his commission. Therefore the judgment of the two lower courts was reversed and judgment was ordered to be entered for the broker.

German Chemical Industries*

THE peace treaty requires that Germany shall deliver to France, during each of three successive years, 30,000 tons of sulphate of ammonia, 35,000 tons of benzene and 50,000 tons of coal tar. The Reparation Commission reserved the right to one-half the supply of dyestuffs and chemico-pharmaceutical products on hand at the time of the signing of the treaty; also an amount up to one-fourth of the product up to Jan. 1, 1915. Now that a year has elapsed since these provisions became effective, it is of interest to read the German reports of company meetings, chambers of commerce summaries, and trade-journal reviews of conditions in the chemical industry.

The two general conclusions that may be drawn from this published material seem at first to be entirely contradictory. The introductory pages of every report and summary discuss the shortage in coal and raw materials, the closing of plants, the scarcity and high cost of labor and the poor transportation facilities. As a consequence, a very great scarcity of the finished product is reported so that orders cannot be filled. Some reports specifically mention the French deliveries as the occasion of the shortage on the market. The impression of industrial hardship that is conveyed in these opening paragraphs is, however, offset at the end of the same reports by the financial statements that record, almost without exception, the declaring of dividends largely in excess of those of 1918. The explanation of the discrepancy is of course to be found in the heavy foreign demand at the high prices of the last few months of 1919.

Below are given a few summaries from the German Annals of Economics and Statistics (April, 1920), from the *Journal* of the Berlin Chamber of Commerce, from trade journals and from company reports.

Resumption of Chemical Trade Dependent Upon Coal Supply

Resumption of trade in chemicals is dependent upon the supply of coal. Shortage in coal has brought a large part of the industry to a standstill, or at least has caused great shortage in production. If, now, a shortage of raw material is to follow, such deficiency in the supply of sulphuric acid, caustic soda, pyrites, tar, sugar and casein will itself be traceable to the scarcity of coal. The *Rhenisch-Westfalia Zeitung* for March 1 says some relief was obtained at the end of February by the delivery of American coal which had been ordered but was not until then available.

The chemical industry seems to be at a standstill. The chemico-pharmaceutical industry is in some respects in a better situation than in January, in other respects in a worse position. Dyestuffs have shown a brief revival because of the receipt of a moderate amount of coal.

The shellac industry also makes an encouraging report. Soap reports run from "bad" to "fair." Asphalt and tar products suffered from lack of raw material. Coking plants, producing tar, ammonium sulphate and benzene, report a freight scarcity; business was in other respects improved over a year ago. Ethereal oils were sluggish, but improving. Benzine and turpentine were not coming on the market. Weak conditions prevailed in the sulphuric acid and fertilizer industries; in the case of the latter, shortage of materials made it impossible to satisfy the demand.

The chemical industry suffered heavily during the past year by reason of the shortage of coal, which became extraordinarily acute toward the end of the year, causing many industries to close. The shortage in other raw materials became more and more serious at the same time that the world demand for chemical products became so insistent. At this juncture many foreign countries put an embargo on the importation of German products. Finally the 25 and 50 per cent deliveries required in the peace treaty affected the chemical market seriously.

Report of Berlin Chamber of Commerce

The report of Berlin Chamber of Commerce for 1920 states that the chemical industry and the trade in chemicals, raw materials and auxiliary products suffered in war time greater changes than most branches of industry. Germany was in normal times heavily dependent upon foreign countries in many matters of production and distribution; this field was entirely cut off by the war. A transformation of the whole industry was the only solution. The brilliant achievements of those who had the matter in hand are testified to in the manufacture of explosives and artificial nitrates.

Increase in salaries and in wages of operatives as well as ever-rising costs of coal and raw material resulted, of course, in continuous increases in costs, which were accentuated by the shortage in coal and transportation. The effect was felt all along the line; the selling price was a mere barometer of conditions. No relief may be expected until the rate of exchange and inflated values have been brought back to normal. The demand is good, indeed almost impossible to meet, and yet production cannot possibly be accelerated.

Government Control—Heavy Demand for Many Products

Government control of sulphuric acid and other basic products grew more rigid rather than more lax. The shortage of pyrites made it useless to attempt to meet the demand. The maximum prices were set higher and higher, but production was dependent upon more fundamental things than money.

Hydrochloric acid was released from control in March, 1919. After a few months' production conditions were such that sales could be made even in Scandinavia and Finland, so that business in this line may be said to have been good. There was also a heavy demand for Glauber's salts, a byproduct of hydrochloric; it was impossible to fill the demand in Scandinavia.

Liquid anhydrous ammonia was in great demand. The small production of ammonium carbonate never permitted market prices to be within reason. Raw material for ammonium sulphate was exceedingly scarce, and yet the maximum price was so low that manufacture was unprofitable. Nitrogen prices reached a business-profit level only toward the end of the year. The production of spirits of ammonia was obstructed at intervals, but it became profitable in time.

Potassium prices were raised again and again, but the demand was still so keen that production was worth while. Copper vitriol was in heavy demand, but speculation drove the prices to too high a point. There was also a strong market for citric acid, but the raw

*Prepared by the European Division, Bureau of Foreign and Domestic Commerce.

material could not be obtained in Italy. Wolfram, molybdenum and vanadium could be obtained only in very small quantities.

Trade in Paints and Dyes

The marketing of pigments and dyes was restricted in the early part of the year because of the revolution; later on conditions improved until it was even possible to export some to neutral countries. With the signing of peace, export to France, Belgium and Italy set in until pre-war figures were met, especially in Belgium and Italy. It is very agreeable to note that the French trade also promises to pick up. England is still holding off. America, once a favorite territory, is still closed to us, and it is doubtful whether after peace is ratified our export to that country can be built up again, since the dye industry is making such strides over there. Injuries as to the market in the Orient indicate that that trade is reviving. In general, it may be said that German pigments and dyes will hold their markets abroad.

The supply of coal, soda, sulphuric acid and chrome salts was so low that it was impossible to fill the orders that piled in at the end of the year. Then the 8-hr. day has become a vital obstacle, as it is impossible to put some of the manufactures on such a basis. Double shifts are no solution; overtime is prevented by the attitude of the workers' organizations, even though individuals are in favor of it. Except for these circumstances, we might be able to build up foreign credits as a means of procuring food.

Pigment and Dye Industries Combine

The pigment and dye industries have found it necessary to combine. The German "Bunt- und Mineralfarben Industrie" and the Union of German Dye Industries were formed. These organizations have justified their existence in arranging for allocation of raw materials and the establishing of fixed prices, putting an end to profiteering. Goods for foreign sale were put at a higher price, so as to equalize the low rate of exchange. Prices are now about the same for all consumers. Altogether, the dye industries are in a favorable situation, except for the shortage of coal and raw materials.

The lac and varnish industry had a heavier demand than in 1918, but could not meet this demand, as the 8-hr. day and scarcity of material prevailed almost throughout the year. In December the restrictions on copal, shellac, rosin and turpentine oil were removed; linseed oil is still under control.

Production is still behind the average of former years. Increased production could hardly be hoped for, in the face of the restriction on the importation of benzine. The industry suffered by reason of the allocation of the raw materials to organizations outside of the trade.

Glue, etc.—Drugs and Herbs

The bone-glue production has been about 50 per cent. Foreign glues rose to impossible figures.

Mineral oils and tar products are on a 30 to 40 per cent production basis. There was a ready sale at home. Export was forbidden.

The drug industry suffered excessively under a shortage of materials. Coal was scarce and operatives were in an unsettled state. In the fall a general strike threw the whole trade into disorder. The retail business had been bad enough during the war; last year conditions were hopelessly bad. Small factories were forced to shut down. Even for medicine and science very little was obtainable. Outside interests got such control that profiteering was inevitable. The general public suffered as a consequence.

Medicinal herbs could not be obtained, as the women and children who formerly gathered them were employed in factories at higher pay. Herbs rotted in the fields and woods; prices rose to ten—even fifty—times their former level.

Reports of German Chemical Companies

The Chemische Fabrik Griesheim-Elektron, of Frankfort, declared in 1919 a dividend of 12 per cent, as contrasted with 7 per cent in 1918—and this after setting aside over 4,000,000 marks for depreciation. This company explains the profits as arising from increased value of pre-war stocks. The Chemische Fabriken of Urdingen explain similar profits through the sale of stock held abroad. The Aktien Gesellschaft für Anilinfabrikation ("Agfa"), of Berlin, reports gross profits of 24,877,000 marks in 1919, as compared with 13,700,000 marks in 1918, warranting a dividend of 18 per cent. The Badische Anilin und Sodafabrik closed its works at Ludwigshafen and Oppau in November because of shortage of coal; the nitrogen works at Merseburg shut down because of political disturbances. In all these cases only a fraction of full production was reached by June, 1919, and yet the firms report large profits by reason of the great rise in prices of dyestuffs. Over 60,000,000 marks were written off, and yet the firm declared net profits of nearly 30,000,000 marks, justifying a dividend of 18 per cent.

The Farbwerke, of Höchst-am-Main, report that manufacturing was largely at a standstill during 1919 and early in 1920, only the pharmaceutical departments producing normally. But here, too, export sales enabled the company to declare a 14 per cent dividend, as contrasted with 12 per cent in 1918, on a basis of net profits of nearly 25,000,000 marks, even after deduction of an extra expense of 80,000,000 marks in increased wages. The gross profits of the Chemische Fabrik Rhenania, of Aix-la-Chapelle, advanced from 1,938,000 marks in 1918 to 5,723,000 marks last year. The dividend was increased from 10 to 25 per cent. Kalle & Co., of Biebrich, reported that only a part of the more important departments were operating, and yet, after deductions for depreciation, the dividend was increased from 7 to 14 per cent. The report is pessimistic as to prospects for 1920.

Prices of Fertilizer for Seven Years Compared

Some idea of this general rise in value may be gained from the following comparative table of fertilizer prices (kilo = 2.2046 lb.):

Fertilizers	Price per Kilo, Marks						
	1913	1914	1915	1916	1917	1918	1919
Thomas slag, phosphoric:							
Spring	3 84	3 92	4 56	3 28	5 76	6.33	8.96
Fall	4.00	4 08	4 80	5 76	5.76	6 33	18.72
Kainit, 12 per cent pure potassium:							
Spring	1 20	1 20	1 20	1.88	1.56	2.16	3.12
Fall	1.20	1.20	1.20	1 56	2.16	2 76	4.92
Potash, 40 per cent pure:							
Spring	6 20	6 20	6.20	6.80	8 20	....	16.40
Fall	6.20	6 20	....	8.20	10.20	14.00	26.80
Ground calcium carbonate	80	.80	.80	1.05	1.20	1.80	3.35
Lime	1.85	1.85	1.85	2.40	4.15	5.00	9.50
Ammonium sulphate	14.00	13.50	23 80	29.60	29 60	29.60	78.00
Calcium nitrate, 60 per cent,	9.35	14.00	22.80	28.00	28.00	34.00	68.00
Ammonium superphosphate	.....	.....	.....	.....	15.40	16.70	43.50
Superphosphate, 10 per cent phosphoric	3.83	3.54	4.85	9.75	9.80	17.80	41.00
Rhenania phosphate	.....	.....	.....	6 60	6.60	10.15	27.75

Synopsis of Recent Chemical & Metallurgical Literature

Developing France's Natural Water Power. — France's natural water power, known familiarly as the "houille blanche," continues to provide one of the most fascinating economic topics, now that the coal problem has become so difficult. About a year ago a committee, designated as the Commission des Forces Hydrauliques, was created officially, its duties being to investigate the water forces of France and establish a plan for the development of hydro-electric power plants. This committee recently rendered its report, which, as far as statistics go, is optimistic.

In round figures, the water power in France may be reckoned theoretically at about 9,000,000 hp. Of this amount, 1,165,000 hp. is in use. About 500,000 hp. additional is being equipped. Inside of fifteen years 3,000,000 more hp. should be realized. The rest remains available for eventual development. The 1,165,000 hp. now installed is capable of 850,000 kw. It furnished in 1919 effectively 700,000 hp. (570,000 kw.). The plants in course of construction will provide an additional 550,000 hp. (365,000 kw.).

The region of the southeast of France is the best developed thus far, with 750,000 hp. already installed, and with 290,000 hp. in course of installation. The southwest has 210,000 hp. and will have 75,000 more in a short time. The central section has 140,000 hp. and will have 125,000 more. The eastern district accounts for 25,000 and 10,000.

Existing plans, if realized, are to provide the 3,000,000 hp. additional of the program inside the fifteen years as projected. Of this total, 1,200,000 hp. will be in the southeast, 500,000 in the southwest, 400,000 in the center, 62,000 in the east. According to these figures, France then will stand in third place for water power among leading countries.

The United States is rated as having 30,000,000 hp., Canada 25,000,000, Norway 7,500,000, Sweden 6,750,000, Austria-Hungary 6,450,000, Italy and Spain about 5,500,000 each. Germany's water power is estimated at only 1,500,000 hp., and that of England at about 1,000,000 hp., but these two countries are richly compensated in coal.

Previous to the war the amount of capital invested in France's hydro-electric power plants was about 700,000,000 francs, of which 525,000,000 francs represented motive power and electricity, 100,000,000 francs for electrochemistry and electrometallurgy, and the remainder in traction enterprises. The preceding figures apply only to the important exploitations, and, as many smaller industries also are utilizing water power, it is safe to add at least 300,000,000 francs more to the total, so that about a billion francs is the figure for the global investment in the "houille blanche" in France at present. Or, if account is taken of the expenditures necessitated by the 500,000 hp. placed in operation during the war, the total investment is considerably more.

During this post-war period of high prices for material of all kinds, it is found that the cost prices for installations, which before the war varied between 500 and 800 francs per horsepower, have risen to a figure between 1,000 and 1,600 francs. It is computed that, for putting into operation 3,000,000 hp., the expense must be calculated at three or four billion francs.

The official report suggests that, in the forming of concessionary companies, the government could participate as stockholder and thus be a party to profit or loss. The opinion is given that new companies should be exempted from taxes during the first five years.

The importance of the question of developing France's water power resources is shown in the simple equation: 8 millions of horsepower are equivalent to 40 million tons of coal.—*The Review*, Am. Chamber of Commerce, France, Sept. 1, 1920.

Influence of Manganese Content on the Life of Steel Ingot Molds.—Steel works and foundries commonly employ for casting of ingot molds an iron analyzing:

	Per Cent
Silicon	1.75 to 2.0
Manganese	0.4 to 0.6
Phosphorus, less than	0.15
Sulphur, less than	0.10
Carbon	3.5 to 4.0

Manganese was limited to 0.6 per cent in the belief that with a higher percentage the molds would crack after a very limited number of pourings.

Tests made by M. GROSCLAUDE (*Génie Civil*, Sept. 4, 1920, pp. 198, 199), covering a period of many years,

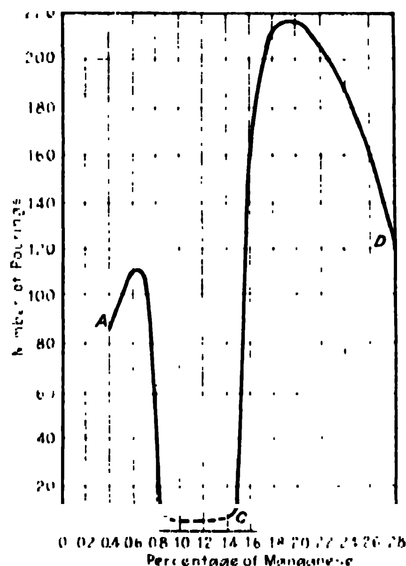


DIAGRAM SHOWING THE RELATION BETWEEN LIFE AND MANGANESE CONTENT IN INGOT MOLDS

have proved that an increase of manganese on the contrary lengthens the life of the molds. Thus, with ingot molds of the above composition the maximum number of pourings was 110, whereas as many as 250 were made with molds of the following composition:

	Per Cent
Silicon	1.5 to 1.8
Manganese	1.75 to 2.25
Phosphorus, less than	0.10
Sulphur, less than	0.05
Carbon	3.25 to 3.50

The average obtained with molds of this composition during two consecutive years was 175 pourings, with a minimum of 125.

The results of the tests are plotted in the accompanying figure, by which it is seen that the manganese content has a great influence on the life of the mold. No tests have been made with analyses between the points *B* and *C*.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Flameless Powder.—OSWALD SILBERRAD of Buckhurst Hill, England, has made a study of the conditions necessary for the production of propellant explosives which shall be flameless and smokeless when fired in guns of a specified size. An increase in the ratio of H-C-OH groups to NO_2 groups has been found to give the desired result. By the application of thermodynamics and internal ballistics it is possible to calculate the amount of carbohydrate material (preferably starch) which must be added to an ordinary propellant explosive in order to reduce the temperature of the gases emitted from the muzzle below the ignition point. The amount of starch to be added to 100 parts of propellant varies from 7 parts in the case of American pyrocollodion to 33 parts for Italian ballistite. Tables are given to facilitate calculations and proper methods of incorporating the starch are also discussed. (1,349,983; Aug. 17, 1920.)

Electrolytic Chlorate Cell.—The cathode of this cell consists of a shell or casing of metal such as cast iron. Interior partitions terminating below the rim of the casing divide the cell into several compartments. These partitions are connected with the casing so that they also serve as cathodes. A carbon anode is placed in each compartment and kept at a fixed short distance from the cathode by means of slate insulators. A porous asbestos cloth covers the cathode surface so that the hydrogen liberated is enabled to escape to the atmosphere without exerting any reducing influence on the electrolyte. An insulating plate of glass is placed in the bottom of each compartment to prevent short-circuiting due to the accumulation of conductive sediment. It is well known that in a cell of this type anode consumption is high when carbon is used as anode material. By making the compartments of different sizes, EDWARD A. ALLEN of Portland, Me., is able to use efficiently anodes which have been reduced in size by oxidation. Thus, the first compartment may be designed to take anodes 2 in. thick, the second 1½ in. and the third 1 in. Provision is also made for change in width of the anodes. (1,351,886; Sept. 7, 1920.)

Electrolytic Detinning Process.—The apparatus comprises a fixed vat for the electrolyte and a rotating hexagonal drum which is divided into longitudinal compartments by cathode plates projecting internally. The scrap which serves as anode material is placed in a removable permeable lining in each compartment. Insulators prevent contact between cathode and anode. (1,353,194, CECIL M. WALTER of Four Oaks, near Birmingham, England; Sept. 21, 1920.)

Ferrochromium.—Ferrochromium was formerly made to some extent in the iron blast furnace, but it was found that the limiting percentage of chromium which could be introduced into the alloy in the blast furnace was about 30 per cent. The most desirable commercial alloy contains about 60 per cent chromium. The late JOSEPH E. JOHNSON, Jr., found that by enriching the blast with oxygen the temperature in the hearth could be raised sufficiently to produce alloys high in chromium and low in both carbon and silicon. A blast containing 40 to 50 per cent oxygen is suitable for this purpose. (1,354,491; Oct. 5, 1920.)

Magnesium Powder.—At the present time, the method used in manufacturing magnesium powder is to cast the magnesium into bars or ingots, which are reduced to powder by sawing, turning or milling. The cuttings produced are classified by screening, those too large for use being ground in some form of mill to reduce them to the proper size. This method requires a large and costly plant, and a very considerable outlay for labor to attend the large number of machines. The process is very slow and tedious, owing both to its nature and to the constant necessity of starting new cuts, replacing pieces of metal which are too short to be further treated, and re-casting the remnants into suitable shape. The large number of machines in motion and the difficulty of collecting the fine powder makes the plant an extremely dangerous one, as friction may at any time ignite the fine powder. Another of the disadvantages of this method is the difficulty of melting magnesium without considerable loss, so that the constant melting and re-melting of the metal to utilize the stubs of bars multiplies this loss. The product resulting from this method is far from satisfactory. Even after careful screening, the grains are not of uniform size, owing to their very irregular shape. When examined microscopically, the grains are found to be in the form of chips or shavings presenting knife edges which cause the grains to cling together, and also present a large amount of surface for oxidation. These characteristics of the powder render it unstable and difficult to deal with in certain applications. DAVID F. NICOL of Montreal, Canada, has found that powdered magnesium can be more conveniently prepared in the following manner: Magnesium is melted under a flux of lithium chloride in a closed vessel. The molten metal is discharged in a fine stream into a jet of nitrogen having sufficient velocity to break up the stream of metal into fine particles. The metal is chilled so rapidly by the cold nitrogen that practically no nitride is formed. (1,351,865; assigned to Shawinigan Electro-Metals Co.; Sept. 7, 1920.)

Bismuth Oxide.—Bismuth is a difficult metal to oxidize to produce lower oxides cheaply. By heating to fusion with an oxidizing agent such as sodium nitrate in the presence of chlorine, bismuth is rapidly converted into the yellow oxide Bi_2O_3. (1,354,806; ELTON R. DARLING of Montclair, N. J., assignor to Ellis-Foster Co.; Oct. 5, 1920.)

Aluminum Chloride.—In the manufacture of anhydrous aluminum chloride by the process of reducing bauxite or alumina in the presence of chlorine, it is necessary to supply heat to the mass to cause the reaction to proceed properly. Various expedients have been proposed but have not met with commercial success. FRANCIS C. FRARY of Oakmont, Pa., suggests the addition of aluminum to the mixture. The reaction between aluminum and chlorine is sufficiently exothermic to maintain the whole mass at the proper temperature. Aluminum dross containing about 40 per cent metallic aluminum forms an excellent raw material for this process. (1,354,818; assigned to Aluminum Co. of America; Oct. 5, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Rendering Non-Plastic Materials Plastic.—Small quantities of neutral or alkaline vegetable extracts are added with alkalis to clay or kaolin masses or non-plastic materials which are liquefied with difficulty by the addition of alkali alone. Neutral, water-soluble saponines or extracts of saponine-bearing plants such as seatwort, cookweed, sowbreads, ivy, chestnut-capsules are especially suitable. Alkaline cellulose-waste lyes and "cellular pitch" can also be used. (Br. Pat. 144,317—1919. A. WALTER, Frankfurt-on-Main, Germany, Aug. 5, 1920.)

Dyes From Natural Products.—Water-soluble dye preparations are obtained from animal or vegetable dye-yielding matters by extracting the raw material with organic solvents, evaporating the extract to a sirup or paste and fusing the product with a water-soluble metallic salt or solid organic acid. The same parent material may be extracted successively with more than one organic solvent, or first with organic solvent and then with water, to obtain different extracts for treatment. According to examples there are obtained a bluish-red dye for wool or silk by fusing an alcohol extract of cudbear with alum; a scarlet wool dye by fusing a pyridine extract of cochineal with cream of tartar; a reddish-mauve wool dye by fusing the same extract with alum; a blue wool dye by fusing an alcohol extract of turmeric with potassium ferricyanide; a navy-blue dye for wool or silk by fusing an alcohol extract of logwood with copper sulphate; a yellow or yellowish-red wool dye by fusing an alcohol extract of madder with alum; purple silk dyes by fusing an acetone or pyridine extract of madder with alum. Other specified materials are: As raw materials, Brazil wood or sanderswood; as solvent, amyl acetate; as fusion reagents, aluminum or ferric acetate, stannous chloride, potassium bichromate, or tartaric, citric, or oxalic acid. (Br. Pat. 144,336—1919. A. M. HART, London, Aug. 5, 1920.)

Removal of Cyanogen Compounds From Coal Gas.—Cyanogen compounds are removed from coal gas as calcium ferrocyanide by treating the gas in a lime purifier to remove sulphuretted hydrogen and carbonic acid, and then treating in the same purifier with slaked lime impregnated with a solution of salt of iron such as ferrous sulphate. The ferrous sulphate may be added to the lime in a tier of the lime purifier near the exit, and when the purifier is spent, the material from this tier is leached, or agitated with a dilute alkali to obtain alkali ferrocyanide. (Br. Pat. 144,398—1919. J. J. HOOD, London, Aug. 5, 1920.)

Separating Suspended Particles From Gases.—In the electrical separation of particles suspended in gases, the parasitic charges carried by freely moving nuclei, for instance nitrogen molecules, the formation of which lowers the efficiency of the precipitation process, are caused to deposit on sluggish particles in fine division and incorporated in the gases; these latter particles, which may be water, oil, etc., may be formed by condensation during the passage of the gas current, and may be either an addition to the gases or an original constituent. In the former case, the material may be added either in the liquid or vapor phases before the gases reach the dust-depositing chamber or in this chamber; and it may be introduced as a spray or may be taken up by the gases in their passage through evaporating vessels or over moistened absorbent bodies. (Br. Pat. 144,701—1919. METALLBANK UND METALLURGISCHE GES., Frankfurt-on-Main, and J. E. LILIENFELD, Leipzig, Aug. 11, 1920.)

Welding Metal Sheets.—In a method of welding thin sheets or foils of aluminum or aluminum alloys—e.g., 0.005 to 0.100 mm. in thickness—to sheets of iron or of other metals having a melting point above that of aluminum, the surfaces of the foils and sheets are separately provided with an extremely fine roughening or matt before being placed together for welding. The consequent annealing of the iron which is necessary when ordinary aluminum sheets are welded to iron plates and then cold-rolled into sheets is thus avoided, and the melting or loosening of the aluminum prevented. The roughening may be produced by cold-rolling of the sheets and foils in separate packs. The iron sheets may also be roughened by brushes or by sand blasting, etching, etc. The sheets and foils are then separately annealed and are then placed together in an airtight manner with roughened surfaces inward. They are then heated to about 600 deg. C. and welded by passing through rolls, the pressure being such as to stretch the foil as much as possible, but to stretch the sheets only slightly. The composite sheets are then heated to 500 deg. C. to anneal the foil. (Br. Pat. 144,706—1919. METALLINDUSTRIE SCHIELE & BRUCHSALER, Baden, Germany, Aug. 11, 1920.)

Hydrogen.—In the iron-steam process of making hydrogen the waste gases of reduction which have been fully spent in passing through a retort or bench of retorts but which still contain reducing gases are treated for the removal of steam and some water vapor, carbon dioxide and sulphur dioxide and other sulphur compounds, and then passed to another retort or bench for effecting reduction of the charge therein; the waste gases may be passed into the furnace setting or discharged into the atmosphere. The process may be carried out with three sets of retorts or benches; while the first set is making hydrogen, the second set is receiving water-gas completely to reduce the charge therein, and the spent gases are treated as above described and passed to the third set; at the next stage, the second set is making hydrogen, the reduction of the charge of the third set is completed by water-gas, and the spent gases are after purification passed to the first set; and so on. To purify the spent gases, they are first passed through a scrubber packed with marble, coke, etc., and down which water trickles and removes the sulphur compounds, then passed through water or potash solution to remove carbon dioxide, and finally through a tubular condenser to remove steam and water vapor; or after passage through the first scrubber, the gases may be passed through a condenser, and afterward through a purifier charged with lime to remove sulphur dioxide. (Br. Pat. 144,751—1919. BRITISH OXYGEN CO., Westminster; S. W. BRAY, Ilford, and I. H. BALFOUR, Buckhurst Hill, Aug. 11, 1920.)

Decolorizing Glycerine.—In processes in which glycerine is recovered from solutions containing sulphuric acid by the addition of barium carbonate and oxalic acid, the glycerine is decolorized by adding the oxalic acid, preferably in the form of powder, before the addition of barium carbonate, and preferably in quantity above that necessary to precipitate the barium salts formed. (Br. Pat. 144,727—1919. ELEKTRO-OSMOSE AKT. GES., Berlin, Aug. 11, 1920.)

Current Events
in the Chemical and Metallurgical Industries

New York Section Meeting, A.C.S.

On Friday evening, Oct. 22, the New York Section of the American Chemical Society was addressed by President W. A. Noyes on "The Foundation for Chemical Development." Dr. Noyes compared the national censuses of chemists, which, at the opening of the war, gave Germany 30,000, the United States 16,000, England 5,000 and France 2,500. One hundred years ago, Liebig went to France to study chemistry under Professor Gay-Lussac. Upon his return to Germany he started the system of university research which led to the subsequent advance of his native land to the front in industrial chemical development.

Dr. Noyes traced the work of Hofmann, and its influence on synthetic dyestuff manufacture after the pioneer work of Perkins. He then took up the thread of American progress and cited the case of Dr. Willis R. Whitney, who taught at Boston Tech on Mondays, Wednesdays and Fridays, did research work for the General Electric Co. at Schenectady on the alternate days and spent his evenings on Pullmans. The efforts of Dr. Whitney have resulted in establishing a research organization ranking among the best in the world. To carry on such work, industries must have men of the highest technical and mental training and to supply these, the universities must have their co-operation.

In the absence of Dr. Harrison E. Howe, Dr. H. A. Bumstead, director of the Sloane Laboratory of Physics at Yale University and chairman of the National Research Council, spoke on the relation of the National Research Council to chemical development. He placed particular emphasis upon the revised tables of physical and chemical constants. From $150,000 to $200,000 will be required for the completion of these tables. Substantial amounts have already been pledged by a number of industries. The speaker closed with a reference to the opportunities afforded by the fellowships in physics and chemistry made possible through a fund established by the Rockefeller Foundation.

Meeting of Engineering Council in Chicago

The regular meeting of Engineering Council was held on Oct. 21 in Chicago, with J. Parke Channing in the chair. Resolutions were passed supporting several measures, chief of which were the model license law for engineers, the Nolan Patent Office bill (H.R. 11,984) proposing an increase in the personnel and salaries of the U. S. Patent Office, and the creation of a Department of Public Works.

M. O. Leighton, national service representative, opened the discussion on the bill for a national Department of Public Works by indicating the lack of interest on the part of the many societies and individuals in the promotion of this measure. While the Council was aware of the futility of any sustained support due to its own early termination, it authorized the promulgation of a letter to the societies calling for renewed enthusiasm. A bill of some kind will doubtless be passed at the next session of Congress, but if the civilian engineers do not act quickly control will rest with the U. S. Corps of Army Engineers.

The model license law was adopted essentially in the form considered by the Council for the past year. It is in form for universal adoption by all states to permit bona fide engineers and architects to operate in any state without the present handicap due to the varying laws now in effect in several.

The names to be suggested to President Wilson as suitable candidates for members of the U. S. Shipping Board are those of Prof. H. E. Riggs, University of Michigan, Ann Arbor, and W. H. Adams, consulting engineer, Detroit, Mich.

The Council authorized support of a measure to secure adequate appropriations for the Federal Power Commission. Decision of the Controller of the Treasury has held the $100,000 previously appropriated as unavailable. Money is needed especially for research work at the Bureau of Standards.

E. J. Prindle, chairman of the committee handling legislation increasing the number and pay of the Patent Office employees, reported the bill, H.R. 11,984, had passed the House at the last session, but was amended in the Senate committee by Mr. Smoot so as to reduce the force and pay. The Council passed one resolution calling on the Senate for a restoration of the bill to its original status and another calling on engineers for support similar to that originally rendered—i.e., by individual letters acquainting Representatives and Senators with the urgency for passing the measure without revision.

The next meeting of Engineering Council will be held in Washington, D. C., Dec. 16.

Marine Exposition, Chicago

The National Marine Show was held in the Coliseum, Chicago, Oct. 18 to 23. Among other exhibitors were the General Electric Co., the Crane Co., the American Steel Foundries Co., John A. Roebling Sons, Ferguson & Lange Foundry Co., the Valentine Varnish Co., the Lunkenheimer Co., the American Chain Co. and Fairbanks, Morse & Co.

While this exposition does not hold such direct interest as the Chemical Exposition for the men of the profession, nevertheless many manufacturers of chemical plants and from the chemically-controlled industries were interested from the point of view of problems involved in the export business. One of the notable features was a large relief map of the world showing all the trade routes and location of all steamship lines. The purpose of the exposition was to arouse interest in the constantly increasing importance of America's merchant sea power and the relation to its maintenance and national prosperity and the wealth and magnitude of lake and inland water shipping, to the end that this part of the nation's transportation may receive the serious consideration of all branches of industry.

Philadelphia Section Meeting, A.C.S.

The regular monthly meeting of the Philadelphia Section of the American Chemical Society was held Thursday evening, Oct. 21, at the Engineers' Club. The testimonial dinner in honor of Prof. W. A. Noyes, president of the American Chemical Society, was attended by forty members.

In his address, "The Foundation for Chemical Development," Professor Noyes reviewed scientific progress in chemistry in order to show that there is a tendency at the present time to get away from the old spirit of scientific research in the pursuit of more material things. He felt that through careful study and application of the principles underlying the classic researches, American chemists should stand supreme among the chemists of the world.

At the conclusion of Dr. Noyes' address, Dr. Pearson, chairman of the Section, called upon Dr. E. F. Smith, who for so many years was professor of chemistry and provost of the University of Pennsylvania, for discussion. Other speakers called upon were: Dr. H. F. Keller, of the Germantown High School; Prof. W. T. Taggart, newly appointed Blanchard professor of chemistry of the University of Pennsylvania; Dr. Abraham Henwood, of the Drexel Institute; Prof. O. L. Shinn, of the University of Pennsylvania; Prof. E. C. Bertolet, of the Philadelphia Textile School.

New Sugar Plant at Mt. Pleasant, Mich.

The Columbia Sugar Co. is building and expects to have in operation in a short time a 1,000-ton plant, designed by Harry A. Vallez, general superintendent of the company. Steel and concrete construction will be used in the main 255 x 70-ft. building as well as in the warehouses, limekiln, boiler plant and pulp house. The plant will be equipped throughout with electric power. Each unit is designed with an individual motor drive so that any unit can be out at any time without interfering with the operation of the others.

Two 1,000-kw. Allis-Chalmers turbines each capable of running the plant alone will be installed so that one may always be kept as a spare for emergency. Mr. Vallez will install two diffusion batteries of eight cells each of 212 cu.ft. capacity each. A rake type cossette conveyor instead of a belt will feed them. There will be two 11-ft. coil pans, one calandria, and quadruple effect evaporators. Twelve rotary filters, six of which will be used for the first carbonization, three for the second and three for the thick juice filtrate, are to be installed.

The pulp-drying house will be equipped with the Burman improved double-shell drier, with specially designed distributing plates so arranged that when the pulp first enters the drum it is broken up in such a way that none of it is burned. The result is a pulp of unusual whiteness. The furnaces of these driers are equipped with the new Jones Automatic Cleaning Stokers.

Beets will reach the factory in standard-gage railroad cars hauled by a motor-driven car pulley into a rotary car dumper capable of handling any size or type of car up to 60 ft. in length. The dumper clamps the cars, turns them over, empties and rights them in about three minutes.

From the dump the beets fall into a long hopper fitted with duplex feeders so arranged as to carry them to one central point to an inclined conveyor, which in turn delivers them to the main belt over the storage bins. This belt passes through a tripper device mounted on a traveling bridge and so arranged that the beets are diverted into a reversible shuttle belt also mounted on the bridge. This belt will deliver them to any point on either side of the main belt up to the outer limit of the sheds, a spread of 125 feet.

Meeting of Sub-Committee on Standardization of Petroleum Specifications

An open meeting of the technical sub-committee on Standardization of Petroleum Specifications was held in the auditorium of the Interior Department building, Washington, D. C., Oct. 18, to discuss possible revisions in the Government specifications on gasoline, kerosene, fuel and lubricating oils. The meeting was called to order by Dr. G. W. Gray, chairman of the sub-committee, and the delegates were welcomed by Dr. F. G. Cottrell, Director of the Bureau of Mines, under whose auspices the meeting was held. Representatives of several of the Government departments and petroleum technical societies, a number of state oil inspectors and some of the leading oil refining and marketing companies and automobile manufacturers were present. The petroleum societies were represented by the American Petroleum Institute, National Petroleum Association, Western Oil Refiners Association and the Society of Automotive Engineers.

There proved to be very little criticism of the lubricant specifications, but the refiners were almost unanimous in asking that the 90 per cent point of the gasoline specification be raised a little. The use of the New Saybolt Fuel Oil Viscosimeter was advocated by the refiners, to test the fuel oils used by the Army, the Navy and the Shipping Board, to replace the specific gravity determination required at the present time.

On Oct. 19 the sub-committee met to consider these and other points in connection with the Federal specifications for petroleum products. All the present specifications were taken up at this meeting, including those for gasoline, kerosene, fuel and lubricating oils and greases, which have been published in Bulletins 1, 2, 3 and 4 of the committee, and the possibility of further specifications for other products was also considered. After two days' closed session the sub-committee adjourned on Oct. 20, with the announcement that a report would shortly be prepared for submission to the Presidential committee and that it was probable that this would take the form of a complete and revised code of specifications for all petroleum products which will supersede the four bulletins mentioned above.

Making Films of Industry

Due to the success which has followed the showing of the Bureau of Mines films portraying the development of the coal and oil industries, numerous applications have been received to make pictures of other industries. These films are made under a co-operative agreement by which the industry furnishes the funds and the Bureau of Mines supervises the making of the picture. "The Story of Asbestos" is just being completed. "The Story of Sulphur" is in process of production. Work soon will start on a film showing the best types of insulation and how it may be used to prevent loss of heat.

Improvements at the Factories of the American Window Glass Co.

Although hampered by shortage of labor and supplies, particularly coal, and lack of transportation facilities, the American Window Glass Co., in addition to its specialties, produced 2,636,101 50-ft. boxes of common window glass during the last fiscal year.

In spite of the difficulties encountered during the past this company, with an eye to the future, has made many changes and improvements at its various plants.

In its No. 1 factory at Arnold City, Pa., it was found necessary, in order to take care of its increased output, to build a second story cutting room. As the old batch plant was entirely inadequate, the company has let a contract for a new one which will handle the requirements of the plant with a fraction of the number of men now employed. Arrangements have been made to install conveyors in the No. 2 tank building, which has been shut down for repairs after an operation of three years and ten months. This installation will mean a saving of a large amount of labor in the daily operation of the machines and furnaces. Equipment for use of producer gas is also being installed.

A new tank is being built at the No. 2 factory at Jeannette, Pa., and conveyors for the cellar glass and back ladle skins are being installed. Extension to the cutting room and construction of a number of additional flattening ovens is under way.

Improvements at the No. 2 factory at Hartford City, Ind., consist of a new tank building and furnace which will be an exact duplicate of that at Factory 2.

In Monongahela factory No. 14, a producer plant and power house have been erected and installations of the producer gas flues to the flattening ovens have been made.

Fort Worth Acid Works Plant

The Fort Worth Acid Works, Fort Worth, Tex., is putting into operation a standard recovery plant for sludge acids. This plant is built along the lines of standard design used for a period of years by the Standard Oil Co., and Sinclair Refining and other large oil producers. The large number of successful independent refineries in the territory will supply ample sludge acids for this plant. These refineries have hitherto been experiencing great difficulty and considerable expense with respect to disposition of sludge and welcome the outlet this recovery plant affords.

The unique feature of design of the process consists in using the waste heat from the acid stills through the evaporating pans in place of the old-type direct-fired pans. This effects a large saving in fuel and eliminates one very heavy maintenance expense, since direct-fire pans are notably short-lived and expensive of upkeep. Both the raw and finished material are loaded into tank cars, compressed air being employed throughout the plant.

Failed to Appoint C.W.S. Officers

No authority has been given as yet for the appointment of Corps or Division Gas Warfare officers. A tentative table of the new Army organization does not include the Chemical Warfare Service. There is some speculation as to whether this indicates that the Chemical Warfare Service will have to continue its fight for recognition despite the fact that the Army reorganization act sets it up as a permanent part of the Army.

The Failure of Metals Under Internal or Prolonged Stress

The Faraday Society, Institution of Mechanical Engineers, the Institute of Metals, and probably also the Iron and Steel Institute contemplate holding, early in 1921, a joint general discussion on "The Failure of Metals Under Internal or Prolonged Stress," according to *Engineering* (London). While various aspects of the subject have already been discussed, some new matter will be placed at the disposal of the co-operating societies later in the year, and it is thought that this will afford an opportunity for a more comprehensive consideration of the subject than has yet been given to it. The problem to be discussed is the failure of metal articles as a result either of external stresses to which they have been exposed for any length of time, or of internal stresses arising from conditions of manufacture, such as cold work, unequal expansion or contraction during casting and subsequent operations, including rapid heating and cooling. It is intended that the subject of the discussion should include the phenomena known as "season cracking," "corrosion cracking," "fire cracking" and analagous forms of failure, and that iron and steel as well as non-ferrous metals should be dealt with. The scope of the discussion would permit of contributions relating to the properties and behavior of materials other than metals which might throw light on the phenomena covered by the title.

While invitations have been sent out to certain men to contribute, this by no means is intended to exclude participation on the part of anyone having new information on some aspect of this broad subject. Correspondence along these lines is therefore invited by the secretary of the joint committee, F. S. Spiers, 10, Essex St., London, W. C. 2.

Packing of Dyes, in Powder Form, for Dispatch to Foreign Countries

The following regulations have been issued by the United States Post Office Department regarding the packing of dyes, in powder form, for shipment to foreign countries:

> Dyes, in powder form, must not be accepted for transmission in the parcel-post mails to those foreign countries admitting dyes in the parcel-post mails, except the dyes are packed in a tin or metal container and such container inclosed in a substanial outside cover, open to inspection, of fiber board or similar material, double-faced corrugated cardboard, or strapped wooden boxes made of material at least a half inch thick.
>
> The inside tin or metal container must be one closed with a screw-top cover having sufficient screw threads to require at least one and one-half complete turns before the cover will come off, the cover of which must be provided with a washer, so as to prevent possible sifting of the contents.
>
> This provision for the employment of screw-top tin or metal containers does not prevent the use of compression (friction) tin top or metal containers, if soldered in at least four places, or the use of lead-sealed tin or metal containers, provided the containers are labeled in printing so as to show the nature of the contents, the quantity, and the name of the manufacturer or dealer, and, in addition, the containers are inclosed in substantial outside covers, open to inspection, of fiber board or similar material, double-faced corrugated cardboard, or strapped wooden boxes made of material at least a half inch thick.
>
> Acceptable packages of samples of dyes, in powder form, not exceeding 12 oz. in weight, and packed in accordance with the requirements of the Postal Union regulations, will likewise be received for transmission in the international parcel-post service, when postage is paid at the rate of 12c. a lb. or fraction thereof.

British Gray and Malleable Cast Iron Industries Form Research Association

A meeting was held in Birmingham, England, on Sept. 30 in connection with the proposal to form a British Research Association for the gray and malleable cast iron industries. Representatives of the industries concerned gathered from various parts of Great Britain. The chair was taken by M. Riddell, president of the Institution of British Foundrymen. Sir Frank Heath, K.C.B., of the Government Department for Scientific and Industrial Research, gave an address in which he outlined the terms upon which the government would assist the scheme. The main features of the plan are that firms in the industry which join the association shall each guarantee a minimum annual subscription for five years: then, with a definite minimum income guaranteed, the government will assist the association with grants of money pound for pound, but at the end of the 5-yr. period will gradually diminish its contribution as the scheme becomes self-supporting. The government will require certain conditions to be fulfilled, and urged, without making it an absolute condition, that labor should be represented on the council of the association

Sir Frank described each firm's subscription to the scheme as an insurance premium against the evil effects of ignorance. Dr. Leslie Aitchison (Birmingham) moved and F. J. Cook (Birmingham) seconded a resolution to the effect that "A Research Association for Gray and Malleable Cast Iron be formed." W. R. Barclay (Birmingham) and B. Collitt (Lincoln) spoke in support of the resolution, which was passed unanimously. A provisional council was then elected to proceed with the formation of the association.

During the meeting several of the speakers referred to the success of the researches carried out on behalf of the American Malleable Castings Association, and one of them made a strong plea for the abandonment of the present system of grading pig iron by fracture, and for the adoption of grading by analysis.

Canada Amends Denatured-Alcohol Regulations

A change in the regulations governing the denaturing of alcohol for industrial purposes has been made by the Canadian Government, with a view of making industrial alcohol available to the arts and industries at a more reasonable price than at present. Circulars are being sent out by the Canadian Department of Inland Revenue authorizing the manufacture and sale without restriction of a new grade to be known as Grade 2 benzol. The denaturants used in this are benzol, nitrobenzol, and pine oil, and the cost of these denaturants will be very small as compared with the cost of methanol, which was formerly the only denaturant allowed to be used. The cost of the denaturant, it is stated, is responsible for the high cost of industrial alcohol, and therefore a committee of three members of the Department of Inland Revenue, with two from the research council, held several meetings to decide on the form of a new and cheaper denaturant to be allowed.

While nine distilleries have been licensed for the manufacture of industrial alcohol, it is stated that only two have yet begun the work. The operation of prohibition in Canada had reduced the output of the distilleries to a great extent, and some of these had closed down entirely. As a result, there is a great shortage of alcohol for industrial purposes.

Glasgow to Make Chemicals From Gas Residuals

The Chemical Works Department of Glasgow Corporation, which was instituted about eighteen months ago as an adjunct of its gas department for the purpose of manufacturing chemicals from the gas residuals, will, it is expected, help to reduce the cost of gas to consumers, reports Consul G. E. Chamberlin of Glasgow, Scotland. It was the custom until about a year ago for the corporation to dispose of the residuals to private firms, from which it received a sum for the use of the buildings and equipment and a certain amount for the materials. When the chemical department was formed experiments were carried out which resulted so favorably that the municipality decided to terminate the contracts with the private firms and to undertake the whole of the work itself.

It is proposed to center the refining processes at the Provan works and to carry on crude distillation at the three other gas works and to increase the existing plant considerably. Refining will commence at once. The principal chemicals to be manufactured are motor benzene, pure benzene, toluene, solvent and heavy naphthas, and carbolic acid. The department will also consider the advisability of making dyes and intermediates. From the new installation about 100 tons more of tar will be made per day. The revenue last year from tar and ammoniacal liquor was $1,491,950, and a conservative estimate places the net revenue from these sources for the current year at $1,946,600.

Believes Gas Warfare Will Be Developed

Efforts to rule out the use of military gases by treaty are not likely to be successful, in the opinion of General A. A. Fries. Gas warfare gives a very great advantage to the intellectual and more highly developed peoples, General Fries points out. As a nation develops intellectually there is a tendency to lose in brawn. The development of chemical warfare has put in the hands of the more highly developed nations, General Fries says, a weapon which would render them absolutely safe from successful attack from any invader who might happen to have more brawn. Gases, he says, form the ideal weapon of the highly civilized man. When gunpowder was introduced in warfare, says General Fries, similar protests were made against its use.

General Fries also points out that since the gases used in chemical warfare are also widely used in industries, there could be no agreement to stop their manufacture.

Looking for Chief Chemist for Edgewood Arsenal

Despite intensive efforts on the part of General A. A. Fries, head of the Chemical Warfare Service, to secure a chief chemist to direct the chemical research work at Edgewood Arsenal, his quest has been unsuccessful. Men with the requisite experience receive better salaries and have other advantages which the Government cannot offer. General Fries is hopeful, however, of finding someone who is in a position to make the necessary sacrifice to take the position.

Nitrate of Soda Movement

Of the 148,338 tons of nitrate of soda which moved through the Panama Canal during August all but 46,000 tons was destined to American ports. The remainder went to the European ports.

A Home for the National Academy of Sciences and the National Research Council

A site for the new building in Washington which is to serve as a home for the National Academy of Sciences and the National Research Council has recently been obtained. It comprises the entire block bounded by B and C Sts. and Twenty-first and Twenty-second Sts., N. W., and faces the Lincoln Memorial in Potomac Park. The Academy and Council have been enabled to obtain this site, costing about $200,000, through the generosity of friends and supporters. Funds for the erection of the building have been provided by the Carnegie Corporation of New York.

Bureau of Mines Succession

Since there is such difference of opinion as to which industry should be represented by the chief of the Bureau of Mines, the suggestion is now made that Dr. F. G. Cottrell, the incumbent, may withhold his proposed resignation and continue in the position of director.

Personal

J. J. ARNSFIELD, advertising manager of Fairbanks, Morse & Co., was elected president of the Engineering Advertisers' Association of Chicago, to fill the vacancy made by the resignation of A. H. Hopkins.

Dr. W. D. BANCROFT, professor of physical chemistry, Cornell University, Ithaca, N. Y., has been engaged by the Norton Co., Worcester, Mass., in a consulting capacity, in connection with its research laboratories.

HOWARD E. BATSFORD is now associated with the newly incorporated American Electric Graphite Mfg. Co., Toronto, Ohio, in the capacity of technical director.

GEORGE GRANGER BROWN is now a member of the staff of the department of chemical engineering, University of Michigan. He was formerly production manager of the Union Special Machine Co.

GEORGE F. DOWNS, president of the Lackawanna Steel Co., Buffalo, N. Y., has been elected a director of the American Iron and Steel Institute, to fill the vacancy caused by the death of Charles H. McCullough, Jr.

ANDREW M. FAIRLIE, sulphuric acid engineer of Atlanta, Ga., has been retained by the Baugh Chemical Co. as consultant in connection with the maintenance and economical operation of its sulphuric acid plants at Baltimore.

WILLIAM A. HAMOR, of the Mellon Institute of Industrial Research of the University of Pittsburgh, has been appointed a member of the National Research Council in the Division of Research Extension.

PAUL E. HOOD has recently taken charge of the experimental department of the Chicago factory of the Marden, Orth & Hastings Corporation.

C. O. JOHNS, who has been for a number of years chief of the color laboratory of the Bureau of Chemistry, has resigned to become director of research of the Standard Oil Co. of New Jersey. Dr. Johns will take up work at his new position about Nov. 15. His work on fundamental problems of the oil industry will probably be conducted at the main plant of the company, near Newark.

R. G. RICH, of the Quigley Furnace Specialties Co., has been appointed assistant manager of the Pittsburgh office, Oliver Bldg.

THEODORE J. SCHAUB has resigned his position as assistant general sales agent of the Crucible Steel Co. of America, to take the position of general sales manager of the Union Electric Steel Co., Carnegie, Pa.

Dr. CHARLES P. STEINMETZ addressed the joint meeting of the American Institute of Electrical Engineers, the Western Society of Engineers and the Chicago Chemists' Club in Chicago, Oct. 20, on the subject "Origin and Energy of the Lightning Flash."

LELAND R. VAN WERT is now with the Harvard Engineering School, Cambridge, Mass., as instructor during the first semester. Two courses in non-ferrous metallurgy will be given.

HILLER ZOBEL has come East from Death Valley, Cal., to engage in industrial chemical engineering research for the Pacific Coast Borax Co., Bayonne, N. J.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Oct. 29, 1920.

The remaking of the iron and steel market is now in full progress. The developments, while apparently mixed in character, are those naturally indicated by the conditions that have preceded. The usual and familiar course of the iron and steel market is being followed except as the peculiar circumstances of the past ten months or thereabout make departures from the normal course natural and necessary.

The chief divergence of the market from a normal course was that prices of the independent steel producers rose far above those maintained by the United States Steel Corporation, and by different amounts at that. Thus there were not simply two markets, there was an indefinite number of markets. If there had been a uniform rise on the part of all producers the liquidation would be uniform. Instead, we have it that nearly all the independent steel producers have curtailed production, while the Steel Corporation's operations continue at the maximum permitted by physical conditions. More than that, there is curtailment common to independents whose position varies. Some, that pursued relatively moderate policies in making prices, have large quantities of business on books, but on account of cancellations and suspensions and postponements of deliveries are unable to predicate a full operation on their order books. These independents are not cutting their prices for the purpose of securing additional business, for to do so would be to jeopardize the contract business they already have. Other independents, with lean order books because they were doing chiefly a prompt business at the particularly high prices prompt deliveries made possible, are cutting their prices, but still do not secure enough orders to operate full, and they curtail production also, though quite differently positioned from the independents first mentioned.

Production of steel at this time is probably about 10 per cent below the rate in August and September, with the curtailment wholly on the part of independents. The Steel Corporation is operating at about 89 per cent of its rated capacity, but its capacity ratings are conservatively low.

Equalization of Steel Market Predicted by April

Whether the open market on steel products or that made by the independents will fall rapidly or slowly may depend upon how many independents seek business where it may be found and how many hold aloof, rather depending for operation on their contracts. As to the extent of the decline, the prediction commonly encountered is evasive, since it is that the independent market will decline to the Steel Corporation level, and as to what that level will be in future there is complete uncertainty. Some predict that the corporation will slightly advance its prices, more or less by a horizontal movement, others predict that there will be no material change, while still others predict that the corporation will make a number of reductions, not horizontal, but by way of equalization according to manufacturing costs, the alignment of which, between the various steel com-

modities, has materially altered in the past year and a half. A common prediction is that the market will be equalized, and on a sound basis, by next April, with a buying movement to occur then or by June at the latest.

Week's Developments

The independent producer which began last week to quote merchant bars at 2.35c., the Steel Corporation price, has withdrawn the quotation, and the bar market appears steady at 3c. to 3.25c., with scarcely any new business being booked.

The softening in strip steel has continued, with 5c. for hot rolled and 8c. for cold rolled the common quotation. Special prices on cold finished steel bars have disappeared, the market being fairly steady at 4.10c.

Sheets have continued to soften, 6.50c. being now a common quotation on black even for prompt shipment, while 8.75c. is exceptional and 9c. common on galvanized, blue annealed being generally on the basis of 5c.

Pig Iron and Coke

The collapse in pig iron and coke has been phenomenal. Following the general advance in pig iron in August, marked more by the price advances than by the tonnage volume of the buying, there came first a period of no demand, and since then there has come a sharp diminution in demand against contracts. Many consumers have instructed merchant furnaces to decrease the rate of shipping against contract, while some have ordered complete suspension. According to trade practice pig iron contracts are not susceptible of cancellation, as is frequently the case with contracts for finished steel products, but the rate of delivery is much at the option of the consumer.

Following the disappearance of buying of pig iron, prices have shown a tendency to decline on each appearance of an inquiry, while with shipping requirements greatly reduced many furnaces have decided to bank or blow out, and the suspension of shipments of Connellsville coke on the customary "requirement contract" has thrown enough coke on the open market to cause spot prices for furnace coke to toboggan. At this writing the market has declined from $17 to $10 in nine business days.

On limited transactions in basic pig iron, chiefly a sale of 1,500 tons by a valley furnace interest to a Pittsburgh district consumer, the quotable market on basic iron has declined from $42 to $40 valley furnaces. On an inquiry for 200 tons of foundry iron for Pittsburgh delivery several valley furnaces showed great willingness to quote $45 furnace, but the business went to another district, at a delivered price still lower than the equivalent of $45 valley, which would be $46.96 delivered Pittsburgh. Bessemer pig iron experienced a $2 decline, to $45 valley, in still more ignominious manner, since bessemer iron has been offered at $45 valley without finding any takers at all.

Pig iron and coke are declining, but it cannot be said that they are seeking their level, since in present circumstances no price can be adjudged a proper one. Coke cannot find a legitimate level when there is such an absence of demand, and pig iron cannot find a proper level when the prospective cost of coke is in doubt.

The Chemical and Allied Industrial Markets

New York, Oct. 31, 1920.

One of the most important features of the chemical market is the large amount of supplies accumulating in the hands of dealers who are finding it difficult to convince buyers that the present prices are fair to both parties. The competition brought about by this condition is weakening the market and inquiries for spot material are subject to source and amount desired. On the other hand, there have been no important changes by producers who maintained their prices at recent levels. *Aqua ammonia*, 26 deg., is now available at 9½c. per lb.; the prevailing dullness has affected this item, which until a short time ago was very scarce, and as a result it has fallen off from the former low price of 10½c. per lb. The weakness in *copper sulphate*, crystals, continues with concessions being offered as low as $7.50 per cwt. in car lots and ranging upward to $9 in less car lots. *Sodium cyanide* is one of the few items that has remained firm throughout the present weakness, as the demand for this material has not been influenced to any extent. Producers' prices have remained steady and current quotations of 26@30c. for car lots and 32@35c. per lb. for less car lots still prevail. There is a noticeable weakening in *sodium bisulphate* and the supplies on hand are ample to meet the very low demand; $7@$7.50 per ton is the latest quotation for car lots.

Movement among the *acids* has been downward, as the table below indicates. Buying is exceptionally weak with consequent surplus of supplies.

DROP IN ACIDS

	To-day	Last Week	Last Month	Last Year
Citric	60@65c.	70@75c.	78@80c.	85c.@$1.00
Oxalic	32@34c.	35@36c.	45@50c.	22@24c.
Phosphoric	19@20c.	20@23c.	22@23c.	10@11c.
Tartaric	60@65c.	70@73c.	75@80c.	$1.20-1.40

Coal-Tar Products

The downward movement in this market has been confined to the intermediates, and even among these it has been slight, as the market is stagnant, with buying at a minimum. In order to attract business concessions are being made on many items. Among these are *aniline oil* and *salts*, the former being listed at 27@30c. and the latter at 33@34c. per lb. *Benzidine base* is also weaker, with current quotations ranging between $1.25@$1.30, which represents a 10c. drop compared with the recent price of $1.35@$1.40 per lb. The *crudes* still maintain the firmness that has been characteristic, although *phenol*, in good supply, is a little easier at a low figure of 11c. per lb.

Waxes

Although buying, as in every other line, has fallen off considerably, the waxes have remained comparatively steady. *Japan* is firm at 18@21c. per lb. and *montan* is a trifle easier at 12@14c. The large supply of *beeswax* on hand has weakened this item considerably and refined dark can be had for 30@32c., while the light is down to 33@36c. per lb.

The Chicago Market

Chicago, Oct. 27, 1920.

Buyers refuse to be tempted even by prices which would have seemed ridiculously low a few months ago. Their offers in most lines are kept at just a little below sellers' asking price, most sales apparently being consummated at a reduction from nominal quotation. By the simple process of buying in meager quantities and that only when the price is satisfactory, the market is being gradually forced down.

In the oil market the combination of cheaper live stock and consequent lower animal oil prices, apparently unlimited crops of flaxseed, corn and peanuts, and the serious curtailment of the textile industry has failed to shake the confidence of some holders of heavy stocks, although current quotations are apparently lower than costs. This feeling of anticipation of a stronger market seems to be based on the belief that stocks in the hands of consumers are unusually low and that a slight increase in industrial activity will promptly act to elevate the entire list.

Heavy Chemicals

Material reduction in the price of *methyl alcohol* has failed to stimulate buying to any great extent and 97 per cent is now quoted at $2.87 per gal. *Ethyl* grade is practically unchanged at $5.60@$5.70 for 190 proof. Old quotations are being maintained nominally on *denatured*, although current transactions are going for about 10c. less, sales being recorded as low as 96c. per gal. Lowered demand and better supply have operated to further weaken *bleaching powder*, a definite price being difficult to name, 6½c. per lb. being probably a fair quotation. *Sal soda* is a little heavy, though the price is unchanged at $2 per cwt. in reasonable quantities.

Buyer and seller seem deadlocked on *glycerine*, stock being held at about 25c. for dynamite grade, with buyers' offers a cent lower. Actual transactions were negligible

during the period. *Alum* is firm, the market being in producers' hands. *Ammonia lump* is held at 5¼@5½c. per lb. and *potash lump*, though less in demand, is equally firm at 8½@8¾c. *Antimony* is in free supply and is quoted at the low figure of 9c. per lb. for the powdered needle grade. Acid prices are all weak and supply seems more than adequate for all demands.

Coal-Tar Products

Curtailment of operations by textile mills and tanneries has accentuated previous weakness. *Aniline oil* and *aniline salt* are both off another cent, now being obtainable at 26c. and 33c. per lb. respectively. *Naphthalene* is changing hands in small quantities only and at prices as low as 10½c. per lb. for flakes. *Phosgene* is back to normal, 50c. per lb. ruling on a quiet market.

Vegetable Oils

This market is also dormant. Producers of *corn oil*, not caring to come into the market at the prevailing price of 9¾c. per lb. f.o.b. works, are further curtailing operations. Visible stocks are low, but consumers show no anxiety for goods. *Linseed oil* continues to drop, jobbers' barrel price now being $1.20 per gal. November delivery is offered at 95c. in tanks and 5c. less is freely talked. *Red oil*, nominally 10c. per lb., shows no activity. Bear talk has forced *soya bean oil* down another half cent to 8½c. in sellers' tanks f.o.b. coast and 17½c. for local spots. At these prices buyers display small interest.

The St. Louis Market

St. Louis, Mo., Oct. 25, 1920.

After the slight changes reported in the last St. Louis market report the chemical market here seems to have become more stable and practically no changes are to be noted in the last two weeks. While everything is and probably will be quiet for some time, the general tone of the market is healthy.

Buyers here, as well as in other markets, are marking time to some extent, but this fact has not caused any cut in production nor is it likely that it will result in price reductions on a general scale. As a matter of fact the last market report noted several small advances, and these prices are continuing firm. Producers here feel that heavy chemical prices are not too high in consideration of the cost factor and a steady demand. Producers report that contracts are being effected on that basis.

Transportation facilities are better just at present than they have been at any time since the war, there being no difficulty in getting shipments of the raw materials and in shipping out the finished products on schedule time.

Demand for the 66 deg. *sulphuric acid* is steady and prices are holding well. This is a slight improvement over the situation two weeks ago and is the turn of the market that producers had been expecting. There is still evidence that the oil refineries are buying on a basis of present needs. Prices on the 66 deg. acid are $24 per ton and 1¾c. per lb. in carboys in carload lots. Not much activity is shown in the market for 98 deg. sulphuric acid and it is quoted at $25 per ton, f.o.b. works. The 60 deg. acid holds firm at the advanced price reported two weeks ago of $16.50 per ton and 1½c. per lb. in carboys. *Oleum* also retains the advance noted previously and is in good demand. The price is $28.50 per ton.

Stocks of *muriatic acid* are still large and demand is a trifle slow. It is quoted at 2@2¼c. per lb. in carboys in carload lots and $25 per ton in bulk.

The demand for *sodium bisulphate* is steady and there is a large supply in producers' hands. The price is $5@$6 per ton. It is a question whether a quieter steel market may not have some effect on this chemical.

The market for *nitric acid* continues to show strength, but prices remain the same and deliveries are good. The quotations are $7 per cwt. on the 36 deg. and $10 per cwt. on the 42 deg. *Standard mixed acid* at 1½c. per lb. for both the 36 deg. nitric and 61 deg. sulphuric is holding steady.

Zinc chloride continues to be quoted $4 per cwt. *Phenol* is quiet at 12c. in lots of 15 tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	....-......	$0.65 - $0.75
Acetone	lb.	$0.19 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	cwt.	7.50 - 8.00	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 - 16.00	16.25 -....
Boric, crystals	lb.	.15½ - .16	.16½ - .19
Boric, powder	lb.	.15½ - .16½	.17 - .20
Citric	lb.	.60 - .65	.66 - .70
Hydrochloric (nominal)	cwt.	2.25 - 2.50	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	.16½ - .18
Lactic, 44 per cent tech	lb.	10 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		........-......	......-......
Nitric, 40 deg.	lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg.	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.32 - .34	.35 - .36
Phosphoric, Ortho, 50 per cent solution	lb.	.19 - 20	.21 - .22
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	......-......
Sulphuric, 60 deg., drums	ton	......-......	......-......
Sulphuric, 66 deg., tank cars	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 66 deg., drums	ton	26.00 - 28.00	......-......
Sulphuric, 66 deg., carboys	ton	.. -. .	- . .
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32 00 - 35 00	40.00 -......
Tannic, U. S. P.	lb.	1.45 1 50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - 70	.80 - .90
Tartaric, crystals	lb.	.60 - 65	.66 - .70
Tungstic, per lb. of WO	lb.	......-......	1.20 - 1 40
Alcohol, Ethyl (nominal)	gal	5.50 - 5.75	......-......
Alcohol, Methyl (see methanol)		....-....	-
Alcohol, denatured, 188 proof (nominal)	gal.	......-......	1.12 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	......-......	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .05½	.05½ - .06
Alum, potash lump	lb.	.07 - .08½	.09 - .09½
Alum, chrome lump	lb	.14½ - .15	.16 - .17
Aluminum sulphate, commercial	lb.	.02½ - .03	. . . .- ..
Aluminum sulphate, iron free	lb.	.04½ - 05	......-......
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 - .35½	.36 - .38
Ammonium carbonate, powder	lb.	.15 - .16	.16½ - .17
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.13 - .14	......-......
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .13	.13½ - .14½
Ammonium nitrate	lb.	......- .10	.11 - .14
Ammonium sulphate	lb.	.07 - .07½	.08½ -......
Amylacetate	gal	....-......	4.50 - 5.00
Amylacetate tech	gal.	......-......	4.00 - 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	13 - .14	.15 - .16
Arsenic, sulphide, powdered (red arsenic)	lb.	16 - .17	.18 - .19
Barium chloride	ton	120 00 - 130.00	....-....
Barium dioxide (peroxide)	lb.	.24 - .25	.26 - .27
Barium nitrate	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		......-......	......-......
Blue vitriol (see copper sulphate)		......-......	......-......
Borax (see sodium borate)		......-......	......-......
Brimstone (see sulphur, roll)		......-......	......-......
Bromine	lb.	.70 - .80	.85 - .90
Calcium acetate	cwt	3.50 - 3.55	......-......
Calcium carbide	lb.	04½ 04½	.04½ - .05½
Calcium chloride, fused, lump	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated	lb	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	cwt.	7 25 - 7 50	8.00 - 8.50
Calcium peroxide	lb.	....-......	1.50 - 1 70
Calcium phosphate, monobasic	lb.	......-......	.75 . .80
Calcium sulphate, pure	lb.	......-......	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.13 - .14	.16 - .17
Carbonyl chloride (phosgene)	lb.	......-......	1.25 1.50
Caustic potash (see potassium hydroxide)		......-......	......-......
Caustic soda (see sodium hydroxide)		......-......	......-......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 , .47
Cobalt oxide	lb.	-	2.00 - 2.05
Copperas (see iron sulphate)		......-......	......-......
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	......-......	.65 - .70
Copper sulphate, crystals	lb.	.07½ - .08	.08½ - .09
Cream of tartar (see potassium bitartrate)		......-	......-......
Epsom salt (see magnesium sulphate)		......-......	......-......
Ethyl Acetate Com. 85%	gal.	.. . -......	1.05 - 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		......-......	. . -......
Formaldehyde, 40 per cent (nominal)	lb	.40 - .45	......-......
Fusel oil ref	gal.	......-......	5.25 - 6.00
Fusel oil, crude (nominal)	gal.	......-......	......-......
Glauber's salt (see sodium sulphate)		......-......	......-......
Glycerine, C. P. drums extra	lb.	......-......	.26½ - .28½
Iodine, resublimed	lb.	4.30 - 4.35	4 40 - 4.45
Iron oxide, red	lb.	......-......	.03 - .20
Iron sulphate (copperas)	cwt.	2 00 - 2 25	2.35 - 2.75
Lead acetate, normal	lb.	. ..-...	.13½ - .16
Lead arsenate (paste)	lb.	11 - .12	.13 - .17
Lead nitrate, crystals	lb.	......-......	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	......-......	1.50 -......
Magnesium carbonate, technical	lb.	.12½ - .13½	.14 - .15
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.25	......-......
Magnesium sulphate, commercial	100 lb.	......-......	3.50 - 3.60
Methanol, 95%	gal.	......-......	2.70 - 3.00
Methanol, pure	gal.	......-......	3.40 - 3.60
Nickel salt, double	lb.	......-......	.14 - .16
Nickel salt, single	lb.	......-......	.13 - .14
Phosgene (see carbonyl chloride)		......-......	......-......
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	......-......	.35 - .37
Potassium bichromate	lb.	.34 - .36	.39 - .40

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0 48 - $0.56	$0.57 - $0.58
Potassium bromide, granular	lb.	. . -	.63 - .65
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.20 - .21	.23 - .25
Potassium chlorate, crystals	lb.	.18 - .18½	.19 - .20
Potassium hydroxide (caustic potash)	lb.	.23 - .25	.26 - .27
Potassium iodide	lb.	......-......	3.20 - 3.30
Potassium nitrate	lb.	.17 - .17½	.19 - .21
Potassium permanganate	lb.	.63 - .68	.70 - .75
Potassium prussiate, red	lb.	.85 - .95	1.00 - 1.05
Potassium prussiate, yellow	lb.	.32 - .36	.35 - .40
Potassium sulphate (powdered)	ton	$240.00 - 255 00	......-......
Rochelle salts (see sodium potas. tartrate)		......-......	......-......
Salammoniac (see ammonium chloride)		......-......	......-......
Sal soda (see sodium carbonate)		......-......	......-......
Salt cake	ton	......-......	48.00 - 50.00
Silver cyanide (nominal)	oz.	......-......	1.25 -......
Silver nitrate (nominal)	oz.	......-......	.60 - .62
Soda ash, light	100 lb	-......	2.25 - 2.50
Soda ash, dense	100 lb.	......-......	3.25 - 3.50
Sodium acetate, U S P, granular	lb.	25 - 26	.27 - .28
Sodium bicarbonate	100 lb	2.50 - 2 75	2.85 - 3.00
Sodium bichromate	lb.	.22 - .24	.26 - .27
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.06½- .07½	.08 - 09
Sodium borate (borax)	lb	.09½- .10	.11 - 12
Sodium carbonate (sal soda)	100 lb	2.00 - 2.10	2.15 - 2.25
Sodium chlorate	lb	.14½- .15	.15½- .1[illegible]
Sodium cyanide, 96-98 per cent	lb	.2[illegible]- .30	.32 - .35
Sodium fluoride	lb	.18 -......	.19 - .20
Sodium hydroxide (caustic soda)	100 lb	4 00 - 4.25	.. -
Sodium hyposulphite	lb	......	.03 .04
Sodium molybdate	lb	2.50 -......	3.25½- ...
Sodium nitrate	100 lb.	3.00 -......	3.75 .....
Sodium nitrite	lb.	11 - .12	.13 - .14
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½- .04½	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb	-	.37 - .38
Sodium prussiate, yellow	lb	.25 - .27	.31 - .32
Sodium silicate, solution (40 deg)	lb.	.01½- .01¾	.02 - .02½
Sodium silicate, solution (60 deg)	lb.	.02½- .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt	2.15 - 2.50	2.60 - 2 75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	09½ 10	10½ - .11
Sodium sulphite, crystals	lb	.04 - 0 4½	.04½ .05
Strontium nitrate, powdered	lb	.15 - .18½	.19 - .20
Sulphur chloride red	lb	.08 - .09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	....
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	......	3.70 - 4.35
Sulphur, roll (brimstone)	100 lb.	......-......	3.40 - 3.90
Tin bichloride, 50 per cent	lb.	.13½- .14	.. -
Tin oxide	lb.	......-......	.55 -
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran	lb.	.13 - .13½	.13½- .17
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, U. S. P.	lb.	.17 - .25	......-
Zinc sulphate	lb.	.03½- .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.25 -- $1.35
Alpha-naphthol, refined	lb.	1.50 1.60
Alpha-naphthylamine	lb.	.45 - .50
Aniline oil, drums extra	lb.	.27 -- .30
Aniline salts	lb.	.33 — .34
Anthracene, 80%, in drums (100 lb)	lb.	.90 -- 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 -- 2.10
Benzidine, base	lb.	1.25 - 1.30
Benzidine sulphate	lb.	1.05 - 1.15
Benzoic acid, U.S.P.	lb.	.85 .90
Benzoate of soda, U.S.P.	lb.	.80 --- .90
Benzene, pure, water-white, in drums (100 gal)	gal.	.35 — .40½
Benzene, 90%, in drums (100 gal)	gal	.33 — .38½
Benzyl chloride, 95-97%, refined	lb.	.35 - .40
Benzyl chloride, tech	lb	.25 -- .35
Beta-naphthol benzoate (nominal)	lb.	3.50 - 4 00
Beta-naphthol, sublimed (nominal)	lb	.90 -- 95
Beta-naphthol, tech (nominal)	lb	.60 - .70
Beta-naphthylamine, sublimed	lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb)	lb.	.18 .19
Ortho-cresol, in drums (100 lb)	lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10 --- 1 15
Cresylic acid, 95-97%, dark, in drums	gal	1.05 1 10
Cresylic acid, 50%, first quality, drums	gal.	.65 - .75
Dichlorbenzene	lb.	.07 .10
Diethylaniline	lb.	1 50 1 60
Dimethylaniline	lb.	.90 -- 1.00
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.32 - 35
Dinitronaphthalene	lb.	.45 - .55
Dinitrophenol	lb.	.40 - .45
Dinitrotoluene	lb.	38 -- 40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 -- 40
Diphenylamine (nominal)	lb.	.80 - .85
H-acid (nominal)	lb.	1.75 - 1 85
Meta-phenylenediamine	lb.	1.25 - 1 30
Monochlorbenzene	lb.	.18 -- .20
Monoethylaniline	lb.	2.00 -- 2.40
Naphthalene crushed, in bbls. (250 lb)	lb.	.12 — .14
Naphthalene, flake	lb.	.10½ — .11
Naphthalene, balls	lb.	.12½ -- .13
Naphthionic acid, crude	lb.	.75 — .85
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.25 — 4.25
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.35 — .38
Para-amidophenol, base	lb.	2.50 — 3.00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlorbenzene	lb.	.08 — 12
Paranitroaniline	lb.	1.10 — 1.15
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.50 — 2.65
Para-toluidine	lb.	2.00 - 2.25
Phthalic anhydride	lb.	.60 -- .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.11 - .20
Pyridine	gal.	2.00 -- 3.50
Resorcinol, technical	lb	4.25 4.50
Resorcinol, pure	lb.	6.25 -- 6.75
Salicylic acid, tech, in bbls. (110 lb)	lb.	.45 - .50
Salicylic acid, U. S. P.	lb.	.45 -- .50
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal	gal.	.30 — .35
Solvent naphtha, crude, heavy, in drums, 100 gal	gal	.20 — .26
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.70 — 2.50
Toluidine, mixed	lb	.45 -- .55
Toluene, in tank cars	gal.	.35 -- .....
Toluene, in drums	gal.	.38½ -- .40½
Xylidines, drums, 100 gal.	lb	.50 --- .65
Xylene, pure, in drums	gal.	.47½ -- .50½
Xylene, pure, in tank cars	gal.	.45 -- .....
Xylene, commercial, in drums, 100 gal	gal.	.32½ - .35½
Xylene, commercial, in tank cars	gal.	.30 — . ..

Waxes

Prices based on original packages in large quantities

Beeswax, refined, dark	lb	$0 30 -- $0.32
Beeswax, refined, light	lb.	34 - .37
Beeswax, white pure	lb.	.55 -- 60
Carnauba, No. 1 (nominal)	lb.	90 -- .95
Carnauba, No. 2, regular (nominal)	lb.	75 -- .80
Carnauba, No. 3, North Country	lb	.25 - .26
Japan	lb.	.18 - .20
Montan, crude	lb	12 — .14
Paraffine waxes, crude match wax (white) 105-110 m p.	lb.	.09 - .09½
Paraffine waxes, crude, scale 124-126 m p.	lb	.09½ - .10
Paraffine waxes, refined, 118-120 m p	lb	.11 -- .11½
Paraffine waxes, refined, 125 m p	lb	.12½ — ..
Paraffine waxes, refined, 128-130 m p	lb.	.13 — .15
Paraffine waxes, refined, 133-135 m p	lb.	.16 - .17
Paraffine waxes, refined, 135-137 m p	lb.	.17½ - .18½
Stearic acid, single pressed	lb.	.20 — .21
Stearic acid, double pressed	lb.	.22 — .23
Stearic acid, triple pressed	lb.	.24 — .25

NOTE—Paraffine waxes very scarce

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls, gross weight, 500 lb.

Pine oil, steam dist, sp gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist	gal	1.50
Pine tar oil, ref, sp. gr. 1 025-1.035	gal.	48
Pine tar oil, crude, sp gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp gr. 0.965-0 990	gal	.85
Pine tar, ref, thin, sp gr., 1,080-1.960	gal	.36
Turpentine, crude, sp gr., 0.900-0 970	gal	1.75
Hardwood oil, f.o.b. Mich., sp. gr, 0 960-0 990	gal	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots

Rosin B-D, bbl.	280 lb.	$12.90 — ..
Rosin E-I	280 lb	12 90 - .
Rosin K-N	280 lb.	12.90 - ....
Rosin W. G.-W. W	280 lb.	12 [illegible]0 — .
Wood rosin, bbl.	280 lb.	12.[illegible]0 — .
Spirits of turpentine	gal	1.12 — .
Wood turpentine, steam dist	gal	1.22 -- ....
Wood turpentine, dest dist	gal	1.18 - ..
Pine tar pitch, bbl	200 lb.	. - 8.50
Tar, kiln burned, bbl (500 lb)	bbl.	14 50 - 15.00
Retort tar, bbl	500 lb.	15 00 - 15.50
Rosin oil, first run	gal	72 -- ....
Rosin oil, second run	gal	75 - .....
Rosin oil, third run	gal.	.92 -- .....

Solvents

73-76 deg, steel bbls (85 lb)	gal.	$0.40
70-72 deg, steel bbls (85 lb)	gal.	.38
68-70 deg, steel bbls (85 lb)	gal	.37
V. M and P naphtha, steel bbls (85 lb)	gal.	.29

Crude Rubber

Para Upriver fine	lb.	$0.26 $0.26½
Upriver coarse	lb.	.17 - .18
Upriver caucho ball	lb	.17½ — .18½
Plantation—First latex crepe	lb.	.25 -- ....
Ribbed smoked sheets	lb.	.24½ — ....
Brown crepe, thin, clean	lb.	.22½ — ....
Amber crepe No. 1	lb.	.22 — .....

Oils

VEGETABLE

The following prices are f o.b, New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.16½ - $0.18
Castor oil, AA, in bbls	lb.	.15 — .16
China wood oil, in bbls. (f o b. Pac. coast)	lb.	.16 — .16½
Coconut oil, Ceylon grade, in bbls	lb.	.15½ — .16
Coconut oil, Cochin grade, in bbls (nominal)	lb.	.17½ — .17½
Corn oil, crude, in bbls	lb.	.12 — .13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½ — .11
Cottonseed oil, summer yellow	lb.	.13 — .14
Cottonseed oil, winter yellow	lb.	.. — ....
Linseed oil, raw, car lots (domestic)	gal.	1.07 — ....
Linseed oil, raw, tank cars (domestic)	gal.	1.00 — . ..
Linseed oil, boiled, car lots (domestic)	gal.	1.09 — . ..

Olive oil, commercial	gal.	3.00	— 3.50
Palm, Lagos	lb.	.10½	— .10¾
Palm, bright red	lb.	....	— ....
Palm, Niger	lb.	.09½	— .10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10¾	— .12½
Peanut oil, refined, in bbls	lb.	.17	— .18
Rapeseed oil, refined in bbls	gal.	1.30	— 1.45
Rapeseed oil, blown, in bbls	gal.	1.60	— 1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14	— .14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10	— .11

FISH

Light pressed Menhaden	gal.	$0.80	— $0.90
Yellow bleached Menhaden	gal.	.83	— .84
White bleached Menhaden	gal.	.86	— .87
Blown Menhaden	gal.	.90	— 1.00

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	— $30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	— [illegible]
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10 00	— 12 00
Barytes, floated, f.o.b. St. Louis	net ton	26 50	— 28 00
Barytes, crude, first grade, Missouri	net ton	10 00	— ...
Blanc fixe, dry	lb	.05½	— .06
Blanc fixe, pulp	net ton	60 00	80.00
Casein	lb	.15	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb	.05	— .07
Chalk, English, light	lb	.05	— .06
Chalk, English, dense	lb	.04½	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00	— 22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00	— 40 00
China clay (Kaolin), imported, lump	net ton	25 00	35 00
China clay (Kaolin), imported, powdered	net ton	30 00	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8 00	— 14.00
Feldspar, crude, f.o.b. Maine	net ton	7 50	— 10 00
Feldspar, ground, f.o.b. Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00	— 21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00	21.00
Feldspar, ground f.o.b. Baltimore	net ton	27 00	— 30.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00	— ....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18 00	— ...
Fuller's earth, imported, powdered	net ton	35.00	— 40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	.	— .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07	.09
Graphite, higher lubricating grades	lb	.11	— .40
Pumice stone, imported, lump	lb	.04	— .50
Pumice stone, domestic, lump	lb	.06	—
Pumice stone, ground	lb	.04	— .07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.	— 10 00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore	net ton	.	— 14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		— 17 00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7.50
Shellac, orange fine	lb.		— ..
Shellac, orange superfine	lb.	1 05	— 1.10
Shellac, A. C. garnet	lb.	.90	.95
Shellac, T. N	lb.	.85	.95
Soapstone	ton	15.00	25 00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50	— 15 00
Talc, rubber grades, f.o.b. Vermont	ton	12.00	— 18 00
Talc, powdered, Southern, f.o.b. cars	ton	12 00	— 15 00
Talc, imported	ton	60.00	— 70.00
Talc, California Talcum Powder grade	ton	20.00	— 35.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55–60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60–65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55–60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45–50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65 70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	— .19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	— .21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00	— 175.00
Ferro-manganese, 76-80% Mn, English	gross ton	170 00	— 175 00
Spiegeleisen, 18-22% Mn	gross ton	82 50	— 85 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00	— 2 50
Ferro-silicon, 10-15%	gross ton	60 00	65 00
Ferro-silicon, 50%	gross ton	80 00	90 00
Ferro-silicon, 75%	gross ton	150.00	160 00
Ferro-tungsten, 70-80%, per lb of contained W	lb	[illegible]	[illegible]
Ferro uranium, 35-50% of U, per lb of U content	lb	7 00	—
Ferro-vanadium, 30-40% per lb of contained V	lb.	6 50	— 8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20½% silica, not more than 1% moisture	gross ton	$10.00	— $11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70	.75
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.75	.85
*Coke, foundry, f.o.b. ovens	net ton	.....	18.00
*Coke, furnace, f.o.b. ovens	net ton	16.50	17.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	80.00	100.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	85.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.60	.70
Manganese ore, chemical (MnO_2)	gross ton	70.00	80.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.65	.70
Monazite, per unit of ThO_2	unit	35.00	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	— ....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12	— .14
Pyrites, domestic, fines	unit	.12	— .14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00	— .
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	4.50	— 5.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	— 3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	— 3.00
Vanadium pentoxide, 99%	lb.	12.00	— 14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25	— 1.50
Zircon, washed, iron free	lb.	.05	— .....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	15.50
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	7 25
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5-ton lots	42.00
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	7.25
Zinc, spot, New York	8.00
Zinc, spot, E. St. Louis	7.50@7.70

OTHER METALS

Silver (Commercial)	oz.	$0 91½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	95.00@105.00
Iridium	oz.	400.00@450 00
Palladium	oz.	85.00
Mercury	75 lb.	70.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	25.50
Copper bottoms	36.00
Copper rods	30.00@35 00
High brass wire and sheets	28.50
High brass rods	27.00
Low brass wire and sheets	31.25
Low brass rods	27.00
Brazed brass tubing	38.25
Brazed bronze tubing	43.00
Seamless copper tubing	29.00
Seamless high brass tubing	28.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12.50	17 00	12.00	13.50
Copper, heavy and wire	12 00	16 00	11.75	12.50
Copper, light and bottoms	10 00	14.00	10.00	11.00
Lead, heavy	5 50	4 75	5.50	6.00
Lead, tea	4 50	3.75	3.75	5.00
Brass, heavy	7 00	10 50	8.00	12.50
Brass, light	5 50	7 50	5.00	6.50
No. 1 yellow brass turnings	7.00	10.00	6.00	6.75
Zinc	4 50	5 00	3.75	5 00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.30	$4.47	$3.47	$3.44	$3.37	$4.08	$3.47
Soft steel bars	4 75	4.62	3.37	3.84	3.27	3.98	3.37
Soft steel bar shapes	4 75	4.62	3.37	3.84	3.27	3.98	3.37
Soft steel bands	6.43	6.32	4.07	6.25			
Plates, ¼ to 1 in. thick	4.50	4.67	3.67	3.64	3.57	4.28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

JEWETT CITY—The Fisk Rubber Co., Chicopee Falls, Mass., plans to build a large rubber plant. B. Allen, 52 Vanderbilt Ave., New York City, engr.

Illinois

CHICAGO—The Sanitary Dist. of Chicago, 910 South Michigan Ave., has awarded the contract for the construction of the Calumet sewage treatment plant, to T. J. Forschner Contg. Co., 125th and Michigan Ave.. $4,900,527.

KEWANEE—The city is having plans prepared for the installation of intercepting sewers, tanks and sprinking filters. Estimated cost, $250,000. Alvord & Burdick, 8 South Dearborn St., Chicago, engrs. Noted May 12.

Kansas

NEWTON—Bethel College is having plans prepared for the construction of two 3-story, 85x150-ft. buildings, including a science hall, etc. Estimated cost, $400,000. Lorentz Selnick & Co., 121 North Market St., Wichita, archts.

Maryland

BALTIMORE—The Church House and Infirmary, Bway. and Fairmont Ave., plans to build a 6-story addition to the hospital. A chemical laboratory will be installed in same. Estimated cost, $600,000. Wyatt & Nolting, 1012 Keyser Bldg., archts.

Michigan

TRENTON—The city engaged C. W. Hubble, engr., 2348 Penobscot Bldg., Detroit, to prepare plans and submit estimates for the construction of water main extensions and filtration plant. The plans include the construction of a filter bed, etc.

Minnesota

DULUTH—J. T. McNicholas, Bishop, has awarded the contract for the construction of a 2-story, 150x150-ft. school on 28th Ave. East, and 5th St., to McLeod & Smith, Sellwood Bldg., at $396,300. Chemical laboratory equipment will be installed in same.

RENVILLE—A. R. Holinberg clk of the Bd. Educ., will receive bids until Dec. 1 for the construction of a 2-story, 90x240-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $300,000. Croft & Boerner, Lonsdale Bldg., Duluth, archts and engrs.

ST. PAUL—The Diocese of St. Paul is conducting a campaign to raise $5,000,000 for schools and colleges. The building plans include the construction of a science hall, etc. at the college of St. Thomas, Mernan Park.

New Jersey

METUCHEN—D. Wortman, archt. and engr., 116 Lexington Ave., New York City, will receive bids until Dec. 1 for the construction of a 1- and 2-story addition to the factory for the General Ceramics Co., 50 Church St., New York City. Estimated cost, $400,000.

New York

BEDFORD HILLS—L. F. Pilcher, State Archt., Capitol, Albany, has awarded the contract for the construction of a filtration plant at the New York State Reformatory here, to M. J. Launders, 199 South Lexington Ave., White Plains. Estimated cost, $6,500.

BUFFALO—The Angola Tire & Rubber Co., 270 North Division St., has awarded the contract for the construction of a 2-story, 50x96x126-ft. addition to its factory, to J. A. Zoll, 398 Bird Ave. Estimated cost, $55,000.

North Carolina

GREENSBORO—The Armour Fertilizer Co. has awarded the contract for the construction of a 1-story, 80x180-ft. fertilizer and storage building, to the Austin Co., Bulletin Bldg., Philadelphia. Estimated cost, $150,000.

Ohio

CLEVELAND—The Cleveland Steel Barrel Co., 9619 Meech Ave., has awarded the contract for the construction of a 1-story, 60x120-ft. factory at 9700 Meech Ave., to R. Hansen, 9723 Sandusky Ave. Estimated cost, $25,000.

MIAMISBURG—The Bd. Educ. will soon award the contract for the construction of a 2-story, 84x92-ft. grade school. Estimated cost, $125,000. F. L. Packers, New Hayden Bldg., Columbus, archt.

WEST PARK—The Bd. Educ. plans to build a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $1,000,000. F. W. Featherstone, clk.

Oklahoma

TULSA—The city is having preliminary plans prepared for the construction of 6 additional filter units etc. Estimated cost, $350,000. Halway Eng. Co, 230 Lynch Block, engr.

WAYNOKA—The city plans an election in November to vote on $60,000 bonds for the construction of a sewage disposal plant. H. S. Olmsted & Co, 417 Exch. Bldg., Oklahoma City, engr.

Pennsylvania

HATBORO—The Roberts and Mandor Stove Co., 11th and Washington Sts., Philadelphia, has awarded the contract for the construction of a 1-story, 60x100-ft. addition to its foundry, to the Austin Co., Bulletin Bldg., Philadelphia.

PHILADELPHIA—The General Carbonic Co., 847 North 3rd St., has awarded the contract for altering the 1-story factory and boiler house, to the Austin Co., Bulletin Bldg. Estimated cost, $10,000.

PHILADELPHIA—The Philadelphia Dyeing & Finishing Co, Frankford and Vandike Sts. is having plans prepared for the construction of a factory on Torresdale St. Chemical equipment for the manufacture of dyes will be installed in same. Estimated cost $50,000. M. Ward Easby, Crozer Bldg., archt.

UNIONVILLE—The Consolidated Bd. Educ., East and West Marlboro, Newlin and Pocopsin, is having preliminary plans prepared for the construction of a 2-story vocational school here. A chemical laboratory will be installed in same. Estimated cost, $100,000. Ritter & Shay, North Amer Bldg., Philadelphia, archts and engrs.

Virginia

QUANTICO—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to build an incinerator plant to include a septic tank, etc., at the marine barracks, here.

West Virginia

BLUEFIELD—The Baptist Educ. Comm plans to build 18 buildings, including a science hall, etc. Estimated cost, $750,000.

Wisconsin

FOND DU LAC—The Fond du Lac Paper Co., c/o Morris Green, 298 Forest Ave., plans to build a 1- and 2-story, 100x300-ft paper board factory on the shore of Lake Winnebago. Estimated cost, $100,000.

MAYVILLE—The Free High School Dist plans to construct a 60x280 ft high school. A chemical laboratory will be installed in same. Estimated cost, $200,000.

MILWAUKEE—The Red Star Yeast Co., 27th and St. Paul Aves., has awarded the contract for the construction of a 2 story, 50x95-ft. yeast manufacturing building, to E. Steigerwald & Co, 3607 Vliet St. Estimated cost, $30,000.

PLYMOUTH—The Plymouth Fdry & Machine Co., has awarded the contract for the construction of a 1-story, 150x162-ft. foundry and machine shop on Stafford St., to M. Runge Main St. Estimated cost, $100,000.

SHEBOYGAN—The Vollrath Co., 13th and Michigan Aves., has awarded the contract for the construction of a 1-story, 180x200-ft. stamping shop for an enamel-ware manufacturing plant on Michigan Ave., to the D. P. Robinson Co., 61 Bway., New York City. Estimated cost, $100,000.

WAUWATOSA—The Aromatic Chemical Co., 61st and Motor Ave., plans to rebuild its 2-story, 60x100-ft. chemical factory on Motor Ave., which was recently destroyed by fire.

WAUWATOSA—The city has awarded the contract for remodeling the sewage disposal plant, to the Kroening Constr. Co., Majestic Bldg., Milwaukee. Estimated cost $27,252.

Ontario

LONDON—The city plans to develop the sulphur well by constructing a plant for purifying the water and removing the sulphur. Estimated cost, $30,000. H. V. Buchanan, Pub. Utilities Bd., London, engr.

MIDLAND—The city has appointed E. A. James & Co., engrs, 36 Toronto St., Toronto to prepare plans for sewer extensions. A sewage disposal plant will probably be installed. Estimated cost, $100,000.

NIAGARA FALLS—The Oneida Community Co. has awarded the contract for the construction of a 1-and 2-story manufacturing building, to Bancroft Jones Co. and for finishing and heat treating buildings to Norman McLeod, Kent Bldg., Toronto. Estimated cost, $200,000.

SMOOTH ROCK FALLS—The Mattagami Pulp & Paper Co. has awarded the general contract for the construction of a 2-story pulp mill and store buildings, to Carter, Halls Aldinger Co., Union Bank Bldg., Winnipeg. Estimated cost, $490,000.

ST. CATHERINES—The Bd. Educ. plans to build a 3-story collegiate institute. A physical and chemical laboratory including equipment will be installed in same. Estimated cost, $400,000.

TORONTO—The Dominion Envelope & Carton Co., 150 Duchess St, has purchased a 7-acre site at Eastern Gap and plans to build a 1-story, 300x500-ft. envelope and paper box factory on same. Estimated cost, $500,000.

TORONTO—The Northern Aluminum Co., Sterling Rd. plans to build a plate mill here. Estimated cost, $200,000. R. H Prack, 50 Bay St., engr.

Industrial Notes

BLAW-KNOX CO., Pittsburgh, Pa., had an exhibit at the American Foundrymen's Association exhibition, held at Columbus, O., Oct. 4 to 8, consisting of clamshell buckets, water cooled furnace appliances and Prudential steel buildings.

THE H. H. ROBERTSON CO., Pittsburgh, Pa., announces the election of C. D. Mercer as vice-president in charge of sales. This occurred at the completion of Mr. Mercer's first year as sales manager of the company. W. S. Tallmann has been elected in charge of operation from Sept. 1. Mr. Tallmann will have charge of all factories, the tin reclamation, the traffic and purchasing departments. D. W. Jasper was appointed manager of the purchasing department, vice W. E. Coe, who resigned to go into the railway supply business with the Beck Hill Corp., New York City. Mr. Jasper joined the company June 1 and has been temporarily connected with the Pittsburgh district sales office.

FREYN, BRASSERT & CO., engineers, Chicago, Ill., have been appointed consulting engineers for the Royal Netherlands Blast Furnace and Steel Works Co., The Hague, and plans and purchases are under way for the construction of two blast furnaces at Ijmuiden, Holland. The plant is planned along American lines throughout, inclusive of furnaces, hot blast stoves, gas washing, ferro-concrete bins, charging, blowing and other equipment. The plant will be the first application of American practice in furnace lines, filling, blowing and general operation with Continental ores and cokes.

DYESTUFFS & CHEMICALS, INC., of St. Louis, Mo., has recently been organized and incorporated with a capital stock of $10,000 to engage in the manufacture of dyestuffs and chemicals. Further information may be had from Joseph F. Kelly, 3023 Allen St., St. Louis, Mo.

THE MONSANTO CHEMICAL WORKS, St. Louis, Mo., has opened a Chicago office where a complete stock of the company's products is to be carried. W. L. Filmer, previously in charge of a division of the company's St. Louis sales department, will be in charge.

PIERCE & SKOGMARK, INC., metallurgical and chemical engineers, formerly at 35 Nassau St., New York City, announce that they are now in the practice of engineering work with L. L. Summers & Co., 110 Nassau St., New York.

THE FREDERICK ENGINEERING CO. has opened up a district sales office at 1247 Marquette Bldg., Chicago, under the managership of Fred W. Gillette, who will have charge of the distribution of automatic stokers and steam jet ash conveyors in this territory.

THE ST. LOUIS CHAMBER OF COMMERCE, PRODUCTION BUREAU, is collaborating with Louis C. Chapman, consulting geologist, in the preparation of a report and survey of the minerals produced commercially in Missouri. The aim of the survey is to establish definite knowledge of the state's mineral resources.

AMERICAN ELECTRIC GRAPHITE MFG. CO., Toronto, O., has recently been incorporated with a capital stock of $175,000. Victor M. Weaver is president and general manager, Alfred Whiteside secretary and treasurer and Howard E. Batsford technical director. The company has a factory two miles south of Toronto, O., at the site of the Calumet Sewer Pipe Co. It has 115 acres of coal land, with mining rights.

THE CHEMICAL EQUIPMENT CO., Chicago, Ill., has discontinued its Philadelphia agency, which was under control of Edward M. J. Figel, and in order to better serve its customers has appointed the Filtration Engineers, Inc., 253 Broadway, New York, as New York district agents, and C. A. Murphey, Hurt Bldg., Atlanta, Ga., as Atlanta district agent.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, Ill., announces a change in name, to the Conveyor Corporation of America. Clarence C. Brinley has been retained as Eastern manager of the trolley carrier dept. and will be attached to the New York office, 110 West 40th St. Mr. Brinley was formerly with Gifford-Wood Co. and during the war was conveyor engineer for the Air Nitrates Corp.

THE FREEPORT CHEMICAL CO. plant, at Freeport, Tex., has been acquired by the Stauffer Chemical Co., San Francisco. General headquarters for the plant, under the new ownership, will be located in Houston. R. E. Demmon, of San Francisco, will be local manager. Refined sulphur in various forms is manufactured. The Freeport Chemical Co. is a separate organization from the Freeport Sulphur Co.

DANIEL M. LUEHRS, industrial consulting engineer, announces the removal of his offices to 2015 East 65th St., Cleveland, O.

THE NATIONAL LIME ASSOCIATION announces the appointment of Major E. Holmes as manager of the chemistry department. Dr. Holmes is a graduate of Indiana University and a post-graduate of Cornell. His industrial experience has been broad and has included the technical control of factory products, development of new products, building and operation of plants, consulting work with department heads, and the direction of industrial research. Dr. Holmes' services are available to everyone interested in the chemical uses of lime.

C. W. HUNT ENGINEERING CORP. has been formed with offices at 113 Liberty St., New York City, for the purpose of handling all sales entailing engineering in connection with the Hunt products and all engineering services previously performed by C. W. Hunt Co., Inc.

THE AMERICAN ENGINEERING CO., Philadelphia, Pa., has opened a new office in Cincinnati, for the purpose of extending Taylor stoker representation and service. M. M. Masson is in charge of the office, at 207 Neave Bldg.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces the successful starting up of new Greaves-Etchells electric furnaces at the Vancouver Engineering Works, Vancouver, B. C., and the Sullivan Machinery Co., Claremont, N. H.

Manufacturers' Catalogs

THE EAGLE-PICHER LEAD CO., Chicago, Ill., has issued a booklet on Eagle-Picher Products.

THE JEFFREY MFG. CO., Columbus, O., calls attention to an attractive 128-page catalog, No. 267, on Jeffrey Machinery for Every Industry, issued by the Export Division. In the foreword it says: "The great saving in time and labor effected by the mechanical handling of materials in nearly every industry of the world, as illustrated in this book, is proof that labor-saving machinery is of invaluable service in this day of modern method." Many photographs are given which have been selected for the purpose of making it possible to draw a parallel to similar operating conditions, while the tables of sizes have been given to make more comprehensive the magnitude of equipments shown.

THE GENERAL ELECTRIC CO., Schenectady, N. Y., is issuing Bull. 18704A, which supersedes Bull. 18704. This bulletin, on Insulating Compounds, presents the principal characteristics and effective adaptations of the wide field of insulating and coating materials in a practical manner. It gives the imperative factors in selection as well as data on black and clear baking and air-drying varnishes, baking and air-drying japans; double-boiled linseed insulating oils; stickers and shellacs; pothead, joint, coil filling, metal filling, impregnating and various sealing compounds; air-chute cement; priming and finishing paints, enamels, lacquers, etc. These several compounds include every form of coating, impregnating, bonding, filling and finishing all parts of electric apparatus and accessories, such as motor, transformer and regulator coil-windings, armatures, compensators, commutator rings, contactor connections, bushings for switches, etc., for waterproofing, insulating, rust prevention and durability. General information is also given on the application of compounds, on baking ovens, thinners, containers, etc.

THE MERRILL CO., San Francisco, Cal., has recently issued an attractive booklet on the Merco Nordstrom Valve, explaining why "It Can't Stick, It Won't Leak, It's Always Lubricated." Copies of the catalog may be obtained from the eastern office of the company in the Monadnock Bldg., in Chicago.

THE A. H. SLOAN CO., INC., Detroit, Mich. has issued Bull. 5-B, on Royer Flow Indicators. These are adaptable to measurement of steam, air, gases, water and a number of cases involving the measurement of chemicals, such as bicarbonate of soda solution, saponified oils, cutting compounds, ammonia liquors, etc. The instrument was originally developed to control the lubricating oils in the main bearings of the turbine power plant installed in the Eagle patrol boat manufactured for the Government, and has since been adapted to chemical work. The construction of all types of meters is based on the Pitot tube principles. By means of tabulated data and graph charts the readings taken by the operator are materially simplified. In measuring corrosive liquids an oil seal is sometimes provided to prevent the solution being measured from coming in actual contact with the steel parts, and the parts which in this case are impossible to protect are made from monel metal or other alloy, depending on the chemical reaction encountered. Type C-200 and E-300 are especially adapted for conditions where the point of measurement is isolated from the point at which the actual reading is to be taken. The portable outfit Type T-200 is an evolution of the stationary type, with means for adjusting the impact tube when it becomes necessary to make a search or traverse from the point of average velocity in the line, also micrometer adjustment for slope to magnify the deflection in the manometer for velocities which are too low to produce a readable deflection in a vertical manometer.

HOLZ & CO., New York City, announces new bulletins on new and improved testing apparatus: Bull. 9, Amsler Standardizing Boxes, for checking tensile and compressive loads of testing machines; Bull. 10, the Humfrey Static Notched-Bar Testing Machine, for the quantitative measurement of the brittleness and ductility of steel and other metals, yielding autographic record of the bending-angle bending-moment diagram; with automatic integrator for total energy absorbed in breaking the test piece; Bull. 11, the Eden-Foster Repeated Impact Testing Machine, for investigating the resistance of metals to fatigue produced by repeated stresses of low force; Bull. 11, Apparatus for Magnetic Analysis, designed by Dr. C. W. Burrows: the rail defectoscope, rod analyzer, wire analyzer and cable defectoscope.

BASTIAN-BLESSING CO., Chicago, Ill., has just received from the press its new catalog on "Rego Welding and Cutting Apparatus." Various details of torches and regulators will be found in this booklet, together with prices of complete equipment and accessories.

ARMSTRONG CORK CO., Pittsburgh, Pa., has issued a new publication, "Nonpareil Insulating Brick," a 72-page book on the insulation of high temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens, kilns, etc. While dealing particularly with the description of Nonpareil brick and their uses the book is more than a catalog. The subject of heat insulation has been thoroughly studied from both the theoretical and practical standpoints, and the results here compiled contribute to make this book a really valuable and instructive treatise. It is conveniently divided into sections, each dealing with a particular type of industrial apparatus so that any one can readily find the data for the equipment in which he is especially interested. Operating records, with and without insulation, are given, actual dollars-and-cents savings demonstrated, and the economy and advantages to be secured by the use of Nonpareil brick described in a most interesting and convincing manner. The book is attractively and substantially bound and profusely illustrated. Its subject matter is of such vital importance to all industries employing high-temperature equipment that plant managers, superintendents and engineers will find it a valuable addition to the technical library.

THE CONNERSVILLE BLOWER CO., Connersville, Ind., has just issued a revised bulletin, No. 110, describing the Victor blowers which are being used in connection with heat-treating and annealing furnaces, forges and other installations where air is desired in small quantities and under medium pressures.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN GAS ASSOCIATION will hold its second annual convention at the Hotel Pennsylvania, New York, Nov. 15 to 20.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY, will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 5, Society of Chemical Industry; Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry, and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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The Federation's Washington Meeting

AS THE TIME approaches for the first meeting of the Federated American Engineering Societies and American Engineering Council in Washington, D. C., Nov. 18, 19 and 20, it becomes increasingly evident that an event of more than ordinary importance is about to transpire. We have endeavored consistently to support these new organizations through constructive criticism and suggestions. Among other points we have emphasized what must be almost self-evident, namely, that the success of the Federation will depend largely upon the number of constituent societies which decide to join. Impressive as a large aggregate membership may be, it is not so vital to the ultimate success of the Federation as the number of individual society members scattered throughout the country. It is gratifying, therefore, to learn that twenty-two societies have definitely cast their lot with the Federation; that eight more are now voting on the proposal and probably will send delegates to Washington. It is now certain that sixty-two delegates will be present, and when the meeting is called to order it is likely that the aggregate membership will be 50,000. Representing as they do engineers of all classes from all parts of the United States the member societies will give to the Federation and Council a potential force in engineering affairs that has never been equaled. Just how this force will be utilized and in what direction it will be exerted will be evidenced very largely in the first meeting of these bodies. In common with all engineers, therefore, we shall follow the proceedings hopefully and with deepest interest.

Making Progress Through Cleavage

THE ether of space enjoys all the rights and privileges of an imaginary thing. It is as elusive as a postulate in theology, for sometimes we have it—and then again we haven't. Some good men need it every hour and, like Sir OLIVER LODGE, find it a medium for the manifestation of departed spirits, while ALBERT EINSTEIN seems to get along pretty well without it. We have considered ether as having 450 times the density of platinum, and matter as therefore composed principally of holes in the ether; we have also regarded it as so airy and diaphanous that its qualities are "beyond numbers" and therefore over in the domain which is referred to by Sir EVELYN DE LA RUE as infinity; and again we have declared it to be *nil*.

Now comes Professor L. ZEHNDER, who reports, in the *Berichte der deutscher physischen Gesellschaft* (vol. 21, pp. 118-25, 1919), a hypothesis in which the ether is a substance whose ultimate particles consist of extremely small, perfectly elastic "ether atoms." These particles possess weight like ordinary atoms, but are relatively much smaller and have a velocity of the order of that of light. In spite of these enormous velocities every atom of an element has an etheral envelope, and so has every molecule. Then Professor ZEHNDER concludes that electricity is the *heat* of ether, that light is the *sound* of ether, while electric potential corresponds to the *temperature* of ether. The electron he holds to be an aggregation of a definite number of ether atoms. The hydrogen atom he believes to be spherical, and to consist of a globular elementary atom of completely elastic substance, surrounded by an ether envelope which is not completely elastic, since it consists of ether atoms compressed together, thereby giving rise to the existence of damped oscillations and ether motions. His views of the properties of ether, of radioactivity and of the problem of spectral lines are discussed at length in the paper.

It was just about 2,500 years ago that DEMOCRITUS formulated his atomic theory. All things he declared to be made up of atoms, and atoms were small, full, incompressible, without pores and homogeneous. They differed, however, in form, in position and in magnitude.

It has taken us 2,500 years to divide atoms into nuclei and electrons, and now Professor ZEHNDER wants electrons divided into atoms of ether. We have no objection. And if these units of ether are to constitute electrons by means of aggregation, then we would like to carve a niche in the temple of immortality for ourselves by suggesting that the units of ether also shall consist of still smaller parts which shall be endowed with whatever properties are needed. It's curious how ultimate particles seem invariably predestined to further subdivision—if we only wait long enough. If the particles we imagine do not carry on their surface the qualities we need, all we have to do is to carve them up to get new surfaces that were not there before. It is perfectly reasonable to do this.

Now we wonder—just wonder—how long this cutting up business will continue! Study leads to observation, and observation leads to the discovery of new principles—and then we cut up the particles to explain the principles. It would appear that the end is yet afar off, for in the understanding of nature we are still little more than children. There is a great deal yet to be observed, and it may be that in the future as in the past our only explanation will be to cleave the theretofore ultimate particles.

Another discussion that bids fair to outlast the youngest of us is the postulate of ether. Is there such a thing, or isn't there? Perhaps it is just as well not to be certain about it; not to pin our faith too firmly on an opinion. There was the phlogiston theory that held us in bondage for nearly two centuries. It was disturbing to progress.

Cause and Remedy Of Fuel Shortage

OF COMMODITIES commonly employed in industry few if any have been as scarce as fuel. After selling for months at about ten times the price seen occasionally before the war, coal has become relatively plentiful in the market, but it is claimed that stocks in the hands of consumers are unusually light for the season of the year and that there is likely to be a severe "car shortage" this winter, producing a fresh and serious scarcity. Petroleum has been scarce and the outlook for future supplies is considered unpromising. Natural gas is being shut off from industries, to be conserved for domestic use, at the ascending prices domestic consumers are expected to pay gladly.

As to the relative importance of the three fuels, it may be mentioned that when comparison is made on the only basis possible, that of heat units shown by scientific tests, production in the past two or three years has been in approximately the following proportions: Coal, 85 per cent; petroleum, 11 per cent; natural gas, 4 per cent. Thus, apart from necessities of certain cases requiring a particular form of fuel, coal presents the great problem, from the mere viewpoint of the production of heat.

Why should the fuel problem jump to such great importance at this time? What is the matter? A long-range view furnishes the answer. The demand for fuel has increased so rapidly and continuously as to put it out of natural proportion. The sum total of human activity at any given time is so much. From decade to decade our population increases by about 20 per cent. The amount of work a man is willing to do in a day decreases instead of increases. Science and invention increase the man's efficiency, more than offsetting this, but leaving no great margin. The sum total of industrial results that the nation can accomplish probably increases by more than 25 per cent per decade, but it certainly does not increase by as much as 50 per cent. All lines of industrial activity, therefore, cannot increase by 50 per cent every decade. If circumstances favor one industry, it must be at the expense of some other industry.

Now look at coal. From a production of 320,072 tons in 1830 the output rose to six and one-half times as much in 1840, 2,070,039 tons. The next decade saw a multiplication by three and one-half, and it was not until 1850 to 1860 that there was merely a doubling. Every decennial year through 1890 saw more than a doubling. Then a doubling required a trifle over twelve years, to a time between 1902 and 1903. Next there was a doubling to a time between 1916 and 1917, or a 14-year interval.

A little industry can double all it likes, for it has a relatively inexhaustible field of men, materials and equipment from which to draw, but when an industry grows to such size as the coal industry it is another matter. People have other things to do than mine coal, and the railroads have a few other things to do besides hauling coal. The people would have no disposition to stop increasing their use of coal, if they could get it in any quantity desired and at prices to which they have been accustomed. The halt in the geometric progression had to be called some time, and now proves to be the time. The work put into the mining and transportation of coal cannot continue to increase much more rapidly than the sum total of our industrial accomplishment increases. A collection of problems, in mining coal with less effort, in transporting fuel, heat or energy more efficiently and in consuming more economically, is therefore presented.

Seeing Ourselves as The Cubans Might See Us

CUBA is about the richest country in the world. It has grown so rich that its wealth has taken on no less than a comedy character. Nearly every city contains a curious monument, usually in the form of a dwelling, of some hallelujah bumpkin who struck it rich and wanted to inflict the fruits of his own uncultured imagination in architecture upon the eyes of all beholders. The sale of patent leather shoes for feet theretofore bare has broken all records. There has been a veritable storm of diamonds and rubies and champagne on the island. Thousands of big sparklers emblazon collarless shirts. Bleary-eyed passengers on returning to this country have found themselves shouting for prohibition as an unexpected rebound from their days of cheer in Havana. Then the price of sugar went down and they have had to declare a moratorium in Cuba. Our good neighbors have been blowing in their money, and now they're in trouble. So we purse our lips and sink our chins into our collars and shake our heads and declare that they should have been more saving and thus avoided their present vicissitudes.

But how much better off are we? Have we saved? Have we been provident? Have we avoided debt when we could do it? Not so much as to make a very deep impression. Last year the people of the United States spent two billion dollars in luxuries, according to a recent statement of the Commissioner of Internal Revenue. That's about $20 a head, with wines and liquors cut out. We're still a long way off from "normalcy." The other day the writer of this stepped into an umbrella shop on Fifth Avenue to have a ferrule put on a stick. The price, which used to be twenty-five cents, was a dollar. "How much is that one?" we asked, pointing to one of dark wood that looked very plain and "conservative," as they call it. "That," said the clerk, "is $29.50. You see, the band is solid gold. With silver bands they run down to $15 or even $11 or $12." "And the price of that?" we asked, pointing to a plain one with no band at all. "This," said the clerk, taking it down and fondling it, "has been turned without taking the bark off, so you see what a beautiful grain it has under the varnish. It is a genuine malacca." "I see," said the visitor. "And how much is it?" "That stick is $40." "Whew! It does seem dear, doesn't it?" "Huh!" exclaimed the salesman. "A stick like that will last you all your life!" The public may have struck against high prices, but everybody doesn't know it yet. There is still a lot of easy money floating around, and easy money isn't good for us. It is bad for children, and no matter how old foreigners may be, most of us, the people of the United States, are still children.

Now that election is over it is time to quit boasting about ourselves and calling those persons bad names who don't vote as we do. When we bear in mind that every factory, every store, every railroad, every undertaking in progress, every development, is built and made with saving, it is but fair and right that we consider how important savings are. Every bank loan is made up of money set aside and saved by somebody or bodies. All the skyscrapers in New York were built with money

that was earned and saved. So is every establishment, big and little, built with the savings of the promoter or the stockholders, or the mortgagor or the depositor with the mortgagor—or all of them.

It is high time that those of us who have a little influence began to set the example of saving and then to preach its virtues. Pretty soon the value of money will increase again and the value of commodities and work will decrease. Then it will be very hard for those who have saved nothing and very comforting for those who have been provident.

Is Soundness in Steel Sacrificed to Tonnage?

AS AMERICANS we are accustomed to bigness—high mountains, wide rivers, great lakes, mighty forests, and open country. Our business and industrial life seems to have been cast in this mold. Favored with tremendous resources of raw materials, our steel industry, as an instance, has grown to perfectly extraordinary proportions, far outstripping in volume that of any other country. Considerations as to size are somewhat commonplace—we, as Americans, rather expect our undertakings to be big; but are we not also dangerously complacent as to the quality of these stuffs we produce in such huge tonnages?

Steam traction was invented and perfected in the United States. We also make tranverse-fissured rails—somehow, sometimes, no one knows why. Americans of ingenuity have designed fighting engines and defences of many types, yet when our steel men had to make them in quantity, a disease called "flakes" attacked the steel, and the doctors have not yet agreed upon the nature of the ailment, let alone proposed a specific. We build the biggest locomotives and the most automobiles, yet more lost time is chargeable to not quite good enough springs than to any other cause. Are we not more interested in volume of output than the excellence of the article in all its details?

Ten years ago there was a horrified outcry from the informed public about the deadly toll of rail failures, and spurred by this or their consciences, American steel makers turned anxious attention to their rail mills. Recent statistics show a most noteworthy improvement in service records; how this has been effected other than by careful attention to details has not been told, yet we suspect that even yet not enough attention is given toward producing sound ingots. Few would contest the statement, "a prerequisite to faultlessly finished material is perfect ingots"; fewer, unfortunately, have a realization that steel is very hot, is highly reactive, is delicate to handle, in fact is not *made*, until it has safely been cast into sound ingots.

But before venturing into a discussion of whether it is commercially possible to produce sound ingots it would be desirable to define the word "sound." "Sound" metal to one may mean an ingot which will roll into a salable product; to another, it may mean a casting without surface flaw or interior cavity, free of chemical segregation and non-metallic inclusions. Both represent the views of extremists. The first is a pernicious byproduct of a period when manufacturing profits are big enough to cover avoidable and profligate waste. The second is a hallucination of a cub inspector, comparatively harmless, even if bothersome.

Soundness may therefore be recognized as a comparative term. Absolute homogeneity in solidified steel is, by its very nature, impossible. Like most substances, it expands when it is heated and contracts on cooling; hot melted steel filling a mold to the brim will have considerably less volume when it has solidified, and consequently the mold will be full no longer. Hence pipes, contraction cavities and shrinkage cracks. It is idle to try to prevent the contraction demanded by nature's law; the best that can be done is so to control the formation of the resulting cavities that this type of defect is surely localized in a definite region.

Similarly, physical homogeneity is evidently impossible in a substance, like steel, solidifying over a wide range in temperature, by the fundamental law that a solid appearing from such a melt has a different composition than the mother liquor. Hence segregation. Even subsequent and drastic heat treatment which may be able to transport carbon over long distances is unable to equalize the distribution of slightly soluble or thoroughly insoluble substances such as sulphides or oxides—substances which are unquestionably normal constituents of steel, and doubtless always will be. Here again, by the very nature of things, the metallurgist is prevented from doing anything but so controlling natural laws that their effects will be felt in a predictable manner.

Despite these limitations, a definite and even precise conception may be had of the term "sound ingot metal." For our purposes it shall mean metal which has been so made, cast and cropped that if split it will be found free from visible cavities or cracks, a chemical survey will not show segregation greater than say 12 per cent of the heat analysis, and a microscopic study will not show quantities of oxidized inclusions.

Future progress toward the "soundness" represented by this definition will come from close observation of the natural properties of fluid steel as modified by the shape and construction of the molds, especially at the head, the temperature and method of pouring, and to a lesser extent but not less essential, the composition of the metal. That Americans can go far in this direction is apparent to every thoughtful observer of existing conditions, which can only be described as scandalous. Whether due to a purchasing public which is helpless, ignorant or impassive, or to makers who have hypnotized themselves into thinking that sound products are really not essential, or if they are they can be worked from spongy ingots, the fact remains that vast tonnages of beams, plates, rails and other shapes are made of ingots which no one, not an extremist, would call "sound." A steel salesman would also point out that this material is giving satisfactory service, and in the long run service is the master test. Satisfactory, *except* now and then! In rails alone these exceptions cause hundreds of casualties a year. Surely a weighty exception!

Rails are only an instance. That American metallurgists have suppressed their natural instincts for quality before production is at once a scandal and an indictment. Or is it that the "quantity-man" stands first in the eyes of big business? No matter. It was all very well as long as American steel was sold to Americans, who wanted trainloads of it cheap. But when the American market is saturated—and is it not becoming so?—big business will find it will have to make belated obeisance to the altar of quality, else the older worshipers from England and Continental Europe will romp off with all the foreign trade. Perhaps even the American public will become discriminating, if these pestiferous propagandists are not quieted somehow!

Gasoline Cracking Processes

Description of Commercial Methods for the Production of Gasoline by the Pyrolytic Distillation of Heavy Hydrocarbons, Including the Burton, Greenstreet, Hall, Rittman, Aluminum Chloride, Dubbs, Jenkins, and Bacon Processes—List of Inventors, Patent Numbers and Dates

BY FRED W. PADGETT

IN A recent issue of this journal,[1] the phenomena of cracking of petroleum were discussed from their chemical aspects without regard to details involving the various commercial processes, which are the subject of the present paper. The writer does not wish to convey the impression that all the processes to be enumerated here are necessarily successful from a financial point of view, but they have in the main been used for the production of marketable gasoline.

The various processes for producing motor fuel from heavier hydrocarbons may be roughly classified as follows:

(1) *The Pressure Still.* A "two-phase" cracking system. Examples are the Burton and Coast processes.

(2) *The Pipe Still.* Generally a "one-phase" cracking system. Examples are the Greenstreet, Hall and Rittman processes.

(3) *The Use of Catalytic Agents at Atmospheric Pressure.* This may include reaction both in the "single-phase" and in the "two-phase" systems. An example is the aluminum chloride process, which is likely "two-phase" to some extent.

(4) *Combinations and Modifications of Two or More of the Above Methods.* The "cracking" may be in either "single-phase" or "two-phase" systems. Examples are the Dubbs, Jenkins and Bacon processes.

(5) *Processes Involving Principles Not Included Under the Above Four Headings, but Which May Involve Similar Apparatus or the Use of Pressure.* These methods may have either "single-phase" or "two-phase" cracking systems. Examples are the proposed processes of Cherry,[2] Coast,[3] Ellis[4] and many other processes, equally unique.[5] In the first, a bipolar, high-voltage, oscillating, silent electric discharge is passed through the vapors; in the second, hot gases are passed through the oil or into contact with oil spray; and in the third, air is supplied to the cracking chamber, where, by combustion of a portion of the oil, the heat necessary for the "cracking" of the remainder is generated.

During the past eight years numerous patents involving almost every conceivable form of apparatus have been granted for the purpose of securing hydrocarbons within the gasoline range from those of higher boiling point. Many of these patents seek to obviate the trouble incident to coke deposition, while others have the object in view of producing a gasoline which is comparable in quality with the natural product. Still others are along entirely new lines.

As early as 1865, James Young, a Scotch industrial chemist, secured a patent for the production of illuminating oil by means of pressure at about 20 lb. to the square inch.

The apparatus of Benton for the production of illuminating oils from residual oils was patented in 1886, but was never used commercially. A pipe coil within a furnace is heated to a suitable temperature while the oil is forced through at a pressure of 285 lb. or more to the square inch. The products of the reaction are released into a vapor chamber, which in turn is in communication with a condenser. At the inlet end of the coil is placed a safety valve and at the outlet a stop cock for regulating the pressure on the coil.

In 1890, a patent was granted *Dewar and Redwood* for an apparatus involving design different from that of Benton. The process was intended for use in cracking Russian residual oil to illuminating oil, but was never applied commercially because of the demand for the starting material as fuel and its consequent rise in price. A retort disposed in a furnace has one end in communication with a dome, the latter also being connected to a condenser. Safety valve, pressure gage, charging line and receiver are also shown, and the condenser and receiver are held under pressure. It is proposed to fill the retort partially, to distill under pressure and to collect the distillate in the receiver. Dewar and Redwood do not state what pressure gives the best results.

THE BURTON PROCESS

Burton's first patent was granted in 1913, and the process is extensively used at the present time by the various Standard Oil companies. In 1918 it was estimated that 10 per cent of the gasoline produced was by cracking, a large proportion of this being through Burton stills. The development of this process marks one of the milestones in the history of petroleum refining and its originator merits the distinction of being the first to demonstrate that pressure distillation could be done safely and practically on a large scale. In addition, Burton realized the limitations of the type of apparatus and did not attempt, in the original design, to make the operation continuous.

The original claims of Burton consisted in the distillation of petroleum under a pressure of 4 to 5 atmospheres and a temperature of 650-850 deg. F., maintaining the pressure upon the volatile products until they had passed through the condenser.

The standard Burton apparatus includes a still of 200-bbl. capacity or more, of conventional shape, so constructed that high pressures may be used. Modifications of the Burton process call for introduction

[1]See CHEM. & MET. ENG., vol. 23, No. 11, Sept. 15, 1920, p. 521.

[2]U. S. Pat. 1,229,886, Jan. 12, 1917, and U. S. Pat. 1,327,023, Jan. 6, 1920.

[3]U. S. Pat. 1,252,401, Jan. 8, 1918, and Cosden-Coast, 1,261,215, April 2, 1918.

[4]U. S. Pat. 1,295,825, Feb. 25, 1919.

[5]Some of the principles involved are as follows: The use of molten metal as a cracking agent; oil may be sprayed against an electrically heated plate within an autoclave; a perforated basket charged with metallic turnings may be disposed in a furnace; oil vapors may be subjected to progressively increasing and then progressively decreasing temperatures; superheated steam; various methods utilizing electric discharge across vapors; emulsified oil as starting material; etc.

of the oil in the vapor line,[6] amounting to semi-continuous operation, the use of false bottoms[7] upon which the main portion of the carbon collects, and lastly a still of the water tube boiler type.[8]

At the present time the Standard Oil Co. of Indiana is operating three types of pressure distillation apparatus: (1) The Burton-Humphreys still; (2) the Clark apparatus; and (3) a later improvement of the original Burton-Humphreys modification involving the use of a special tower through which the vapors proceed before entering the water-cooled condensers. The first is generally operated intermittently or "batch," the latter two "semi-continuously"—i.e., oil is pumped in to replace that removed by distillation.

The arrangement of the vapor lines and receiving houses is of interest. The vapor lines from the Burton-Humphreys stills ascend gradually, terminating in manifolds which in turn connect with aërial condensers. During operation, vapors liquefied in the aërial condensers are continuously being refluxed to the stills. The uncondensed vapors from the aërial condensers enter the water cooled coils, where liquefaction takes place accompanied to some extent by solution of permanent gases in the distillate passing through the coils. From each water-cooled coil a "run line" terminates in an upright drum (gage glass at the side) which serves as a temporary receiver for the pressure distillate and also as a chamber for the separation of permanent gases not in solution in the distillate. A manifold constructed from small pipe connects together the tops of all the receiving drums in a battery of stills and serves the following important purposes: First, the equalization of pressure throughout the entire battery; second, the *control* of pressure on the stills in the battery (by means of a relief valve); and third, the withdrawal of permanent gases not in solution in the distillate.

The distillate in the receiving drums, consisting of from 50 to 60 per cent of the original charging material and yielding 50 to 55 per cent of gasoline upon subsequent fractionation in steam stills, is continuously withdrawn and collected in tanks at a pressure near that of the atmosphere. The gases which are produced during "venting" contain considerable quantities of gasoline vapor and may be treated by standard methods for gasoline recovery. The heavy residuum left after repeated "cracking" of the primary distillates heavier than gasoline and the primary residuums has a density approaching that of water and finds application as road oil.

It is claimed for the Burton process that by proper "rerunning" of primary residuum and heavy distillates in the pressure stills, 75 per cent of an oil, such as Oklahoma crude, may be recovered as gasoline. For obvious reasons, however, this is not the customary practice.

The Design and Operation of Pressure Stills

At the temperature at which the pressure still operates steel begins to decrease in tensile strength. Therefore, it is evident that a fundamentally important consideration lies in the material and method of construction of the stills.[9] As an outgrowth of this need there are now firms which specialize in the construction of stills for severe usage.[9] The stills are solid metal $\frac{1}{2}$ to $\frac{3}{4}$ in. in thickness and hammer welded,[10] this method of construction being claimed as superior to both riveting and to acetylene or electric welding, for the purpose in view. In the operation of pressure stills the operator has before him thermometers and pressure gages, which inform him of the conditions prevailing within the various units under his control.[11] In the operation of some pressure stills using gas oil as the starting material, the distillation is continued at the average rate of 1 to 2 per cent an hour and the run is completed in 48 hours, giving a yield of 35 per cent of 450-deg. F. end point gasoline. During distillation the bottom of the still is watched if any "hot spots" develop, due to superheating from deposited carbon, and close surveillance is maintained to determine if it will be necessary to close down the still before the run is completed. After each run the deposited carbon is completely removed from the still before rech..rging.

During the operation of pressure stills, the proper distribution of heat on the bottoms of the still is important. Between operating periods it is customary to inspect the apparatus carefully at all points and often to measure the thickness of the metal so that the amount of corrosion, due to sulphur compounds in the oil, may be ascertained.

The Greenstreet Process[12]

The first patent in this process was granted to the applicant in 1912,[13] and a plant of this design has been in operation in St. Louis for a number of years. By this method the oil vapors are subjected to heat while traversing tubes in the presence of steam. The oil to be treated is first forced through preheater coils so arranged in the furnace that a very high temperature is not secured. The oil is then mixed with steam and enters the cracking coils, where the vapors are subjected to the most severe temperature conditions in the entire cycle. From the cracking zone the products leave the coil and enter drums of considerable size where the velocity of the vapors is lessened, the heavier constituents condense, while cracking and polymerization continue for a longer time than otherwise would be the case. Leaving the expanding drums, the lighter vapors are reduced in pressure before they enter the condenser. The heavier products are drawn off from the bottom of the expanding drums.

The Design and Operation of Pipe Stills for Cracking

In the Greenstreet process the cracking coil units are of 2-in. pipe 425 ft. in length, six or more of which are arranged in the furnace to make up the complete installation. These coils are suspended from steel beams at the top of the furnace in a way that facilitates easy removal and replacement. The furnace is operated by a stillman who has before him gages, meters and thermometers for noting the conditions prevailing in the process. When operating pipe stills in the presence of steam[14] for the production of motor fuel from heavier hydrocarbons, the rate of flow, temperature, pressure and quantity of steam depend upon the character of the initial material. Thus kerosene would neces-

[6]U. S. Pat. 1,199,464, Sept. 26, 1916.
[7]Humphreys patents 1,122,002 and 1,122,003, Dec. 22, 1914 and 1,119,700, Dec. 1, 1914.
[8]Clark patents 1,119,496, Dec. 1, 1914; 1,129,034, Feb. 16, 1915, and 1,132,163, March 16, 1915.
[9]See, in this connection, the work of Bjerregaard, *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 573.
[10]U. S. Jenkins in the construction of his apparatus utilizes a combination of riveting and electric welding at the joints on the inside. The metal is $\frac{3}{4}$ in. in thickness.
[11]Liquid meters are sometimes placed on the run lines.
[12]*Petroleum Age*, vol. 6 (1919), p. 66.
[13]English Patent, 16,452, July 13, 1912.
[14]Private communication.

sitate the use of less steam, but a higher pressure and temperature, than gas oil, to secure the best results. In operating pipe stills for cracking, it is considered necessary to determine optimum operating conditions for a particular type of starting material, and then to adhere as strictly as possible to these conditions during subsequent runs. "Close cut" distillates are said to give the best results.

The Hall Process

Although developed by an American, this process was first tried on a commercial scale in the British Isles, being used throughout the war for the production of benzol and toluol from gas oil. In this country the Texas Company has been interested in the process and has done considerable research, but at this time has no information which it wishes to make public. The apparatus, in a broad way, resembles that of Greenstreet, but has the fundamental difference of operation in that steam is not used. The operation of one of Hall's British plants was described by Lomax in 1916, but since Hall has been a prolific inventor, especially on methods of treating the distillates secured, it is possible that important changes have been incorporated in the commercial operation since that time.

It has been reported that the Hall process is being used to "crack down" heavy Mexican crude to a suitable viscosity for use as fuel.

The oil[15] traverses the coil and is gradually heated until the most severe conditions are encountered at the outlet where the pressure is reduced to near atmospheric, the speed of the vapors reaching 5,000 to 6,000 ft. per minute. From the expanding drum the vapors pass through a series of dephlegmators where several products of varying boiling point are removed and finally to a compressor where the vapors are compressed and then cooled. Each coil is composed of 600 ft. of cold-drawn 1-in. (internal diameter) tubing, and the coils are spoken of as being arranged in nests.

For the production of motor fuel a temperature of 550 deg. to 600 deg. C. obtains at the tube outlets (pressure, 75 lb.), but in working for benzol a temperature of 750 deg. C. and pressures of 100 to 105 lb. to the square inch are necessary. No doubt these conditions will vary for various types of starting materials. It is claimed that motor fuel to the extent of 70 per cent can be secured from the total original oil charged, by rerunning certain residues from the dephlegmators.

The Rittman Process[16]

So many are familiar with the principles of this method that a detailed description is unnecessary here. Suffice it to say that the "cracking" takes place in the vapor form in an upright tube. Oil is atomized into the tube at the top and the gasoline vapors and tar are taken off separately from the tar pot at the bottom. Carbon is removed from the sides of the tube in the cracking zone by means of a rod and chain, the latter being thrown against the sides when the former is revolved. Optimum conditions for operation are given as follows by Rittman and Dean: for gasoline 500 to 550 deg. C. and a minimum of 12 atmosphere pressure; for the production of aromatics a temperature of 625 to 700 deg. C., and a minimum pressure of 8 atmospheres are recommended. A single tube of the Rittman type is specified by Bowie as 13 to 14 in. in diameter and 13.5 ft. in length.

The Aluminum Chloride Process[17]

The most conspicuous developments under this method have been carried out by McAfee[18] of the Gulf Refining Co. The oil is heated and stirred in a still in the presence of anhydrous aluminum chloride or other anhydrous salt of aluminum. Before treatment the oil must be freed from water and a quantity of the catalyst equal to a maximum of 8 per cent by weight of the oil charged is added before the distillation is begun. Fractionating towers are interposed between the still and the condenser so that the higher boiling vapors may be returned to the still along with aluminum chloride which has been vaporized and carried out. The distillation is continued slowly at a temperature of 500 to 550 deg. F. over a period of 24 to 48 hours. By this method, a yield of gasoline of 15 per cent or more may be obtained from residual oils.

Very interesting in connection with this process is the effect upon the residue remaining in the still and the character of the distillate secured. At the end of the distillation it is found that the aluminum chloride is enclosed in granular coke, which is easily removed, and that a heavy oil free from asphalt, its viscosity in no way impaired by the procedure, may be separated from the coke and then utilized for the production of high-grade lubricating oils, the recovery of paraffine wax or the manufacture of petrolatum. The distillate secured by aluminum chloride treatment is water white, possesses a pleasant odor and in order to secure the finished gasoline it is only necessary to wash the "re-run" distillate with dilute alkali and water.

By the action of anhydrous aluminum chloride on residual petroleum, sulphur compounds are destroyed and possibly nitrogen and oxygen compounds such as naphthenic acids as well.

The one difficulty suggesting itself as being inherent in this process is that of recovering the aluminum chloride, or of manufacturing it cheaply.

Other Processes

Three methods which have recently come into prominence because of favorable reports concerning their operations are those of Dubbs, Jenkins and Bacon.

The design and operation of the *Dubbs plant* is given in the report of a committee of the Western Refiners' Association to its members. Extracts from this report are quoted as follows: The plant proper consists of a cracking coil made up of ten lengths of 4-in. extra heavy lapwelded pipe, each 20 ft. in length, joined on the ends by return bends. This coil of 4-in. pipe is located horizontally in a furnace in two rows, six of the pipes being in the lower row and four in the upper row. The furnace temperature is maintained at approximately 1,540 deg. F. The outlet of the 4-in. coil is connected to an expansion chamber, which consists of four 20-ft. lengths of 10-in. common extra heavy pipe. These pipes are connected in series by return bends so as to form an expansion chamber approximately 80 ft. long. These 10-in. pipes are located horizontally in a chamber and are not heated, but lagged to prevent loss of heat by radiation.

[15]Lomax, *J. Inst. Pet. Tech.*, vol. 3 (1916), p. 36.
[16]See U. S. Bureau Min. Bulletin 114 and Technical Paper 161.
[17]See *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 737.
[18]*Ibid.*

The raw oil is fed into one end of the 4-in. coil by means of a force pump, and as the oil passes through, it is heated to about 820 deg. F. and is then discharged from the other end into the 10-in. expansion pipes, which are maintained approximately half full of oil. The vapors are liberated from the oil and pass up through connecting goosenecks to a manifold, then to vapor lines leading to a spiral vapor condenser and finally into a water-cooled condenser. A pressure of about 135 lb. to the square inch is maintained on the entire apparatus. The unvaporized portion of the oil in the 10-in. coil is continuously drawn off from the end of the last unit.

In regard to the Dubbs process, it should be noted that the "cracking" takes place in a "two-phase" system.

The results of a test run of 168-hr. duration are summarized as follows:

Total gas oil treated, gal	20,952
Total uncondensable gas, cu.ft	25,851
Fuel used [19] – equivalent of 3,677 gal. of 14 Bé fuel oil.	

Products (per cent yield of original oil charged):	Per Cent
Gasoline (440 end point), (58-59 deg. Bé)	26 29
Kerosene (40-41 deg. Bé.)	14 11
Pressure distillate bottoms (31-32 deg. Bé.)	27 19
Residuum (13-14 deg. Bé.)	24 71
Loss	7 70

The principle of the *Jenkins process* is the use of an apparatus resembling the water-tube boiler. The tubes in the latest installation are 2½ in. outside diameter, and cold drawn. The furnace is of the vertical baffle type with Dutch oven, no heat coming in direct contact with either the longitudinal or transverse drums. The operation of the process is continuous and the oil is circulated mechanically. The safe limit of operation (with the type of starting material being used) has been found to be when a volume of oil equal to fourteen times the charging capacity has been passed into the apparatus. Working under these conditions, it is claimed that the life of the still is greatly prolonged and that the time of cleaning is five minutes per tube. In closing down after a run the reduction of temperature is accomplished gradually by forcing more charging oil into the apparatus under complete mechanical circulation, thus eliminating undue stresses or strains which might be caused by a sudden temperature drop. Mr. Jenkins contributes the following data in connection with a run of 46 hours, using pressure distillate gas oil[20] from Homer crude as the starting material:

Total oil circulated, gal	17,130
Overhead pressure distillate, gal	11,600
Fuel used 48,000 cu ft. of city gas (natural).	

Products (per cent yield of original starting material):	Per Cent
Gasoline (118 i.b p., 460 end point).	24
Kerosene	29
Steam still bottoms	14
Pressure still bottoms (52 vis. Saybolt at 100 deg. F. and when treated, 4-½ color)	27
Total loss	6

The pressure used in the above run varied from 105-110 lb. gage; temperature 700-710 deg. F.

THE BACON PROCESS

The Bacon process was developed under the direction of Raymond F. Bacon and Benjamin T. Brooks at the Mellon Institute of Industrial Research. As originally designed, some difficulties were encountered during operation because of coke deposition on the tubes but, according to the latest information, certain improvements have made the process appear very promising. The "cracking" is carried out in vertical tubes 20 ft. in length and 6 to 19 in. in diameter, the oil level being maintained at the top of the heated zone, and the process operated continuously. The oil inlet and vapor outlet are located at the top of the tube. The lower ends of the tubes are connected to a drum into which the tar and coke settle and are drawn off from a pipe at the bottom. When operating an apparatus of this type, coke accumulates very slowly on the metal surface in the cracking zone and in addition a large heating surface is exposed to the oil. The pressure specified is from 60 to 300 lb. to the square inch, but preferably 100 lb. The yields of gasoline (56 Bé.) claimed for various oils are as follows:

	Per Cent
Oklahoma gas oil (32 deg. Bé)	45
Mexican fuel oil (12 deg. Bé)	50
California fuel oil (14 deg. Bé)	47
Caddo heavy crude (12–14 deg. Bé.)	48

THE PRESENT STATUS OF THE PETROLEUM "CRACKING" INDUSTRY

While the past eight years has seen an enormous amount of research and invention along this line, the present finds but few which may safely be designated as established processes. A conclusion which is soon reached is that no matter how promising a process may appear at the beginning, only extended plant operation determines its commercial success. The operation of the pressure still is approaching something like standard practice in many refineries, but even then has its limitations. Some time ago one optimistic refiner informed the writer that he had directed his research staff to bend its energies toward the discovery of a chemical agent, either catalytic or otherwise, which would transform all, or nearly all, of the heavy hydrocarbon mixture into gasoline, with only negligible loss due to coke and gas formation. However difficult this may be, such a course would seem to be the most legitimate in view of the results in the past ten years along other lines.

In the field of pure research it is desirable that the problem of the composition of petroleum be undertaken in a broad way and with sufficient funds and personnel to insure the solution of the problem within a reasonable time. In the past this work has been handicapped, not by the lack of expert or enthusiastic direction, but by the need of more extended facilities. Such routine work as fractional distillation consumes a great deal of time.

The need of research upon the properties of the higher members of the hydrocarbon series other than the aromatics has been emphasized by Brooks[21] and needs no discussion here.

A Select List of Patents on Cracking

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Alexejew, G., German 39,949, Jan. 20, 1887.

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Bacon, R. F., Brooks, B. T., and Clark, C. W., U. S. 1,131,309, 1915; U. S. 1,334,731, March 23, 1920.

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Barbet, E. A., French 380,282, Oct. 3, 1906; French 390,558, July 31, 1907.

[19] Consumed during the run.

[20] It should be noted that this starting material has already been once through the process.

[21] CHEM. & MET. ENG., vol. 22 (1920), p. 933.

Bell, A. F. L., U. S. 1,231,095, July 3, 1917.
Benton, G. L., U. S. 342,564, May 25, 1886; U. S. 342,565, May 25, 1886.
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Born, S., U. S. 1,234,124, July 24, 1917.
Brownlee, R. H., U. S. 1,308,161, July 1, 1919; Can. 185,052, June 25, 1918.
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Burton, W. M., U. S. 1,105,961, Aug. 4, 1914; Can. 155,567, May 12, 1914; U. S. 1,167,884, Jan. 11, 1915; U. S. 1,049,667, Jan. 7, 1913.

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Cherry, L. B., U. S. 1,327,023, Jan. 6, 1920; U. S. 1,229,886, June 12, 1917; British 104,330, Dec. 1, 1916.
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Cobb, E. B., U. S. 1,322,762, Nov. 25, 1919.
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Wave Power Transmission

From Our London Correspondent

London, Oct. 13, 1920.

The formulation of a new and practical method for the transmission of energy is a rare occurrence, and the announcement just made by W. H. Dorman & Co., Ltd., of Stafford, seems to be of far-reaching importance to the mining, shipbuilding and allied industries. The principles of the transmission of power by wave impulses through liquids were necessarily kept secret during the war owing to their use for the automatic firing of guns on airplanes and like purposes. Since the armistice, wave power tools have reached a high state of development and the opinion is generally held that in the mining industry particularly sweeping economies are to be expected by the adoption of this system in place of compressed air.

Briefly the apparatus consists of a wave generator comprising one or two metal cylinders each fitted with a piston driven by any suitable high-speed prime mover and a corresponding wave motor at the far end of the transmission pipe line. The pistons at the wave motor end are suitably connected to the tool or other mechanism to be operated, such as a rock drill, riveting hammer or rotary mechanism, the energy being transmitted through the pipe line in the form of a succession of power waves rendered possible by the slight compressibility of the water or other liquid medium and to a smaller extent by the slight expansion of the pipe line under pressure. The mean pressure in the pipe line for rock drill work is about 750 lb. per sq.in., but the special ball-jointed pipe lines are tested to 15,000 lb. per sq.in. It is claimed that an over-all mechanical efficiency of 50 per cent is attained as against 10 per cent with compressed air, while maintenance costs are one-third and capital costs one-half those obtaining in compressed air work. The usual "frequency" is 2,400 waves or blows per minute and the use of springs and the presence of air at the drill point are eliminated. Lubrication in unnecessary and existing standard appliances can be converted to the new system. The extension of this method of energy transmission is foreshadowed in regard to piledriving, coal cutting, oil conveyors and other industrial applications.

Production of Potash in Alsace—Correction

In our issue of Sept. 1, 1920, p. 382, we published an excerpt from the June 30, 1920, number of the *Frankfurter Zeitung* stating that during 1919 Alsace produced 40,000 metric tons of potash.

H. J. Baker & Bros. of New York inform us that their principals, the Société Commerciale des Potasses d'Alsace, have brought to their attention the fact that this figure is not correct and that the actual figure for potash produced by Alsace mines for the year 1919 was 92,000 metric tons.

We are glad to make the correction accordingly.

Operations in a New Orleans Foundry*

By Frank A. Stanley

The photographs herewith illustrate some of the operations of a New Orleans foundry engaged in the production of sugar machinery.

The greater part of the work of this firm is of a very heavy character and much of it is loam molding in which the cores and molds are swept up by striking boards or sweeps. The sweeps are made of rigid metal striking bars or spindles held vertically in heavy brackets with suitable bearings and carrying adjustable arms to which the boards are bolted for various sweeping operations. A view of such work is shown in Fig. 1. Most of these molds are made up of brick and loam with a certain amount of clay in spots. The sand or loam inside the brick mold is usually ¾ to 1 in. thick, and commonly loam is used as a binder for holding the bricks together. The building up of the mold by the sweeping process is followed by baking over night in big core ovens, the whole brick mold being picked up bodily by overhead cranes and transferred to cars which are run into the ovens.

In molding big rings, drums, cylinders and the like the brick and loam work is built up and swept to any desired height and diameter and both molds and cores are handled advantageously in this manner.

An Interesting Molding Job

A job of special interest is represented by Figs. 2 and 3. This is the molding of a cone-shaped casting which is part of a calandria vacuum pan. The casting is of brass and its diameter is 13 ft. or more, depending upon the size of vacuum pan manufactured. In the conical face of this casting there are cored over four hundred 3½-in. holes, which are afterward machined to receive the ends of short copper tubes connecting two of these cone castings together in the assembled vacuum pan in much the same manner as tubes are placed in a boiler. The cone casting in the 12- or 13-ft. size is about 6 ft. high. The thickness of the metal in the wall is about ½ in.

*Reprinted from *American Machinist*, vol. 53, p. 411; Sept. 2.

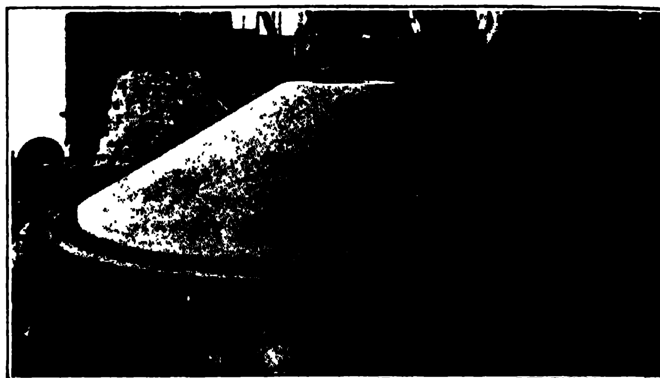


FIG. 2. PART OF A MOLD FOR A VACUUM PAN

The lower half of the mold, Fig. 2, is built up first, loam and sand being used over a brick center and the cone swept to dimensions ready for baking in the oven. This cone is used as a core or center for the molding of the supper half of the mold, and for this purpose a half-inch thickness of sand is left all the way round on the lower cone to represent the thickness of metal to be run. The top half of the mold is placed in position and molded to the lower cone.

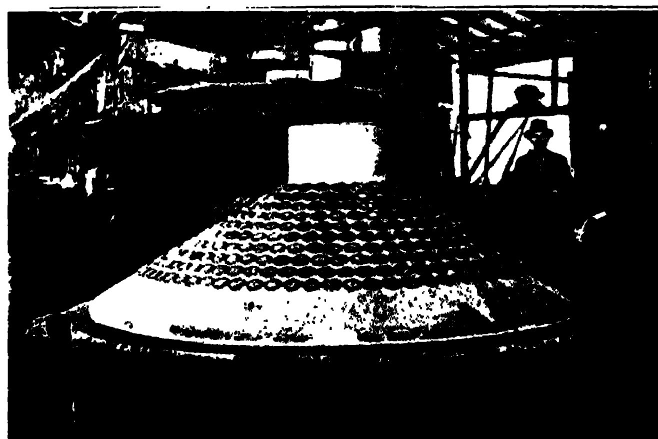


FIG. 3. OVER 400 CORES IN PLACE

Afterward the half-inch of extra sand thickness is swept off the lower cone and the latter is scribed with a series of lines around its surface for the accurate placing of the 3½-in. cores to form the openings through the walls. These small cores are dry sand, baked as usual, and are positioned as shown by Fig. 3, where they may be seen in ten circles around the cone.

When the top of the mold is placed in position the metal is poured through the neck and flows down over the sloping cone. About 3,700 lb. of metal is run in this job. The operations illustrated are from the plant of Dibert, Bancroft & Ross, New Orleans, La.

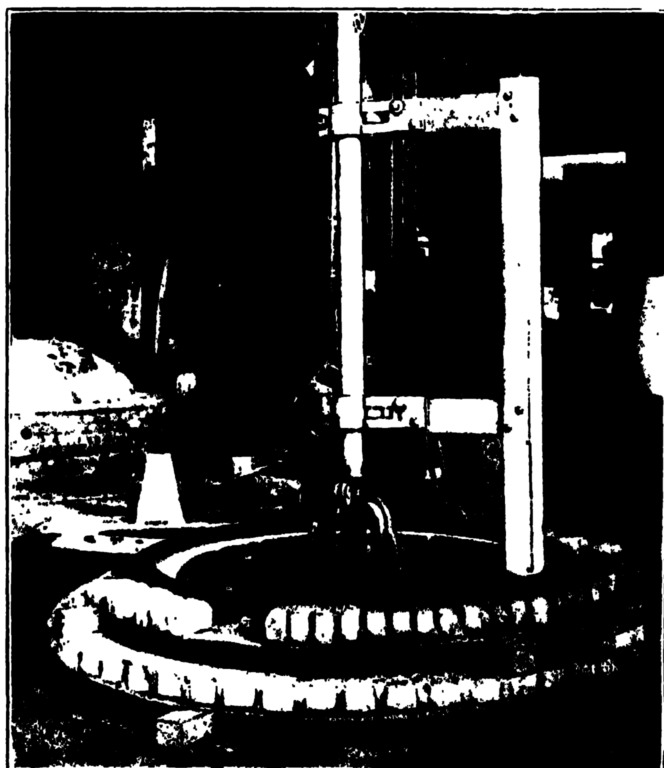


FIG. 1. THE SWEEP IN POSITION

Report on Helium Study Expected Soon

The field work in connection with the helium study being made under the general supervision of the Bureau of Mines will be completed within a month. A report on the work will be available shortly thereafter.

A Disastrous Explosion of Aluminum Dust

A Description of the Investigation by Federal and State Officials of the Causes Leading to the Aluminum Dust Explosion, the Manner in Which the Explosion Occurred and the Results of This Investigation

BY DAVID J. PRICE*

IN RECENT years a large number of disastrous explosions have occurred in industrial plants in both the United States and Canada. Careful investigation of these explosions has shown that in many cases the ignition of flammable dusts created during the operating processes has resulted in large losses of life and extensive property damage. Some of these explosions have taken place in industries where "dust explosions" had not previously been known to occur and the necessity for control methods were not fully recognized. Among the more recent explosions of this nature was an explosion in an aluminum goods manufacturing company's plant in a Northwestern state, which attracted the attention of the engineers engaged in prevention work. The explosion caused the death of six girls and injuries to as many more.

A thorough investigation by Federal and state officials indicated that the explosion was due to the ignition of "aluminum dust" by sparks produced by the friction of a piece of wire on the interior parts of an exhaust fan. This article reviews in a brief manner the circumstances under which the explosion occurred and the results of this investigation.

PROCESSES ENGAGED IN

At the time of the explosion the company was engaged in the manufacture of a complete line of aluminum ware, such as teakettles, teapots, cooking utensils and similar articles manufactured from this material. The aluminum was delivered to the factory in sheet form, varying in size, gage and length, and ranging in width from 7 to 24 in. After the metal sheets entered the factory they were given a light coating of grease to assist in the handling and to prevent tearing and cracking during the processes of cutting, punching, stamping and spinning. The grease and dirt were later removed by passing the articles, after shaping, through naphtha, lye or acid baths. They were then dried and ready for the finish application.

*Engineer in charge, Grain Dust Explosion Investigations, Bureau of Chemistry, Washington, D. C.

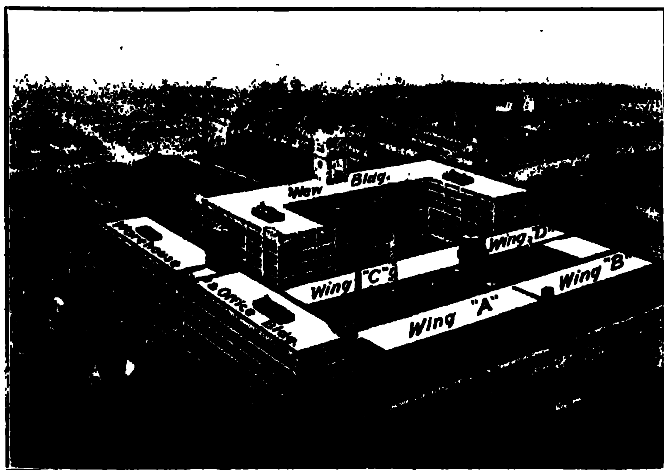


FIG. 1. EXTERIOR VIEW OF PLANT, SHOWING ARRANGEMENT OF BUILDINGS. EXPLOSION OCCURRED ON TOP FLOOR OF WING "C."

Four different finishes were applied, depending on the article. For convenience these finishes may be designated as (1) high polish, (2) satin, (3) acid and (4) emery. The explosion occurred in the satin-finishing department located on the third floor of Wing "C" (Fig. 1).

SATIN-FINISHING DEPARTMENT

The satin-finishing department was located in a room on the third floor approximately 200 ft. long and 40 ft. wide, occupying a little over one-third of the south end. About twenty-five girls were employed in this department. In addition about thirty other persons worked in the room in connection with other departments. The girls affected by the explosion worked in the satin-finishing section.



FIG. 2. VIEW SHOWING DUST-COLLECTING PIPE UNDERNEATH WORK BENCH, IN WHICH EXPLOSION OCCURRED

Nine lathes were used in this satin-finish process. These machines were placed on a long wooden bench, and two girls were employed to a machine. The lathes were made up of a spindle approximately 30 in. long with a circular steel brush at each end. This brush was made of fine steel wires, radiating from the center. The satin or "scratch" finish was applied by placing the aluminum ware against the revolving steel brush. During this process fine particles of the aluminum are removed. This creates what might be termed

"aluminum dust," and for sanitary reasons an exhaust system was installed to aid in its removal and improve working conditions for the employees in this room.

DUST-COLLECTING SYSTEM

The steel brushes used in applying the satin finish were surrounded by hoods connected by a 3-in. pipe to a main trunk line, which averaged 12 in. in diameter. It was connected to a 35-in. exhaust fan with a 16-in. opening, which drew the dust from the machine and discharged it to the atmosphere outside. The trunk line extended underneath the bench (Fig. 2) and varied in diameter from 6½ to 16 in. This was about 56 ft. in length and was fitted with four 6-in. hand holes for cleaning purposes. The fan was constructed of steel and had a steel casing. It ran at 700 r.p.m., and discharged through a 12 x 12-in. opening.

The first three machine hoods were connected separately to the trunk line, while the remaining six machines were connected in pairs, one trunk leading from the main line and then separating one line to each hood (Fig. 3). The girls fatally injured were working at wheels 12, 13, 14, 15 and 16. The other injured employees were located at machines 1, 2, 10, 17, 18 and 19.

ACCOUNT OF EXPLOSION

The explosion occurred about 11 o'clock in the morning, Feb. 26, 1920, while the plant was in full operation with about 800 employees on duty. The explosion was accompanied by a loud report, which was heard for considerable distance from the plant. The weather was clear and cold with minimum temperature for day of 1 deg. below zero; maximum, 16 deg. above zero; relative humidity, 29.7 per cent.

The finishers, all of whom were girls, were seated at their benches, when like a bolt of lightning a blinding flash of fire enveloped them and in an instant their clothing was a mass of flames. Six of the girls died from their injuries, while as many more were seriously burned.

The room in which the explosion occurred was well lighted, having sixteen large windows on the west side and twelve on the east side. Each opening was 6 x 8 ft., thirty panes of glass to the opening.

About one-sixth of these panes were shattered, and a few of the steel window frames were slightly bulged. Both side walls, which were 16 in. thick, were bulged. The west wall was sprung about 3 in. at the ceiling, and the east wall was forced out about 2 in. at the same point. This crack appeared for a distance of about 50 ft. on each wall.

The damage to the building can be considered very slight, and no surrounding property was affected. The fire following the explosion was readily checked by the efficient sprinkler equipment within the building, combined with the excellent work on the part of the employees and officials, who fought the flames until the arrival of the city fire department. The general condition regarding upkeep and cleanliness of the plant was very good, a factor which must be recognized when the small area affected by the explosion is considered.

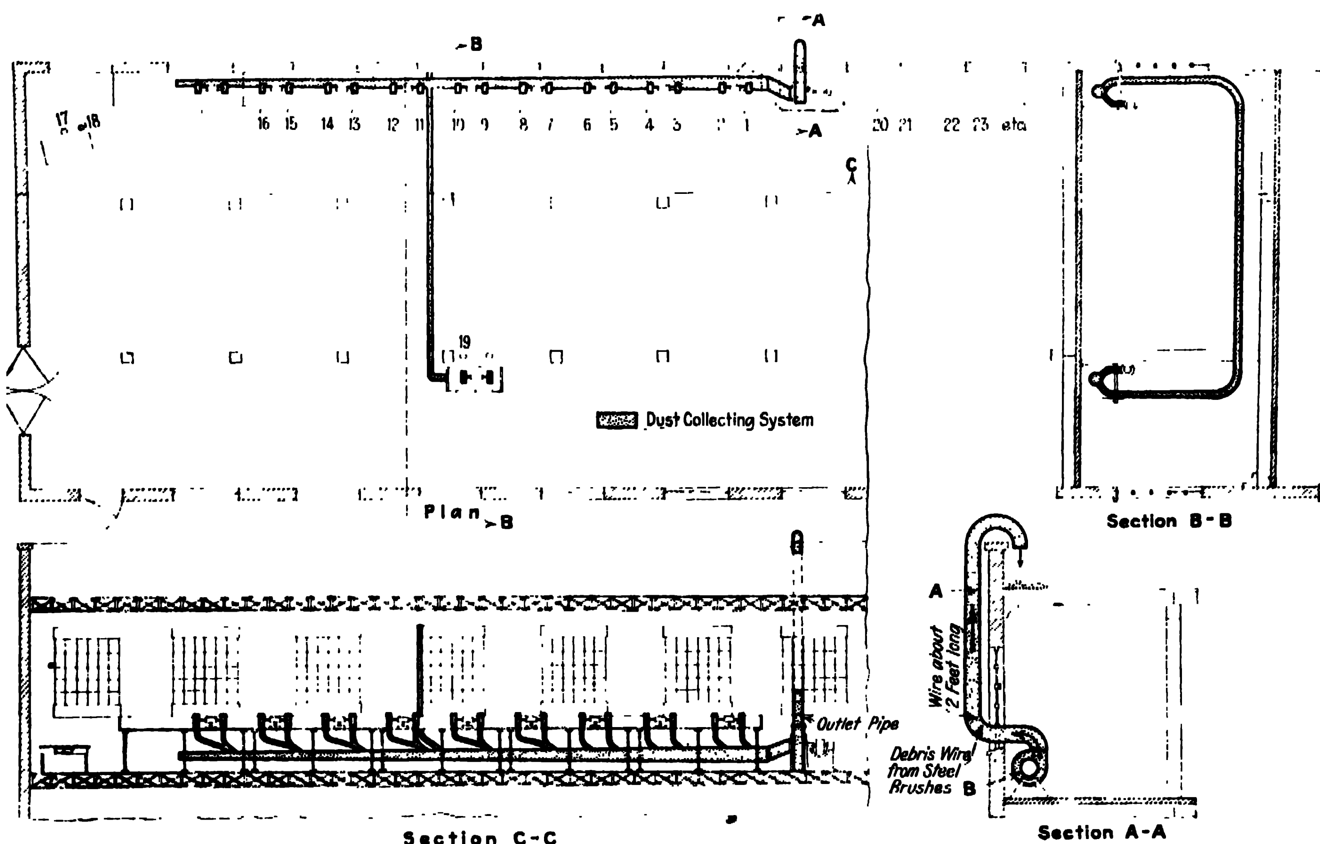


FIG. 3. PLAN, ELEVATION AND SECTION OF OLD SATIN-FINISH DEPARTMENT, SHOWING THE DUST-COLLECTING SYSTEM

CAUSE OF THE EXPLOSION

The cause of the explosion was attributed to a piece of No. 7 B. & S. iron wire about 8 ft. long winding itself around the blades of the exhaust fan. The metal-

the sparks as a result of friction of the wire on the interior parts of the fan ignited the finely divided aluminum dust. The fan was opened by C. W. Keniston, sanitary engineer of the State Industrial Commission, and the wire was found in position in the fan as shown in Fig. 4. A full view of the wire showing its length can be seen in Fig. 5.

How the wire was introduced into the fan was not definitely determined, but the general opinion prevailed that the wire entered the fan from the outside. The exhaust pipe from the fan extended out through a window and up to about 5 ft. above the roof level, and discharged onto the roof.

At the time of the explosion the company was engaged in erecting a new building adjacent, and various kinds of guy wires had been strung to the tops of near-by buildings. Whether through carelessness a piece of wire was laid on the mouth of the exhaust pipe or through malicious intent was placed within the pipe was undetermined at the time of the investigation.

The arrangement of the pipe leading from the fan to the roof was such that the wire coming in from the outside would be required to pass through two 15-deg. turns. It is, therefore, possible that the wire may have been lodged in the pipe for some length of time, gradually working down by the vibration of the pipe until eventually it was struck by the paddles of the fan.



FIG. 4. VIEW SHOWING POSITION IN WHICH A PIECE OF NO. 7 B. & S. IRON WIRE WAS FOUND IN THE EXHAUST FAN

It was stated that two girls within 10 ft. of the fan, employed at a wrapping bench immediately north of the exhaust fan, heard a noise within the fan a short time prior to the explosion. This noise was heard distinctly on two occasions previous to the blast. It appeared to be simply a rattle, and one girl on hearing it arose from her chair and walked away from the fan. The explosion occurred before she could reach her sister, a distance of probably 8 ft. The second girl, who was sitting closer to the machine, heard the rattle three times and stated that the explosion occurred immediately following the third noise and that she saw smoke first before the blinding flash occurred.

Two pieces of wire were removed, one from the fan and the other from the exhaust pipe. This indicated that probably the original piece of wire was broken; one piece winding itself about the blades, and the other sticking in the pipe.

It appears that the trunk line under the bench was cleaned out at certain periods, approximately every two months. It was the intention to clean out this pipe a few days later. In removing the dust and dirt from the pipe a cable, along with a wooden scraper, was used. The wire found in the fan did not correspond to the description of the cable used in the cleaning process.



FIG. 5. FULL LENGTH OF WIRE FOUND IN THE EXHAUST FAN AFTER THE EXPLOSION

It was estimated that an average of about 30 lb. of dust and dirt was taken from the trunk line every two months.

Previous Explosion

A slight explosion was observed in this exhaust system a few months previous to the disaster referred to in this article. A workman was engaged in cleaning out the exhaust system of the satin-finishing department prior to the time that the finishers came on for the day's shift. The fan was running, and during the cleaning process the wire being used came in contact with the fan blades. This produced a series of sparks, and an explosion followed which broke open the trunk line at the point it entered the fan. This definitely established the possibility of an ignition of the aluminum dust by sparks produced in this manner.

Flammability of Aluminum Dust

Samples of the aluminum dust were collected from the pipes of the suction system. In sifting the dust through cheesecloth of ordinary mesh onto the flame of a match, the dust readily ignited with brilliancy



FIG. 6. VIEW SHOWING BRUSHES USED IN THE SATIN-FINISHING PROCESS AND CONNECTIONS LEADING INTO THE MAIN TRUNK LINE. NOTE THE COVER HOOD ON THE BENCH

and rapid propagation of flame. The Bureau of Mines, U. S. Department of the Interior, reports that "aluminum dust burns quietly when in a pile, but if this pile be disturbed in such a manner as to raise a cloud of dust into the air the burning takes place with explosive violence. If a dust cloud already formed that has a density within the explosive limits be ignited a violent explosion results." In experiments conducted in that bureau it was found that in some cases aluminum dust could be ignited at temperatures even lower than those necessary for the ignition of 200-mesh standard Pittsburgh coal dust. At 800 deg. C. the aluminum dust cloud ignited with a brilliant flash, while higher temperatures were necessary to ignite coal dust.[1]

Relation of Dust-Collecting Systems to Explosion Frequency

A number of disastrous dust explosions originating in the dust-collecting systems have occurred in manufacturing plants in recent years. In an explosion of chocolate dust in an Eastern plant, the explosion originated within the exhaust fan, presumably from sparks struck by foreign materials. The entire plant was destroyed, three lives were lost and the total property loss was estimated at $1,000,000. An explosion of flour dust occurred in a Western mill a few months ago in the trunking leading from the grinding rolls to the exhaust fan. Under the method of installation in these systems, as a rule, the dust and air are so well diffused in the pipes leading to the fan as to permit an explosive mixture to be present. When an ignition source of sufficient temperature is introduced, the dust cloud is readily ignited and the explosion propagates. The relation of dust-collecting systems of this nature to dust explosions and fire frequency has made evident the necessity for research engineering investigations to develop effective methods of prevention.

[1]Technical Paper 152, "The Inflammability of Aluminum Dust," by Alan Leighton, Bureau of Mines.

Proposed New System

The proposed new system, plans of which are shown in Fig. 7, is based on the fact that the aluminum and iron dusts, when in a finely divided state and mixed with air in proper proportions, form an explosive mixture, which can be ignited by an external source of heat or flame. The system was designed under the direction of C. W. Keniston, engineer in charge of industrial hygiene of the Industrial Commission of Wisconsin, and the following description is taken from his report to the commission:

1. The new system proposes to furnish a positive inlet for all air exhausted from the building, this to be provided for by an efficient ventilation system.

2. No exhaust ducts to be used. (Induced or secondary currents of air required.)

3. No exhauster used or no machine (through which air currents containing explosive mixtures are carried) in which moving parts are made of materials which could generate sparks.

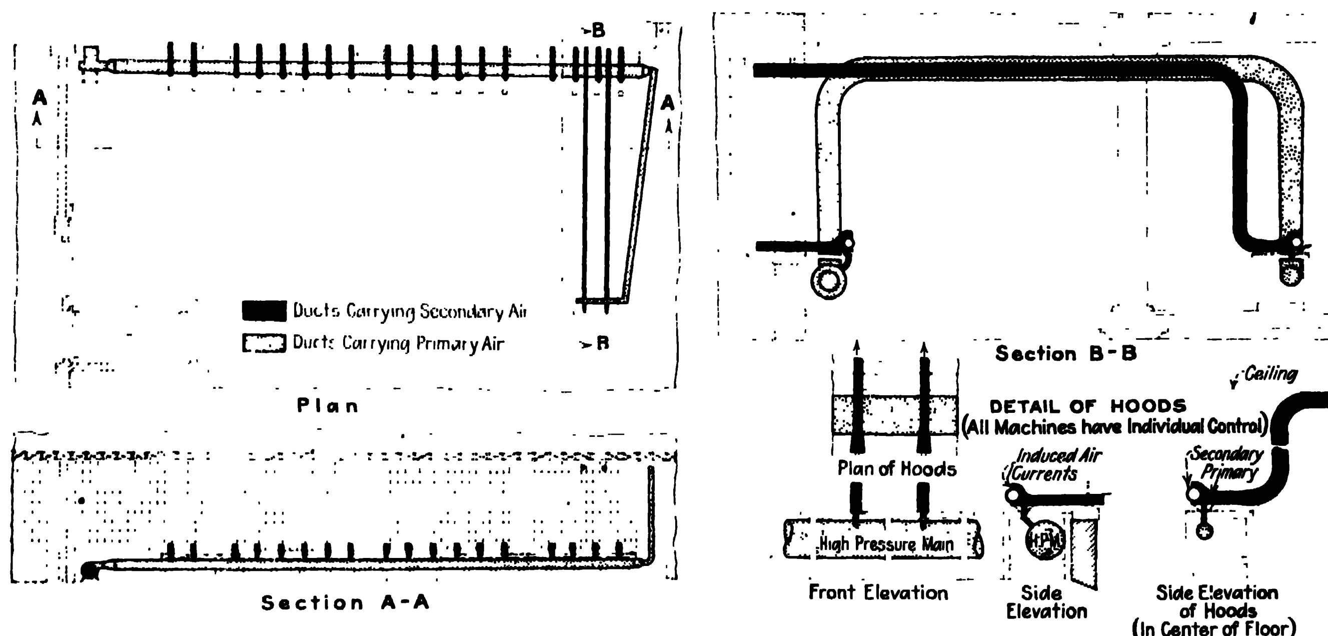


FIG. 7. PLAN, ELEVATION AND SECTIONS OF NEW SATIN-FINISHING DEPARTMENT, SHOWING THE PRIMARY AND SECONDARY AIR DUCTS

4. By the elimination of exhauster and exhaust ducts this system eliminates the contributing conditions to the explosion hazards and also the opportunity for the direct cause of the explosion to ever occur.

Tests and research work demonstrating the feasibility and practicability of the proposed system were made. The ducts for primary and secondary air are shown in Fig. 7. It will be noted that these secondary air currents, which pick up and carry out the aluminum dusts, pass through no equipment which could be an explosion chamber. Further details can be obtained through the Industrial Commission.

A certificate of inspection was issued to the company reading as follows:

> There are required in your places of employment ventilation systems so designed, constructed and operated that the conditions of employment can be considered safe for health by the Industrial Commission.
>
> Plans and specifications are to be submitted within a reasonable period of time. These plans must show the items on the following list which govern the design of your systems:

PLANS AND SPECIFICATIONS FOR VENTILATING AND EXHAUST SYSTEMS

List of factors which govern the design, and those details which govern the proposed installations should appear on the plans:

General surroundings.

Plans and elevations—with section if necessary.

Location of windows, roofs, partitions, exits.

Location of equipment and character of the work performed.

Number of persons employed and their distribution.

Available cubic feet of air space (total space less that taken up by equipment and materials).

Location of proposed ventilation and exhaust machinery.

Location and sizes of air inlets and outlets.

Location, size and shape of ducts and pipes.

Location, size and type of fans and motive power or ventilator.

Materials used in construction of fans and ducts.

Cubic feet of air moved per hour.

Velocity of air per minute produced at the throat of the hoods of exhaust systems.

Any proposed heating, cooling or purification apparatus used in connection with the system.

Any apparatus used to take care of the discharge of the system.

After the above-mentioned research had been carried on to the satisfaction of the Industrial Commission, the following recommendations and requirements were added to the above-mentioned certificate of inspection:

The following recommendation applies to the new plant, fourth floor. We recommend that the system required as a protection to health in the satin-finishing department be designed, constructed and operated in the following-described way so that the conditions of employment can be considered safe for health in all ways, including explosion hazards:

Static suction required in the hoods must be produced as an induced current of air by the use of a pressure air jet. This can be constructed in accordance with the experimental data found to be practical in a series of experiments conducted especially for this particular problem. The air currents carrying the dust must be carried to the outside atmosphere through the shortest pipe possible and without passing through any fans or large conveying ducts similar to those used in other exhaust systems. The air jets must be so constructed that the operator of each wheel may control the air jet used for its suction.

IMPORTANCE OF DUST EXPLOSION PREVENTION TO INDUSTRIES

The extensive losses to life and property as a result of the large number of dust explosions occurring in manufacturing establishments fully emphasizes the need for a thorough engineering study of the problem. Large quantities of foodstuffs are destroyed in these explosions and fires in the industries where food products are manufactured. In a period of less than 12 months —May, 1919, to April, 1920—at least six disastrous explosions, causing a loss of eighty lives and property damage to the extent of $7,000,000 have occurred. In addition a large number of explosions have taken place in factories, without any life loss or extensive damage.

In a "starch dust" explosion in a factory in the Middle West during the past year forty-three lives were lost and $3,000,000 property damage was done. In two explosions of grain dust, in modern elevators constructed of fire-resistive materials, one in the United States and the other in Canada, twenty-four lives were lost and as many others injured, with both plants badly damaged. In fighting a fire in a spice plant a few months ago, eighteen firemen were caught when a wall was "blown out" during the progress of the fire. Four of the firemen lost their lives and a thorough investigation suggested the possibility of the falling timbers forcing a cloud of "spice dust" onto the flames of the fire, causing an explosion.[2] Explosions are occurring in sugar refineries, starch factories, flour mills, grain elevators, chocolate plants and other similar industries where flammable dusts are created.

ENGINEERING INVESTIGATIONAL WORK

The Bureau of Chemistry of the U. S. Department of Agriculture, in co-operation with the milling and grain companies throughout the country, is conducting investigational research work to develop methods for the control and prevention of dust explosions in industries where grain or its products are handled. In order to assist the bureau in this work and to obtain all information available pertaining to the behavior of these explosions, the disaster in the aluminum plant was carefully studied by the engineers. This procedure has also been followed in the investigation of dust explosions in other types of industrial plants.

The results of the investigation after the explosions in not only the grain-handling plants but in the other manufacturing establishments as well have developed many essential lines of engineering work. The explosions are not only occurring in many cases in industries where they had not been experienced previously but the investigations are developing new causes relating closely to construction of plant, mechanical operating equipment, dust-collecting and control methods and similar factors. The explosions have taken place in some of the largest manufacturing plants in the United States and Canada, where the safety engineers were applying all known preventive measures. Before dust explosions of this nature can be effectively controlled, these new problems arising must be solved, in order to reduce our losses to life, food and property.

A Method for Determining the Opacity of Eye-Protective Glasses to Ultra-Violet Rays

A quick method for determining the opacity of eye-protective glasses to ultra-violet rays has been worked out by the U. S. Bureau of Standards. The photographic method usually employed requires several hours for making such a test, while by the new method, which is radiometric, a test can be made in a few minutes. The test is based upon the fact that all glasses are opaque to radiations of wave lengths less than 0.3 micron (1 micron = 1/1,000 mm.). It is, therefore, only necessary to examine eye-protective glasses for opacity to ultra-violet radiations of wave lengths 0.3 to 0.4 micron. Radiations of these wave lengths are easily obtained without employing a spectroscope by simply filtering the light from a quartz vapor lamp through a suitable glass screen placed over a vacuum thermopile. Measurements of one part in 10,000 are easily obtainable, whereas on the basis of the requirements of the proposed Safety Code for Head and Eye Protection, an accuracy of one part in 1,000 is all that is necessary.

Rice Straw as Raw Material in the Paper Industry

According to *Eastern Engineering*, a combine of Dutch paper manufacturers proposes to establish a factory in the Dutch East Indies for the manufacture of paper from rice straw. It is stated that excellent writing paper has already been made from this material.

[2]"Will Spice Dust Explode" *Simmons Spice Mill*, August, 1920, and *Tea and Coffee Trade Journal*, August, 1920

Legal Notes

By Wellington Gustin

Oral Agreements Excluded When Written Contract Is Neither Uncertain Nor Ambiguous

Judgment for the Detroit Copper & Brass Rolling Mills has been affirmed by the United States Circuit Court of Appeals, Eighth Circuit, in the action brought against it by the Century Electric Co., of St. Louis. The controversy arose out of a written contract of sale of 400,000 lb. of brass rods, a portion of which were returned by the Century company because it was claimed they were too hard to be cut and made into brass primers by automatic screw machines.

The Detroit company defended on the ground that it was under no obligation to make the rods of such a degree of hardness that they could be so machined. The written agreement contained no covenant of that nature.

The Century company offered to prove that in the negotiations for the contract, just before it was made, the Detroit company made an oral agreement to that effect. The court ruled out this evidence because it varied a written contract, by adding a new covenant to it. The Century company contended that there was an implied warranty to that effect, but the trial court held otherwise, and directed a verdict for the Detroit company. An appeal was had on these disputed grounds.

In the written contract the ingredients of the brass rods are stated in these words: "The basis for the mixture to consist of 60 parts copper and 40 parts spelter." Other provisions of this contract covered the amount of the rods, times, place and manner of delivery, prices and payments. The contract ends with the statement that the written agreement is the final understanding of the parties and no changes may be made unless reduced to writing and signed by both parties.

This sale was solicited by the Century company, the purchaser, which had a contract with the Bethlehem Steel Co. to furnish Russian brass primers for 3-in. shells. The Century company asked for quotations on the brass rods described in the contract, and the Detroit company gave prices, followed by a personal interview of four hours between the agents of the corporations and the execution of the contract upon the close of that conference.

Written Contract Conclusive, Decides Court

The Century company offered to sustain its claim that the Rolling Mills made an oral agreement and an implied contract to sell it brass rods soft enough to be readily cut and made into brass primers by the use of automatic screw machines. In its opinion the Court of Appeals pointed out that the written contract clearly describes the ingredients of the mixture. When the parties were negotiating for the contract, the buyer might have required, and if the seller had consented, might have obtained a provision in the written agreement that the seller would sell and deliver brass that could be readily cut and made into Russian primers by the use of automatic screw machines, but it did not do so, said the court. When the parties selected, out of the numerous suggestions discussed during their four-hour conference, the terms to which they agreed and which they embodied in their written contract, the legal presumption arose that they had rejected and did not agree to or intend to agree to the suggestions discussed in the negotiations which were omitted from the writing. And where, as in this case, the written contract imports a complete legal obligation free from uncertainty and ambiguity, that presumption is conclusive, said the court.

It further said the rule that all previous negotiations are merged in the written agreement, and that parol evidence to modify it is incompetent, rests upon the conclusive presumption that the parties have written into it every material term and item of their agreement, and evidence of a contemporaneous parol contract is as incompetent to add another covenant or term to the writing as it is to change a covenant or to withdraw it therefrom.

However, the buyer contended that the seller knew the custom of cutting and making the rods into Russian primers by the use of automatic screw machines, that the seller represented that he could produce the goods to make such primers, that it had sold brass rods for this purpose to another concern, which had bought brass rods from another brass company, which were defective, and had finally come to it to get the proper kind of brass, and therefore there arose an implied warranty that the brass it sold the Century company would be of such proper hardness.

All Agreements Should Be in the Contract

Answering this contention, the court said that if the buyer had employed the seller to make and deliver brass rods to be cut and made into Russian primers by automatic screw machines, and had intrusted to the judgment and skill of the seller the ingredients and composition of the mixture from which the rods should be made and the percentage of lead which the rods should contain, such a warranty might have arisen.

It might have specified and written into the contract the exact proportion of lead the bars should contain, so that they could be readily machined, for the proportion of lead in the rods conditioned their hardness. It might have written into that contract that the seller should use such a proportion of lead as would make them readily machinable. It did neither of these things, but expressly provided in the writing that the mixture should contain 40 parts spelter and 60 parts copper, and then, three days after the making of the contract, telegraphed the seller that the rods must contain only 1 per cent of lead, which latter terms were accepted by the maker.

Therefore, the seller made and delivered a product which complied with all these requirements of the contract and the rule applies that, when a known, described and definite product is ordered of a manufacturer, although it be stated by the purchaser to be required for a particular use, yet if the known, described and definite thing be actually supplied, there is no implied warranty that it shall answer the particular purpose intended by the buyer (cf. 79 Fed., 43 and 611).

Again, the terms of the written contract show that the express warranty of the contents of the mixture and of the proportion of the lead in it, which conditioned the degree of its hardness, raises the conclusive presumption that no other warranty of their degree of hardness was implied. The express warranty of one or more of the qualities of an article excludes an implied warranty of the same qualities or of other qualities of a similar nature.

Steel Rails From Sink-Head and Ordinary Rail Ingots—I

General Plan of Investigation—Ingot Practice—Temperature Observation—General Comparison of Two Ingot Types—Comparison of Chemical Composition —Items Relating to Manufacture

BY GEORGE K. BURGESS*

THE results of the experimental rolling into rails of several types of ingot, including several designs of sink-head ingot and others, with the coöperation of the Maryland Steel Co., reported by Messrs. Hadfield and Burgess[1], looked sufficiently promising to the rail committee of the Pennsylvania Railroad to warrant the purchase of 100 tons of ingots cast by Sir Robert Hadfield in England, in order to make a more effective study of the suitability of this type of sink-head ingot for the manufacture of rails. It was also considered desirable to carry out similar series of tests of ingots of ordinary rail steel rolled at the same time and under as nearly identical conditions as possible in the same mill[2]. President F. W. Wood of the Maryland Steel Co., Sparrows Point, Md., offered the facilities of that plant for this investigation, as in the case of previous experiments reported by Hadfield and Burgess. The rolling of ingots for the present investigation was done in 1915 at the Sparrows Point plant, then known as the Maryland Steel Co., now a part of the Bethlehem Steel Co.

The planning of the details of the investigation, after correspondence with Sir Robert Hadfield, was made by A. W. Gibbs, chief mechanical engineer of Pennsylvania Railroad Co.; F. W. Wood, president of Maryland Steel Co., and the present writer, and the tests were carried out by members of the technical staffs of their representative organizations, to whom acknowledgment is here made for their indispensable aid.

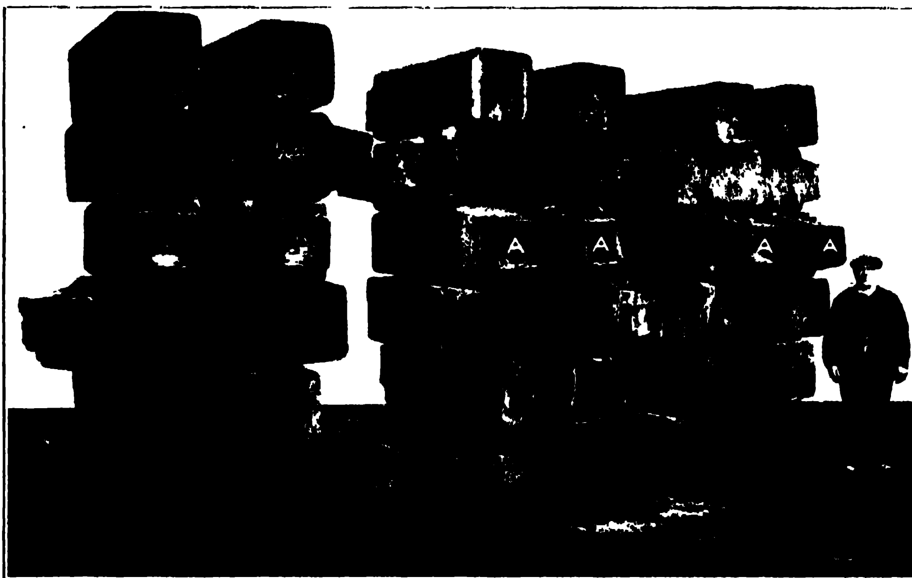


FIG. 1. ONE HUNDRED TONS OF HADFIELD INGOTS SUPPLIED TO THE PENNSYLVANIA RAILWAY

It was expected by Sir Robert Hadfield that the sink-head ingots made under this system[3] would yield rails of remarkably high quality as regards "soundness, freedom from all piping and all segregation." From an inspection of the data concerning the manufacture of the ingots made by this process he also felt confident in stating: "This shows in a remarkable manner the uniformity of the ingots, also that every one of them is perfectly sound, free from blowholes, with no piping and segregation below 8 per cent discard."

The results of the present investigation of thirty-seven ingots of the Hadfield type (Fig. 1) show that he was not far astray in the confident prediction of uniformity, physical soundness, and freedom from chemical segregation. In fact, it is difficult to imagine thirty-seven ingots from as many different heats of bessemer steel more uniform in quality and properties and as free from those undesirable qualities and uncertainties that beset the ordinary ingot.

The ingots with which they were compared, the product of three heats, five from each heat, or fifteen ingots in all, are not less instructive, in that each group, or heat, represents a distinct practice in open-hearth manufacture. In this investigation, therefore, from the point of view of steel-making, we are really comparing the products rolled from two types of ingot representing four methods of manufacture.

The rolling, inspection, tests and analyses were car-

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[1]Hadfield and Burgess, "Sound Steel Ingots and Rails," *Trans.*, A.I.M.E., vol. 51, pp. 862-880, 1915; *Iron and Steel Inst.*, vol. 91, pp. 40-124, 1915.

[2]See also the valuable paper comparing American-made sink-head and ordinary ingots for rails by Edward F. Kenney: "The Commercial Production of Sound and Homogeneous Steel," *Am. Iron and Steel Inst.*, p. 144, 1915.

[3]The method in brief consists in casting the ingots on cars, usually with the small end down. Each ingot mold is provided with a sand top. After the mold is filled to the desired height with steel, a layer of slag about ½ in. thick is placed upon it and the remainder of the mold is then filled with charcoal. Then, through suitable piping, an air blast is directed in numerous jets upon the charcoal (for 20 to 40 min.), which is burned thereby, the combustion supplying additional heat to the top of the ingot, which helps to keep the top fluid and to retard its solidification, while the lower parts are rapidly losing heat by its transfer to the mold. Sir Robert A. Hadfield, "Plant for Hadfield Method of Producing Sound Steel Ingots," *Trans.*, A.I.M.E., 1913, p. 669.

ried out with the greatest care, and by a series of actual weighings all the material from the several ingots was accounted for.

Ingot Practice

Since the sink-head ingots were cast in England and rolled in this country they were necessarily subjected to the unusual process, at least in rail manufacture as ordinarily practiced, of reheating from the cold condition. The plan was considered of allowing at least some of the comparison ingots to go "stone cold" and reheat them before rolling. However, in view of the fact that the ordinary type of ingot is not designed to meet this condition, which practically never obtains in practice and which therefore would be a possible misleading condition to impose on the comparison ingots and of no practical value, the Maryland ingots were all rolled directly after being cast. These ingots were stripped from 20 to 30 min. after casting and put while still hot into the soaking pits, where they remained from 1 hr. 40 min. to 2 hr. 23 min.

The sink-head ingots after preliminary heating were charged into relatively cool pits. The heat was gradually turned on after ½ hr. and the ingots remained in the pits from 17½ hr. to 21½ hr. The thirty-five sink-head ingots which were rolled were divided into three series and rolled on successive days, Aug. 16, 17 and 18, 1915. Three heats of comparison ingots were rolled, one on Aug. 16 and two on Aug. 18. There was no delay or other unusual condition in the mill during the rolling. The ingots of a group were rolled in succession, without intermission, and after the mill had been warmed up by rolling at least one complete heat of the regular product of the mill.

Temperature Observations

Temperature observations were taken of the soaking pits before, and at intervals after, immersion of ingots of both types; of all ingots in the blooming mill; and of rails from both series of ingots at the finishing pass. In order to heat them gradually, the Hadfield ingots lay on the surface of the soaking pits approximately 12 hr. before charging. They were too hot to bear the hand comfortably when charged, at which time their estimated temperature was about 50 deg. C. (122 deg. F.). The pits which received these sink-head ingots were allowed to cool to the temperature of 600 deg. C. (1,112 deg. F.) to 750 deg. C. (1,382 deg. F.). (Table I.) The immersion of the ingots further cooled the pits by about 200 deg. C. (392 deg. F.) as measured immediately after charging. The gas was turned on the pits ½ hr. after charging. The Maryland ingots were charged into the soaking pits hot according to the usual practice.

The temperatures of Table I were taken with a platinum-rhodium thermocouple connected to a pivot type of indicator. The couple was enclosed in nickel sheath except the tip, which was exposed. In some cases the temperatures were obtained by the use of an optical pyrometer of the Morse type.

By means of the optical pyrometer, temperatures of the ingots were taken during rolling. Average values, obtained from seven or eight observations with optical pyrometer at alternate passes, after the first roughing pass, were taken of the ingots in the blooming mill. The temperature of the steel at the surface was lowered about 17 deg. C. (63 deg. F.) to 40 deg. C. (104 deg. F.) during the rolling into blooms. Typical illustrations of rolling temperatures are given in Table II for several ingots of both types. Table I contains finishing temperatures of Hadfield rail bars, taken at the finishing pass, by sighting on the center of base of rail bar with an optical pyrometer. Each observation is the average of two readings.

Ingot No.	Temp. of Soaking Pits at Time of Charging Ingots Deg. C	Ingot Temperature After 14½ Hours Deg. C.	Ingot Temperature When Drawn Deg. C.	Ingot Temperature Blooming Mill Deg. C.	Finishing Pass (Taken on Base of Rail) 1st Rail Bar Deg. C.	Finishing Pass (Taken on Base of Rail) 2nd Rail Bar Deg. C
1	700	1310	1300	1130	1016	1007
2	700	1310	1300	1140	1030	1020
15	700	1310	1300	1137	1026	1017
21	700	1310	1300	1123	1025	1005
24	700	1310	1300	1172	1025	1010
28	700	1310	1300	1157	1019	1008
7	750	1300	1290	1125	1028	998
9	750	1300	1290	1149	1024	1016
13	750	1300	1290	1116	1034	1008
14	750	1300	1290	1143	1043	1019
22	750	1300	1290	1144	1032	1018
35	750	1300	1290	1140	1034	1011
6	650	1200	1295	1149	1048	1025
18	650	1200	1295	1166	1032	1023
19	650	1200	1295	1180	1069	1044
23	650	1200	1295	1154	1047	1026
26	650	1200	1295	1173	1047	1034
31	650	1200	1295	1146	1036	1016
4	650	1240	1280	1156	1040	1016
10	650	1240	1280	1147	1046	1022
11	650	1240	1280	1138	1029	1012
12	650	1240	1280	1142	1047	1029
29	650	1240	1280	1148	1034	1005
36	650	1240	1280	1136	1038	1016
16	600	1305	1315	1182	1018	955
17	600	1305	1315	1164	1036	1016
20	600	1305	1315	1179	1045	1023
27	600	1305	1315	1153	1040	1024
30	600	1305	1315	1157	1032	1020
33	600	1305	1315	1160	1029	1017
3	600	1300	1316	1156	1033	1023
5	600	1300	1316	1149		
8	600	1300	1316	1151	1029	1023
25	600	1300	1316	1153	1035	1000
34	600	1300	1316	1140	1014	1004
Average	658	1276	1299	1150	1034	1014
Maximum	750	1310	1315	1182	1069	1044
Minimum	600	1200	1280	1116	1014	955

TABLE II. TYPICAL BLOOMING TEMPERATURES, IN DEGREES C

Sinkhead Ingot Nos. 7	14	28	34	Comparison Ingot Nos. 2	7	13	15
1,136	1,152	1,181	1,165	1,184	1,179	1,179	1,168
1,147	1,147	1,171	1,165	1,171	1,179	1,171	1,157
1,144	1,136	1,162	1,157	1,168	1,176	1,168	1,136
1,114	1,147	1,147	1,141	1,184	1,160	1,157	1,149
1,123	1,141	1,147	1,131	1,171	1,163	1,157	1,147
1,125	1,141	1,147	1,123	1,165	1,157	1,147	1,136
1,112	1,139	1,147	1,120	1,163	1,157	1,147	1,144
1,103	. .	.	1,125	..	....	....	...
Av. 1,125	1,143	1,157	1,141	1,173	1,167	1,161	1,149
Grand average			1,145	Grand average		...	1,168
Maximum			1,213	Maximum		....	1,206
Minimum			1,093	Minimum		..	1,136

TABLE III. TEMPERATURES OF WORKING OF COMPARISON INGOTS

Ingots — Ingot No.	Blooming Mill, Deg. C.	Rails — At Finishing Pass (Taken on Base of Rail) 1st Rail Bar, Deg. C.	2nd Rail Bar Deg. C.
1	1,149	1,026	1,006
2	1,173	1,016	993
3	1,164	1,040	1,025
4	1,179	1,053	1,039
5	1,177	1,064	1,027
6	....	1,031	1,005
7	1,167	1,029	1,018
8	1,176	1,030	1,001
9	1,159	1,038	1,009
10	1,180	1,038	....
11	1,162	1,039	1,003
12	1,181	1,046	1,025
13	1,161	1,032	1,018
14	1,149	1,025	1,016
15	1,149	1,021	1,018
Average	1,166	1,035	1,001
Maximum	1,181	1,064	1,039
Minimum	1,149	1,016	993

In Table III are similar data for the comparison ingots and rails, except that the pit temperatures were not taken. It will be noted that good uniformity of rolling and finishing temperatures was obtained.

A series of measurements was taken to compare the temperatures of this investigation taken at the finishing pass with those taken[4] at the hot saw by sighting on the head of the rail. The reading noted in Tables I and III of finishing temperatures should be reduced by about 11 deg. C. (52 deg. F.) to correspond to previous observations at hot saw.

The observed ingot and rail temperatures were taken on the outside oxidized surfaces, which are colder than the interior metal by 75 deg. C. (167 deg. F.) to 100 deg. C. (212 deg. F.). This would account for the apparent discrepancy between the soaking-pit and ingot temperatures, and would make the average true finishing temperature somewhat higher than 1,100 deg. C. (2,012 deg. F.).

General Comparison of the Two Ingot Types

Method of Numbering Ingots. The sink-head ingots were numbered H1, H2, etc. . . . H37, and the ingots made in the ordinary manner were numbered M1, M2, etc. . . . M15.

Weight of Ingots. The sink-head ingots were weighed cold and the others were weighed hot. The approximate weight of the sink-head ingots was 5,300 lb. each, and of the Maryland ingots 7,300 lb.

Size and Shape of Ingots. The English-made ingots were cast with sink-head on large end, while the American-made ingots were cast small end up. Hadfield's ingots were 19¼ in. square on top, 17¼ in. square at the bottom and 50½ in. high, exclusive of 13¾ in., the approximate height of the sink head. American ingots were 18¼ in. square on top, 19¼ in. square on bottom and 63 in. high. Further details of the sink-head cavities may be had from Table IV.

Loss in Heating. The sink-head ingots were weighed while cold before reheating and the comparison ingots were weighed while hot. The abnormal loss in weight sustained by the former should be deducted from the nominal ingot weight in computing the net ingot. It so happens that the average bottom bloom crop for the ingot made in an ordinary manner is 0.5 per cent greater than for the sink-head ingot; so that if the loss on heating for the comparison ingots is taken as 0.5 per cent there will be an exact balance. The English cast ingots remained in the soaking pits about ten times as long as the comparison ingots. If it is, nevertheless, preferred to compare actual percentages of material available for rails, that from the sink-head ingots should be increased by 2.5 per cent, since there was a loss of 3 per cent, of which about 2.5 per cent can be charged to reheating. When this correction is made, it will later be shown that the average sink-head ingot gives about 84.8 per cent material available for rails instead of 81.9 per cent. (Ingot H24 should not be used in the computation, as it was accidentally given an excessive bloom crop.) The expression "material available for rails" as here used refers to physically sound steel only. Subsequent chemical analyses showed a much greater discard was necessary to eliminate segregation above 12 per cent, as will be shown later in Tables XII and XIII.

Comparison by Heats. It will be noted that the three heats of comparison ingots have each very distinct characteristics, as expressed, for example, in material available for rails, which are the results of varying open-hearth and casting practice. In group M1 to M5, the percentage of material available for rails was 86.9 per cent; in group M6 to M9 85 per cent, and in group M11 to M15, 65.8 per cent (Table VI). It was for this reason that, in addition to the general average of prop-

[4]Bureau of Standards Tech. Paper 38, "Observations on Finishing Temperatures and Properties of Rails."

TABLE IV. CHEMICAL COMPOSITION AND HEAD PARTICULARS OF SINK-HEAD INGOTS, REPORTED BY SIR ROBERT HADFIELD

		Chemical Composition					Sink-head Particulars			
		Per Cent								
Ingot No.	Heat No.	C	Si	S	P	Mn	Height to Which Filled in Head, In.	Depth of Settling, In.	Capacity of Cavity, c.c.	Percentage of Settling to Total Bulk of Ingot
H1	4774	0 65		0 040		0 94	14 00	8 25	9,950	3.19
H2	4738	0 63 0 64		0 042		0 91	13 50	9 00	10,300	3 31
H3	4847	0 63-0 64		0 047		0 93	13.75	9 25	10,450	3 37
H4	4915	0 65 0 66		0 049		0 92	14 00	9 75	9,675	3 10
H5	4873	0 69		0 050		0 95	14 00	9.38	10,250	3 29
H6	4939	0 63 0 64	0 16	0 045	0 028	0 92	13 00	7 50	8,800	2 84
H7	4627	0 64		0 052		0 97	14 00	8 25	9,600	3 08
H8	4680	0.65	0 14	0 049	0 029	0 92	13 75	8 50	10,250	3 29
H9	4709	0 58		0 049		0 93	13 00	7 75	8,930	2 88
H10	5085	0 63-0 64	0 16	0 042	0 031	0 86	13 25	9 25	11,000	3 52
H11	5018	0.64	0.16	0 039	0 031	0 92	14 00	8 76	10,040	3 21
H12	4641	0 67 0 69		0 045		0 92 0 94	14 50	8 50	9,000	2 89
H13	5059	0 63 0 64		0 049		0 92	14 00	8 88	10,750	3 44
H14	4835	0 69		0 046		0 91	13 50	7 75	9,520	3 05
H15	4978	0 67 0 68		0 051		0 96	14 50	9 88	9,260	2 95
H16	4992	0 66		0 045		0 94	13 50	9 75	9,000	2 88
H17	4825	0.66		0 045		0 92	13 50	6 88	9,000	2 89
H18	4829	0 66		0 041		0 98	14 00	8 50	11,100	3 55
H19	5073	0 63 0 64		0 045		0 90	14 00	9.50	10,500	3 37
H20	4696	0 66		0 038		0 96	13 50	6 50	8,600	2 77
H21	4801	0.66		0 036		0 95	13 50	8 13	9,150	2 90
H22	4723	0.63		0 044		0 95	13 50	8 00	9,900	3 17
H23	5046	0 62-0 63		0 042		0 93	13 50	7 00	10,500	3 37
H24	5030	0 60		0 055		0 94	13 50	10 13	11,950	3 82
H25	4668	0 58		0 042		0 93	14 50	8 50	10,100	3 24
H26	4813	0 64	0 14	0 048	0 032	0 93	14 00	8 63	10,800	3 45
H27	4515	0 64	0 20	0 048	..	1 01	14.25	7 00	9,000	2 89
H28	4588	0 64	0.19	0 047	...	0 97	13 00	7 25	8,930	2 86
H29	4908	0.64	...	0 041	..	0 84	14 00	8 75	9,750	3 11
H30	4851	0.61-0 62	0.21	0.045	0.031	0 92	14 00	9 63	10,900	3 49
H31	4600	0.65	0.15	0.049	. . .	0 96	13.50	8 50	9,825	3 16
H32	5004	0.65	....	0 052	.....	0.94	14.00	8 50	10,175	3 27
H33	4761	0.65	....	0 048	.....	0 90	13.50	8 50	10,800	3 47
H34	5099	0.63-0 64	....	0.039	.....	0 86	11.00	8 88	10,040	3 34
H35	4887	0.63	....	0.050	.....	0 89	14 00	9 00	10,500	3 36
H36	4653	0.61	....	0.053	.....	0 85	13.50	7.75	9,900	3 17

erties of all Maryland rails, averages were computed for each of the three Maryland heats. The three rollings of the Hadfield ingots show great uniformity, however expressed, and this indicates that the manufacture of the ingots in all cases apparently was carried out in accordance with a uniform practice.

Inspection of Ingots. The sink-head ingots were examined while cold for surface defects, and the surface condition of all ingots was noted by another observer as they passed through the blooming mill. There were side splashes, rough sides and rough corners on nearly all the sink-head ingots, and only four of the thirty-five were noted as clean blooms in rolling, as compared with eight clean blooms from the fifteen comparison ingots.

Comparison of Chemical Composition

Sink-Head Ingots. The chemical composition of the sink-head ingots (Table IV) and the rails therefrom shows a remarkable degree of uniformity. Thus, for the "O" analysis (near the tread) the average carbon is 0.648 per cent, with an average deviation from mean of 0.017. If we take the "C" test piece (top crop from the second bloom) as representing the ingot composition, the average for carbon at the top of the web is 0.644 per cent and near the tread is 0.653 per cent, the average deviation from mean in each case being 0.017.

The average phosphorus content of the tread position is 0.032 per cent, with an average deviation of 0.002; for sulphur (same position) the average is 0.047 per cent, with a deviation of 0.004. For the top of the web the concordance is somewhat less good. Manganese and silicon are very uniformly distributed.

Comparison Ingots. These ingots were cast with small end uppermost of analysis shown in Table V and

TABLE V. COMPOSITION OF MARYLAND STEEL

Heat No	2x4497	1x3632	2x4510
Ingot Nos.	M1 to M5, incl.	M6 to M10, incl.	M11 to M15, incl.
Per cent carbon	0 608 to 0.630	0 642 to 0.654	0.642 to 0.650
Per cent silicon	0.148	0.185	0.191
Per cent sulphur	0.067	0.092	0 097
Per cent phosphorus	0 010	0.014	0.019
Per cent manganese	0 710 to 0 720	0.650 to 0.660	0.760 to 0.810
Per cent chromium	0 270	0.290	0.270
Per cent nickel	0.760	0.780	0.760

except for a nickel content of 0.75 per cent and chromium content of 0.28 per cent accompanying the Cuban ore used in the blast furnace, they were of a composition and uniformity comparable with the sink-head type, the average "O" (tread) position having a carbon content of 0.645 per cent (sink-head 0.648 per cent), with an average deviation from mean of 0.036. The manganese content is 0.70 per cent, as compared with 0.89 per cent for the sink-head ingots, phosphorus 0.019 per cent (sink-head 0.047 per cent). Group M11 to M15 has an average phosphorus content of 0.028 per cent, which quite closely agrees with that of English-cast ingots. This sub-group is also from its method of manufacture the best to compare with the imported ingots.

The sulphur content of the comparison ingots fol-

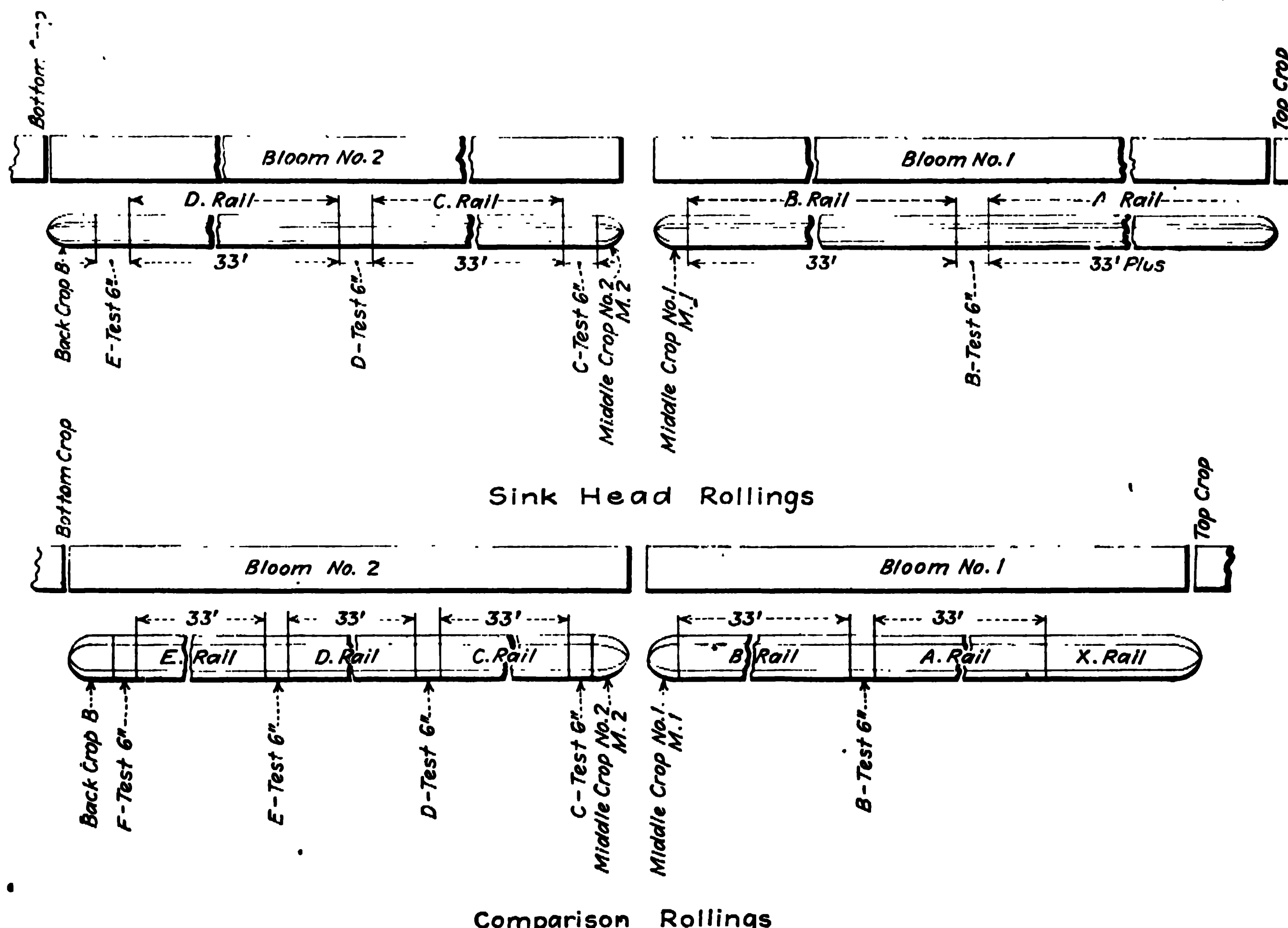


FIG. 2. DIAGRAM SHOWING CUTTING OF BLOOMS AND RAILS FROM INGOTS OF BOTH TYPES

lows the grouping by heats; the tread analysis of the C rail, for example, for ingots M1 to M5, has a sulphur content of 0.076 per cent; for ingots M6 to M10, the sulphur is 0.101 per cent; for ingots M11 to M15, the sulphur is 0.118 per cent. The manganese and silicon of the first two groups are practically identical, while both are slightly higher in the third group (M11 to M15). Chromium and nickel are practically constant at 0.28 per cent for the former and 0.75 per cent for the latter for all three groups.

Disposition of Ingots

Of the thirty-seven sink-head ingots cast at Sheffield, thirty-five were rolled into blooms at the Sparrows Point mill and the remaining two ingots were sectioned longitudinally for metallographic examination. The examination of H32 was made by the Bureau of Standards and H37 by Hadfields, Ltd. In addition to splitting two ingots, it was also decided to examine similarly top blooms from one of each of the two types of ingot (H5 and M10). The blooms and ingots examined in this manner were selected at random. All blooms were rolled into rails directly without reheating and all material was accounted for by actual weighing.

Blooming Mill

All ingots were rolled in thirteen passes in a two-high mill to blooms 8 x 8½ in. The English-made ingots entered the blooming mill with the sink-head toward the rolls, one-half receiving the first or "squaring up" pass in this direction, no draft being given on second pass, while the other half were given no draft on the first pass, the "squaring up" being done on pass No. 2. The Maryland ingots were rolled according to ordinary practice entering the rolls the small end first.

Blooms

Each ingot was cut into two blooms (8 x 8½ in.) as shown in Fig. 2, and rolled directly into rails —that is, without reheating of blooms. The second bloom from sink-head ingots made two rails (C and D), and that from Maryland ingots three rails (C, D and E). The first bloom from the sink-head type of ingot made a B and (generally) a short A rail; the first bloom from the comparison type of ingot made a B, A and (short) *x* rail. The blooms were sheared top and bottom as little as possible for the safe passage of the bar through the rolls. Each piece cut was marked, weighed and preserved.

Rails

In the rail mill there are six passes in the roughing rolls, four in the intermediate rolls and one finishing pass, making a total of twenty-four passes from ingot to finished rail. The rails, which were Pennsylvania 100-lb. section, were cut at the hot saw as shown in Fig. 2.

The rails were inspected for surface defects, piping and discard to physically sound steel. The classification into "firsts" and "seconds" from surface conditions was made by the Pennsylvania Railroad Co. inspectors; the discard to "physically sound steel" was made by cutting back in 5-ft. lengths.

There were a relatively large number of "second" rails from the sink-head ingots, sixty-one out of a total 104 rails, or 59 per cent. There were only four in fifty-seven from the comparison ingots, or 7 per cent. The A rails are not included for either group.

There appears to be no reason why ingots of the sink-head type should not be as well surfaced as any other, and the high percentage of seconds should not be attributed to the type of ingot, as the bottom of the sink-head was well within the "A" rail, which was not classified. Probably the severe and unusual reheating conditions contributed somewhat together with the original surface condition as influenced by condition of the molds and teeming practice, toward producing the large number of "seconds" from the Hadfield ingots. A large percentage of "seconds" was similarly obtained from the reheated Hadfield ingots reported on by Hadfield and Burgess[1].

(Parts II and III will be published later.)

Free Thiocyanogen

By Clarence Jay West

In 1815 Gay-Lussac discovered that cyanogen, C_2N_2, could be prepared and that it was capable of existing in the free state. This was the first organic "compound radical" discovered. Cyanogen was called a radical by Liebig because

1. It is a never varying constituent in a series of compounds.
2. It can be replaced in these compounds by other simple bodies.
3. In its compounds with a simple body this latter may be easily separated or replaced by equivalent quantities of other simple bodies.

Of these three chief and characteristic conditions of a compound radical at least two must be fulfilled if the substance is to be regarded as a true compound radical.

Other compound radicals which are well known are nitrogen peroxide, NO_2, sulphur dioxide, SO_2, etc.

Following the discovery of cyanogen, Liebig in 1829 undertook to prepare free thiocyanogen by the action of chlorine upon silver, lead and potassium thiocyanates under various conditions, but was unsuccessful. The next step came when Linnemann (1861) shook an ether solution of iodine with silver thiocyanate. Silver iodide was formed, but the substance in solution decomposed so easily that it was not studied.

That free thiocyanogen was really present in this ether solution has been shown by the recent work of Söderbäck [*Ann.*, vol. 419, p. 217 (1919)]. He has shown that chlorine, bromine or iodine acting on a number of metallic thiocyanates such as silver, lead, mercuric, cadmium, zinc and cuprous, in a variety of solvents such as ethyl chloride, ethyl bromide, carbon disulphide, carbon tetrachloride, benzene, absolute ether, etc., yields a precipitate of the metal halide and a solution containing free thiocyanogen. The substance is best isolated from about a twice normal solution in carbon disulphide, by cooling with ether and liquid CO_2, and by filtering in a funnel cooled in the same way. Thiocyanogen forms rhombic plates, white to pale yellow in color, which melt at —2 to —3 deg., to a pale yellow liquid. These may be supercooled to —20 deg., but at —30 deg. always solidify. The liquid is unstable and quickly decomposes, changing from yellow to a dark reddish brown. While the crystals are soluble in organic solvents, water decomposes them, yielding thiocyanic acid, HCNS, hydrocyanic acid, HCN, and sulphuric acid. Söderbäck believes the molecular formula to be $(SCN)_2$, from its reaction with hydrochloric acid.

Arthur D. Little, Inc.,
Boston, Mass.

[1]See reference on p. 921.

Education of the Engineer

In Fifty Years Engineering Has Become a Learned Profession, a Wonderful Advance Considering the Conservatism and Complacency of Educators and Public—Yet No Better Engineers Are Being Produced, Largely Because of Inattention to Fundamentals

BY ROBERT S. WOODWARD*

WHEN I left the University of Michigan forty-eight years ago I found, much to my surprise and chagrin, that people whom I took to be the best educated people of the time led me to believe that there was no prospect that a man who has this elementary training we call engineering could become either a scholar or a gentleman. The nearly universal opinion was that the only way to achieve those desirable ends was to pursue a course of study which led to the degree of A.B. It was thought that the pursuit of studies in mathematics, say, beyond the confines of Euclidean geometry, would be narrowing in their influences, and that prejudice, I am sorry to say, has persisted in some quarters even to this day.

Engineering Now a Learned Profession

Few of you young men who are here can realize the great change that has taken place since then. The engineer has now come to be recognized as a member of a learned profession. In those old days there were only three learned professions recognized—those of law, medicine and theology. The great class of people whom we then called humanists, and whom we still call humanists, were separate and apart from the professional classes, and they, in those days as in these, held themselves to be far above the groveling crowd, even in professional matters. But in the meantime great progress has been made, and I think perhaps you may be interested to know what, in a brief statement, is my verdict as to the reason why you have achieved so much. To put it in a homely way, such as was used in New York City when I dealt somewhat in Tammany politics, the chief reason for your success is that you have been willing to "say little and saw wood." In other words, you have been willing to have your measure taken by merit alone, and that, in the long run, is the only ground on which a man may be expected to stand with any degree of permanence.

The title of my address, assigned to me, by the way, is "Education of the Engineer." But I fear that some of you don't know that in respect to education I am both a Philistine and an iconoclast. I have been at war with education all my life. I think in the courts it would have been said, if my testimony had been solicited, that I was a recalcitrant witness. I am disposed to think, although I have been connected with three universities, including the University of Michigan, and have been not lacking in experience as professor and as administrator in educational affairs, that the general verdict would be that I am far from orthodox; so that if I vent some of my spleen, you should not be surprised.

However, I am disposed to think that agitation is a good thing, and one of the things we must have; after the fashion of the Irish politician in Philadelphia, I have come to think, as he put it, "It is well for one to let folks have what they wants." And so, perhaps, it is well, if not inevitable, that what we call education should be what it is. I am going to indicate to you some of the faults I have to find with current education, not that I expect any rapid changes will take place, for the business of education is the most conservative business with which men are concerned. First, let me remark on this peculiarity of Americans: with us education is a passion. There is no interest which is so dear to the heart of our average American as education. We can raise money for almost any kind of a scheme in education. On the whole I think that has been a good thing, but it has not been without its sinister effects.

Another peculiarity about education is that it is a subject of perennial interest. There are coming on crops of successive individuals and generations who come to the subject as if it were entirely new; as if all that need be learned had to be learned by them; and I think it must be admitted that all they learn is learned by them; they cannot learn from other people. But the fact that our young folks come to the subject of education with such assurance and with such optimism illustrates a general fact with regard to that sort of knowledge we call history.

It is a curious and a depressing fact, when we come to think of it, as an old man like me sometimes thinks about it, that we learn less from history than from any other source of human knowledge. Perhaps you would be inclined to dispute that. But have we not had to witness it? One of the most extraordinary examples in all history is furnished by the Paris Peace Conference. Haven't things been set up temporarily or adjusted at that Conference, as if there had not existed twenty centuries of recorded history? Wasn't that Conference one which proceeded as if we had had no previous experience in international law, or in economics, or in anthropology? I think that furnishes the most striking illustration in the whole history of mankind of the fact that we learn almost nothing from history.

"Law of the Conservation of Ignorance"

Turning now from this more serious aspect of my subject to something which is more humorous: Do we not find this fact illustrated in education? Things go on about the same. Our standard courses of education in the colleges and universities are about the same as they were five or six or seven hundred years ago. We have gone on with very little change; and it is probable we shall go on in much the same fashion. In one of my addresses read at Columbia University I made some reference to this subject, and I said our procedure with respect to education is strictly in accordance with the

*President, Carnegie Institution of Washington.

"law of the conservation of ignorance." If you care to look up the subject, you will find that I have elaborated that statement and explained how it happens. There are good anthropological reasons for the statement we proceed in accordance with the "law of the conservation of ignorance."

Educators Complacent in Regard to Education

Let me refer to another aspect of education in general. Is there anything concerning which we, as educators—and now I speak as an ex-professor and as an ex-dean—is there anything with regard to which we are more complacent than we are with regard to education? And is it not now being sounded from a thousand platforms? There must be a thousand degree-giving establishments in the United States. From a thousand platforms we may now hear it said that "education makes the man." No proposition can be more nearly wrong than that. I flatly contradict all such statements. Yet we listen to it from year to year with the utmost complacency, with a spirit of serene opacity. Nothing can shake our confidence in our systems of education. Our confidence in education is perhaps most strikingly illustrated, if quantity of noise is a measure, by our monthly, semi-annual and other dinners—alumni dinners. Who has not attended a number of these, and who has not discovered in them a striking similarity to Mr. Bryan's brief description of an old-fashioned Jeffersonian or Jacksonian dinner? When we get together on these occasions, some sing, some dance, some speak, but most of us whoop like wild Indians, with a degree of confidence which shows that we have not the slightest pangs of conscience with regard to what we call education.

Many Humorous Aspects to "Education"

But why raise any such questions as these now? This, of all times, is perhaps the most inappropriate occasion to raise a question concerning the curricula; even the curricula of engineering schools, or questions with regard to the conflict of study, or questions with regard to the requirements for degrees. I would be the last to raise any doubt concerning these, because all such technical matters have been settled with a high degree of exactness by our academic friends. They have got the number of points a man or a woman must make down so fine that they express them to four significant figures. It must be evident, then, that it is nearly useless to inquire into these questions, because it must have been settled by our teachers and by the heads of our colleges and universities just what is necessary to make an educated man. Nevertheless, to an old fellow like me, who has been both inside and outside these camps, there are many things that tend to make one laugh, and I trust that whatever I may have to say or have said in criticisim of education will not be taken too seriously. I am sure of this, that whatever I say will produce only the slightest effect; yes, an effect which will be purely ephemeral. Nevertheless, there are some very funny things to be found in education; some fallacies that any hard-headed student could easily puncture. But I am disposed to pass these matters over, partly because we engineers have a society for the promotion of engineering education, which has also settled all these points. Yet I think you will agree with me that in spite of all the energetic and active work that society has done, we are not turning out any better engineers now than we turned out fifty years ago. Do you ask the question why it is that we are not turning out any abler men now than we did fifty years ago? Well, I think it is worth while for us to ask and to try to answer that question.

Here is another question raised by my friend President Eliot, emeritus of Harvard, who created quite a stir in military circles a few weeks ago when he stated that the selection of the men for the work of the Naval and Military academies was not good. I think that statement is obvious. If you wanted to select a good able body of engineers, you would not ask Congressmen to name the men to become graduates of these great schools. Look at the product, however. You must judge institutions and organizations by their products and not by any more refined method. I agree fully with Dr. Eliot, but at the same time I think both parties are right. Where is the paradox? There is a paradox, and it leads me to come to my first point concerning education.

Here is my first proposition: Education does not consist in studying certain things. It consists rather in studying some things thoroughly well. And then my next proposition is that our boys and girls turn out fairly well from educational establishments, not by reason of them, but in spite of them.

The important factor which we educationalists have from time immemorial overlooked is that of heredity; what a man will be when he goes through this, that or the other college depends far less upon the college than the man's inheritance. To put the case in another way, we only need to refer to the formula for the generation of a gentleman furnished by Oliver Wendell Holmes. You know Holmes said, "If you want to generate a gentleman, you must begin 400 years before he is born." Well, so it is in education. Our boys and girls turn out fairly well from the colleges and universities, not by reason of them, but in spite of them. They turn out well because they are on the average of good stock, and that explains why it is that the men from the schools of West Point and Annapolis are, on the whole, able and praiseworthy men.

Thorough Training Needed for Specialists

It would be easy to cite many illustrations of the fallacies to which I have referred. You know our old and dominating predecessors in the educational world—namely, the humanists—claim that a man, in order to be educated, must study certain things, and particularly certain things in strictly limited quantities. For example, if he pursue mathematics beyond the elements of algebra and the elements of Euclidean geometry, he is stigmatized by our friends and humanists as a narrow specialist. There is something very ridiculous about that common phrase. I think it would be more logical and more polite to say that the training of the specialist —I don't mean the dilettante, but the specialist who knows more than other people about a subject—must be broadly liberal in order that it may be minutely special. And as to that more general proposition I referred to, that "education makes the man," I think it ought to be replaced by this proposition. It is very simple, perhaps too simple—Man makes the education. That is all there is to it, when we come to sift it all down and let the wind out of it. What a man is will depend chiefly upon his industry and upon the capacities which he has inherited from his forefathers.

But some of our critics with regard to engineering education have special charges to bring against students

of engineering. It is alleged they are not only narrow specialists, but that they do not know English; they do not know how to pronounce their own language; they are unable to write their own language. Now, all that is true. It is worse than that. It is a truism and hence a platitude, because there are very few people, however they may be educated, who can speak the English language correctly, or speak any language correctly, and there are very few who can use it with skill. Some of my friends have heard engineers make some very serious mistakes which they would not have made if they had known a little of Greek. To take an example as an illustration, a very little knowledge of Greek would enable a man to say "aëroplane" instead of "air-e-o-plane"; but a much less knowledge of spelling would enable him to know the same thing; and as anybody who pays attention may see, there are about as many who have studied Greek who make this vulgar error as there are those who have not studied Greek. Similarly, in these days we hear much said about science and research, but, as you know, this word research is almost universally mispronounced. It is one of the 25,000 words that are commonly mispronounced. We in our American impetuosity have advanced the accent of that word to a position not yet approved by the lexicographer. But I find that people who have studied Greek and Latin, and who have had all the advantages of classical learning, are about as apt to use "re′ search" as other folks. So I conclude that the correction for these errors is not to be found in studying certain things, but is to be found in the slow and painful process of generating men and women who will give attention to words. If a man is a good speller he must give attention to the spelling of words. No amount of study in Latin or Greek or Sanskrit or Choctaw will help him very much. So, if a man is going to be successful as a lawyer, as a doctor, as an engineer, his success will not depend upon his having studied certain things, but it will depend upon the degree of attention which he gives to the things which are before him, concerning which he needs to know.

A short time ago I had a humorous illustration of the serene confidence of a good friend, a humanist, in his learning when he stood alongside an automobile and awaited the opening of the hood to look in on that physical laboratory which we now call the engine of an automobile. He had never given any attention to such subjects, and he was very glad he had a negro chauffeur who did know a little about it. Something had gone wrong with the engine, and it was necessary to find what was wrong. Well, after pacing up and down alongside the hood of the automobile, he turned to me and said, "*Ultra vires*"! Undoubtedly what needed to be done to that engine was beyond him. That illustrates how easy it is for us to be content with little knowledge of some things and to imagine ourselves lords of the universe.

I have two or three faults to find with our engineers. You know that a long time ago John Stuart Mill emitted in one of his books that aphorism, "A man ceases to be progressive as soon as he feels that he is king of his company." Now, during the past fifty years, the engineers have made extraordinary progress. They have come into their own, and some of them have come to feel their sufficiency, and what I fear is that some of us are in danger of making the same classic errors made by our friends the humanists. I occasionally hear some of our engineers assert that if we could only have the affairs of the world turned over to us we could make them go a good deal better than they are now going; and while there is much truth in this, I suspect there is some degree of error in it, and that having seen a number of classes of predecessors fall into this crass error, it would be well for us to take note of it and try to avoid it in the engineering profession.

In line with that, I would like to say that one fault I find with our schools of engineering now is that they are devoting very little time to research. I think it is a characteristic fault of the schools of engineering in our country that they are willing to take what they can get from other sources, and not cultivate a capacity for original investigation, and have that sort of progress which comes from research. There are a few schools in the United States—and there are individuals—who during their leisure time carry on important researches, but I do not think there are any more such today than there were forty years ago.

This is especially to be regretted at this time, because now is the time of great opportunities for the American engineer. I would like to see a school, or a high school of engineering perhaps we should say, after the French model, for the prosecution of engineering studies, something comparable with the Ecole Polytechnique of Paris. Some of you may not be aware of the fact that a very considerable proportion of the leading engineers in the history of the world have come from the Ecole Polytechnique. Great names are connected with that school. Going back 100 years ago, there were Lagrange, Laplace and Poisson, who laid the foundations of mathematical physics; then a little later came that great aggregation of engineers beginning with Navier, who laid the foundations and built the superstructure of that extraordinary branch of mathematical physics which we call the theory of elasticity, a branch of mathematical physics far and away greater than Einstein's theory, which has attracted so much attention in the past six months.

Now, the thing I want to call your attention to, and especially you young men with whom the future of engineering education largely rests, is that we need to have in our country somewhere, somehow, a great school for theoretical study, which may become comparable with the Ecole Polytechnique. This is not only a great opportunity, but a great duty before us.

A Study of the Hardness of Glazes by the U. S. Bureau of Standards

An attempt is being made to differentiate the different glazes applied to clay products according to their hardness by tests similar to the Brinell test commonly used for metals. The hardened steel sphere used in the Brinell machine is replaced in this case by a conical steel point, the penetration of which into the glaze under high pressure is an index of the hardness of the material. This penetration is measured by means of a micrometer microscope. The pressures employed for forcing the point into the glaze are quite high and have been as great as several hundred thousand pounds per square inch. Although the test has not yet been brought to a satisfactory status, it has differentiated between the several types of enamels and glazes examined. Thus enamels are punctured under fairly low pressures while high-fire porcelain glazes are exceedingly resistant, and white ware glazes occupy an intermediate position.

The Manufacture of Lime for Chemical and Metallurgical Purposes*—III

Methods of Heating Rotary Kilns — Description and Comparison of Pulverized Coal and Producer Gas Installations — Boilers in Series With Kiln — Power Consumption—Cost Data†

BY RICHARD K. MEADE

PULVERIZED coal, producer gas, natural gas and oil are all employed for heating kilns. Localities where natural gas can be used are few and the cost of oil at the present time is prohibitive in most sections of the country, so the fuels generally available are pulverized coal and producer gas. Natural gas is the most convenient fuel and producer gas the most troublesome. Oil is a very convenient fuel to use and the installation also costs less, except where very large storage tanks have to be provided. When oil is used for a fuel, the apparatus necessary to heat the kiln is similar to that required for heating a boiler with this fuel. Almost any type of burner which will atomize the oil and give a conical flame will work satisfactorily. The writer has used Rockwell, Hauck and Kirkwood burners with success. He has also obtained equally good results with a burner which he had made up from his own design out of ordinary pipe and fittings. In all of his installations, he has employed air at from 30 to 40 lb. pressure not only for atomizing the oil but also for forcing it to the burners. In his system there are, in addition to the main storage tank, two small supply tanks, each of which will hold a supply of oil sufficient to last the kiln for from four to six hours and which are capable of withstanding a pressure of 100 to 125 lb. The two tanks are used so that one will be in service while the other one is being filled. The oil is forced from these tanks to the burner by means of compressed air, just as acids are lifted. The writer's experience has been that high-pressure air atomizes the oil better than low-pressure air and the use of air to force the oil to the burners does away with the oil pumps and allows one apparatus to do the work of two.

Owing to the difficulty of securing oil cheaply in most localities, the average lime manufacturer, as I said, will have to decide the question of whether he will use pulverized coal or producer gas for heating the kiln. There are some points in favor of each. Producer gas will give the purest quality of lime. Pulverized coal, on the other hand, will be more economical and easier to handle.

PRODUCER GAS

Producer gas burns a nice clean lime. The temperature of the flame obtained is ample to burn good chemical lime and if the producer is a good one and is well taken care of, fairly uniformly burned lime, free from core, will be obtained. Producer gas, however, varies with the operation of the producer. The hand-fed, hand-rabbled producers give a gas the quality of which depends very largely on the man who operates them. When such a producer is freshly charged with coal there is a rush of gas through the furnace. The gas then gradually decreases in calorific power until the next charge of coal is put in the producer. Automatically stoked and fed producers operate much more smoothly and if at all well handled this objection is practically eliminated.

The producer should be located under a bunker so that the coal may be fed directly into the hopper of the former. Arrangements should also be made for removing the ashes conveniently. The producer should be located near the kiln so that no more heat will be lost by radiation than is absolutely necessary. The piping should be so arranged that the flues can be cleaned easily. Usually each kiln has its own producer or producers and no valves are inserted between the kiln and producer, the rate at which the producer is operated

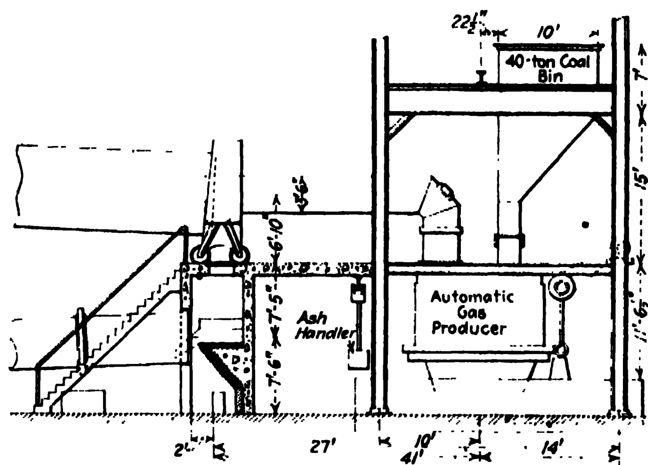


FIG. 7. PRODUCER GAS INSTALLATION

controlling the flow of gas to the kiln. Where two or more small kilns or other furnaces are heated from the one producer, etc., valves will, of course, be necessary. In the event a valve is not used, a sand damper or some means of shutting off entirely the producer from the kiln should be provided so that the lining of the latter may be repaired when desired without allowing the fire in the producer to go out. Fig. 7 illustrates the installation of a gas producer in connection with a kiln.

As an 8 x 125-ft. kiln will require from twenty to twenty-five tons of coal to heat it, or a gasification of about 2,000 lb. of coal per hour, it will be seen that one kiln is large enough to have its own producer or producers and one large kiln is always to be preferred to several small ones.

The largest mechanically stoked producers will take care of from 3,000 to 3,500 lb. of coal per hour, or

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 17 and 18, Oct. 27 and Nov. 3, 1920, pp. 841 and 873.

about thirty-two to forty-four tons per day, but much smaller producers can be obtained with the automatic feed and stoking arrangement.

About 0.4 lb. of steam will be required to operate the producer for each pound of coal gasified. This is equivalent to approximately one boiler-horsepower per ton of coal gasified in twenty-four hours. Or an 8 x 125-ft. kiln would require twenty to twenty-five boiler-horsepower.

One man per shift can take care of a mechanically stoked producer with the help of another man part of one shift to get coal into the bunker, take away the ashes, etc.

I estimate that the cost of producer gas in a well-equipped plant is approximately as follows, figuring on a producer which will gasify 2,000 lb. hourly:

Attendants, 1 man @ $4, 3 shifts	$12 00
Attendants, 1 man @ $3 20, 1 shift	3.20
Steam, coal @ $5	6 00
Supplies, repairs, etc.	5 00
Cost per 24 tons of coal gasified	$26 70
Cost per ton	$1 09

Added to the above should be the losses from the producer. With smaller producers, cost of attendance would, of course, be more per ton, which would raise the cost of the gas.

Comparison of Producer Gas and Pulverized Coal Fired Operation

The advantages which pulverized coal has over producer gas for heating rotary limekilns are, first, the much more uniform rate of supply of fuel to the furnace, as where proper feeding devices are used there is a continual supply of fuel to the furnace at a regular and uniform rate, and this fuel is, of course, of the same thermal value at all times and does not vary in this as does gas. Second, with powdered coal the loss of carbon due to that remaining in the ash is avoided. Third, it is possible to burn powdered coal with almost the exact quantity of air necessary for combustion, which is not possible with producer gas. This means a higher flame temperature and a saving of fuel. Fourth, in the producer there is a loss of coal due to carbon completely burned to carbon dioxide. A certain portion of this loss is of course conserved as sensible heat in the gas and is utilized provided the producer is set close enough to the kiln to cut down radiation losses.

The efficiency of a producer is seldom greater than 85 per cent and is generally less than this compared with pulverized coal.

Experiments which the writer has made indicate that when pulverized coal is used about 40 per cent of the ash of the fuel enters the lime. Assuming, therefore, that 450 lb. of coal is required to burn a ton of lime and that the ash amounts to 10 per cent of the weight of the coal, one ton of lime would contain 18 lb. of ash, or about 0.9 per cent. I am giving herewith two analyses showing lime burned with pulverized coal containing 11 per cent ash and what the same lime would be burned with producer gas.

COMPARISON OF LIME BURNED WITH PRODUCER GAS AND PULVERIZED COAL

	Analysis of Lime Burned With Pulverized Coal	Analysis of Lime Burned With Producer Gas
Silica	2.44	2.10
Iron oxide and alumina	1.15	0.80
Lime	94.33	95.00
Magnesia	1 22	1.24
Loss on ignition	0.86	0 86

A larger amount of ash will be retained by lime in which there is a lot of fine material, such as where the fine limestone dust has not been screened out, than will remain where the dust is screened from the coarse stone. The dust seems to catch and hold the ash rather than to allow it to be carried away by the draft of the kiln.

The cost of pulverizing twenty-four tons of coal daily is approximately as follows:

Drying the coal — 0.2 tons coal @ $5	$1 00
Attendants 1 man, 1 shift, 8 hours @ $4	4.00
Grinding 400 kw.-hr. @ 2c	8 00
Supplies, repairs, etc.	4 00
Cost of pulverizing 24 tons	$17 00
Cost per ton	$0 71

It is hardly necessary in this paper to go into the various methods for pulverizing coal. The subject has been dwelt on quite extensively in technical literature the last few years.[1]

Pulverized Coal Installations

Sufficient to say, two general systems may be employed for heating the kiln with pulverized coal. One system in which the coal is pulverized and blown into the kiln at the same operation and the other in which the coal

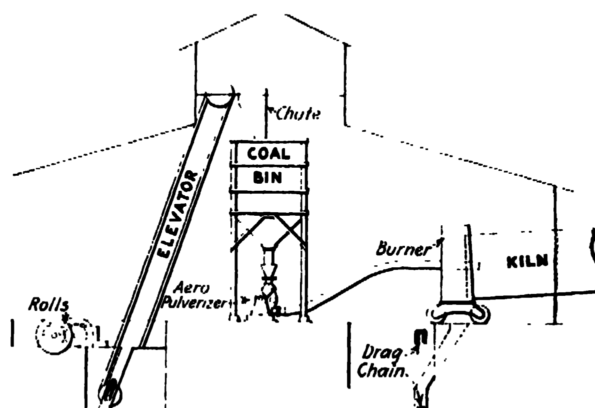


FIG. 8 ROTARY KILN HEATED BY AERO PULVERIZER

is pulverized in a separate plant, the pulverized coal conveyed into a bin at the kiln and fed from this into the burner as desired.

Fig. 8 shows the former installation in which an "Aëro" Pulverizer is used. This latter consists of a series of paddles which revolve about a horizontal axis in circular chambers through which air is drawn by means of a fan on the same shaft as the paddles. The coal is pulverized by being thrown against the walls of the chambers by the paddles and is drawn out with the necessary air for combustion and blown directly into the kiln through a pipe which extends directly from the pulverizer to the kiln. This pulverizer is supposed to work on damp coal and with Eastern coals has given fairly good satisfaction without drying the coal. With some of the coals in the Middle West, however, the experience has not been so good. The Aëro requires about 18 hp.-hr. (13½ kw.-hr.) per 1,000 lb. of coal pulverized, or with ordinary fuel consumption about 7¼ hp.-hr. (5½ kw.-hr.) per ton of lime produced. It should be remembered in comparing this power with that required by other machines that the above includes power necessary to blow the coal into the kiln, etc. This machine may be looked upon as a cheap method of

[1]See Meade, *Transactions* of American Institute of Chemical Engineers, vol. I, p. 98.

heating the kiln with pulverized coal rather than as the most efficient, as it does not pulverize the coal very finely.

The best method of preparing the coal and the one which would probably be used by a large lime plant would be to pulverize the coal with either Raymond or Fuller mills and convey it into a suitable storage bin, from which it would be fed to the kiln as required. Fig. 9 illustrates this system, a Raymond mill being used.

Either one of these two pulverizers will require the

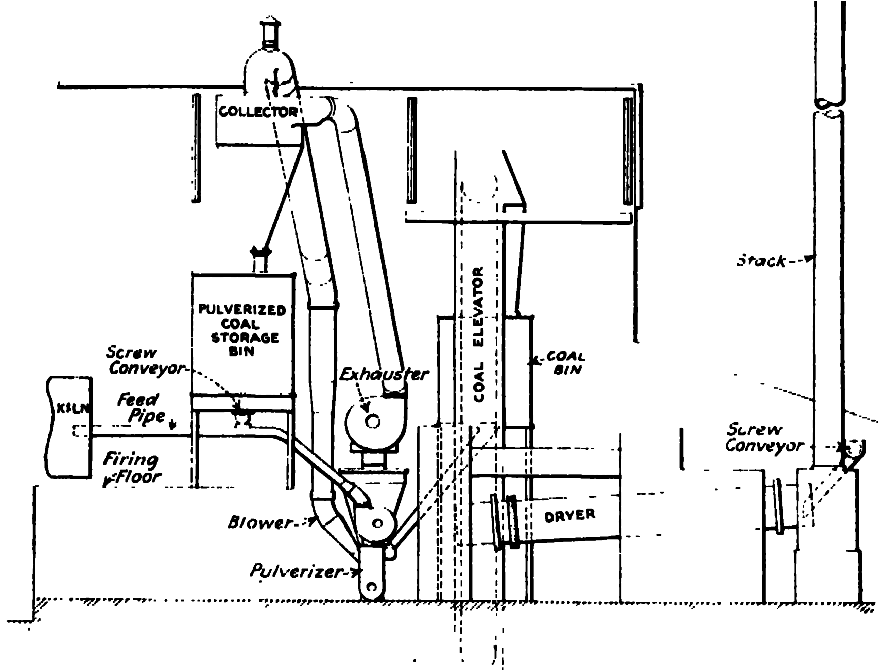


FIG. ROTARY KILN WITH SEPARATE COAL VERIZING PLANT

coal to be crushed to about 1 in. and to have been dried. The Aëro Pulverizer will also require that the coal be reduced to 1 in. For crushing the coal a set of rolls is usually employed and the drying may be done in any of the accepted types of rotary coal driers.

The coal bin should hold sufficient coal to last the kiln sixteen to twenty-four hours so that the pulverized coal plant need not be operated more than one shift. The coal is fed out of the bin at a uniform rate by means of a worm, the speed of which can be altered to give the desired amount, and dropped into the burner. Either steam or high- or low-pressure air may be employed to blow the coal into the furnace. Low-pressure air at 6 to 10 oz. from an ordinary blower is usually employed, about 50 per cent of that necessary for combustion being so supplied.

Boilers in Series With Kiln

The waste gases leave the kiln at about 1,300 deg. F. and hence contain a large part of the heat liberated by the burning of the fuel. This heat can be successfully utilized in boilers, as has been done in the cement industry[1] where an efficiency of 70 per cent has been obtained. The weight of gases usually amounts to between 6,500 and 7,500 lb. per ton of lime produced. The heat in the same will, therefore, be approximately 2,275,000 B.t.u. This is about 40 per cent of the total energy of the coal burned, the remaining 60 per cent being distributed about as follows: Decomposition of the limestone, 54 per cent; radiation from the shell, 6 per cent. Of this waste heat 70 per cent has been successfully utilized by waste heat boilers, or about 1,500,000 B.t.u. per ton of lime produced. This is equivalent to 1,550 lb. of steam at and from 212 deg. F., or 45 boiler-horsepower (hours). A kiln burning four tons of lime per hour, therefore, would be good for about 180 hp. In the new lime plant of the Eastern Potash Corporation, designed by the writer, boilers are being installed. In most chemical plants where steam is needed for evaporation the plan should certainly be employed, as not only power enough to operate the kiln can be obtained but considerable in excess.

Fuel Consumption

The fuel requirements of a rotary kiln are from 2,800 to 3,500 B.t.u. or 400 to 500 lb. of coal per ton of lime, 37 to 45 gal. of oil per ton of lime, 500,000 to 625,000 cu.ft. of natural gas per ton of lime.

This is better than can be accomplished with the best hand-fired kilns and but slightly less than that claimed for the best types of gas-fired kilns. The quantity of fuel required depends, just as in the case of the vertical kilns, upon the nature of the stone, the kind and quality of the fuel, the skill of the operator and the kiln itself. The most economical kiln is one in which the ratio between length and diameter is greatest. That is to say, of two kilns having the same diameter but different lengths operated under the same conditions, the longer kiln will have the greater fuel economy (and incidentally the greater output also).

If we deduct the fuel required to produce this power from that required to burn the lime, the efficiency of the rotary kiln will far exceed any other type. To produce 180 hp. about 720 lb. of coal per hour will be required, while to heat the kilns 1,800 lb. of coal per hour will be required, leaving 1,080 lb. of coal charged against the lime burning—or 7.4 lb. of lime per pound of coal.

Where the gases from the kiln are needed in the chemical process they can be drawn off from the kiln stack by means of a fan. Generally speaking, the gases from a rotary kiln are not quite so rich in carbon dioxide as those from a vertical kiln due to the leak through the annular space where the kiln revolves in the stack chamber. By proper arrangements for closing up this opening as much as possible, a gas containing about 24 per cent carbon dioxide on an average can be obtained. The waste gas always contains dust consisting of particles of limestone and lime and, if pulverized coal has been used for burning, the ash of this coal. The gases may be cleaned practically free of this by the use of water sprays, gas washers, etc.

One man can attend to the kiln provided the stone is placed in the feed bin for him. If there are more than one kiln, one man and one assistant can attend

[1] See Baylor, *Transactions of the American Institute of Chemical Engineers*, vol. 10, p. 209.

to as many as three kilns. If the Aëro is employed to pulverize the coal, the kiln tender looks after this also. The coal, however, should be placed in the bin above this for him, so that all he has to do is to see to the proper operation of the kiln, cooler and pulverizer. Any intelligent man can be broken in to operate the kiln in a satisfactory manner.

Power Consumption

The power required to operate a rotary-kiln plant will be about as follows per ton of lime produced:

	Hp hr.	Kw-hr
crush limestone	2 50	1 9
revolve kiln, feeder, etc	4 25	3 2
revolve cooler	1 25	1.0
pulverize coal, separate plant	5 50	4 1
feed and blow coal into kiln	2 00	1 5
pulverize coal, Aëro system	8 00	6 0
scellaneous, stone elevator	1 00	0.8
Total where pulverized coal is used	16.50	12.5

Repairs to the kiln are light and consist in an occasional renewal of the lining at the lower 20 or 25 ft. of the kiln. The lining of the upper part of the kiln will last for many years, but in the hottest part of the kiln the lining must be renewed every six to nine months, although a careless attendant can burn out a lining in a few weeks' time. An allowance of 25c. per ton will easily take care of repairs to the kiln, relining when necessary and the lubricants, provided the kiln is properly handled. Under existing conditions a rotary-kiln lime plant of the best construction will cost approximately $950 per ton of lime produced per day. This figure includes a steel building entirely over the kiln and a pulverized coal plant or mechanically stirred producer. Where an Aëro Pulverizer or oil fuel is employed the cost is slightly less. It is not absolutely necessary to cover the whole kiln with a building. If this is not done, of course, the cost will be reduced.

The cost of producing lime in a rotary-kiln plant in the Middle Eastern States at this time is about as shown in the accompanying table. The first column represents cost with an output of 100 tons daily, stone quarried at the plant and a coal at $5 per ton. The second column represents cost with a 30-ton plant where stone is purchased and coal costs $7.50 per ton.

COST SHEET OF A RO RY-KILN LIME PLANT

Stone, 2 tons	$1.50 to $2.50
Coal, 0.2 ton	1.00 to 1.50
Labor	.20 to .60
Power, 15 kw.-hr at 2c.	.30 to .45
Repairs, supplies, etc	25 to .35
Total	$3 25 to $5.40

Glueing Turpentine Barrels

Turpentine will readily penetrate through the staves of an ordinary wooden barrel. It is therefore necessary to coat the inner surface of the barrel with ordinary glue, which is insoluble in turpentine but readily soluble in water, say naval stores experts of the Bureau of Chemistry, United States Department of Agriculture. Turpentine soon leaks out from a barrel that has been carelessly or improperly glued, as well as from one containing any water, regardless of how well the glue was prepared or applied. Consequently great care must be taken in preparing the glue and applying it to the barrel, and finally also in so filling the barrel with turpentine that no water gets into it.

As a rule, glue makers furnish with their product a formula showing the proper proportions of glue and water. The following formula is recommended by one of the largest producers of animal glue:

Glue, lb.	20
Water, gal.	8
Commercial borax, powdered, lb.	$\frac{1}{4}$
Commercial glycerine, lb.	$\frac{3}{4}$

The glycerine is added to make the glue more elastic, and may be omitted if the directions for preparing the glue here given are carefully followed.

Late in the afternoon place the quantity of glue required for the next day's work in a perfectly clean jacketed or double-boiler glue kettle, cover with the proper quantity of clean cold water, and let it dissolve slowly to a jelly. When glue prepared in this way is heated the next morning, it dissolves in the water rapidly and smoothly, and has the further advantage of being somewhat stronger than that simply mixed with cold or hot water and immediately heated.

Since animal glue rapidly loses its adhesive strength when it is subjected to a high temperature, it should never be boiled. Glue prepared in a single unjacketed kettle over an open fire will almost certainly become too hot and boil when not watched, or it will not be hot enough to glue the barrels properly without waste. In preparing the glue, then, use a double boiler or jacketed glue kettle. The boiling water in the lower pot heats the glue in the upper pot to the proper temperature without bringing it to a boil. Do not keep the glue hot longer than necessary. Have the barrels ready to glue as soon as the glue is hot, glue at once, and clean the glue kettle for the next day.

Before glueing the barrel, drive the hoops down moderately tight. Then pour about 1 gal. of the hot glue into the barrel, plug up the bunghole, and sluice the barrel around well, making sure that the glue comes into contact with every bit of the inside surface. Remove the stopper, place the barrel on a rack over the glue kettle, and allow the excess glue to drain directly into the kettle. As soon as most of the excess glue has drained out, take the barrel from the rack, and stand it on one head in a level place. About one-half hour later, drive the hoops down absolutely tight, so that the tension on the hoops all around the barrel will be equal, and let it stand on the same head, thus permitting some of the soft glue still inside the barrel to settle down in the chine, where most of the leaks occur. Allow the barrel to stand, bung open, for several days under a shed, protected from the sun and rain, and then glue again exactly as before, but making sure that the barrel stands on the other head this time. After two days the barrel is ready for use. Barrels glued in this way should give little if any trouble from leaking, provided no water is allowed to get in.

As animal glue is extremely subject to decomposition through the action of bacteria and molds from the air, glue left in an open kettle soon begins to decompose, as shown by its foul odor, thus becoming no longer fit for use. It is, therefore, highly important to keep any left-over glue sweet and clean if it is to be used again. The unused glue should be poured into a can which may be tightly covered and stored in a cool place, and the pot thoroughly cleaned. Fresh glue is ruined if put in a filthy pot containing decomposed, foul-smelling material. The borax recommended in the formula is to help keep it sweet, and should be dissolved in the glue when ready for use.

Electric Furnace Refractories*

A Brief Description of the Raw Materials Now Available for Highest-Grade Brick, Together With a List Showing Recommended Refractories for Melting the Different Metals and Alloys, and Practical Hints on the Care, Storage and Laying of Roofs, Hearths and Linings

BY A. F. GREAVES-WALKER†

ONE of the most important problems facing manufacturers and operators of electric furnaces at the present time is that of refractories for linings and roofs.

The greatest advancement in furnace design and usage came during the period of the war. From the standpoint of the refractories manufacturer this was unfortunate, as the conditions prevailing in the industry at that time prevented him from giving the electric furnace the attention it deserved. Not only were the sources of some of the best raw materials cut off, but added to the great problem of supplying an ever-increasing demand in all metallurgical and chemical lines were many new ones presented by nearly all users of refractories. It was not surprising, therefore, that the electric furnace received what must have appeared to be scant attention.

In discussing the subject of refractories it will be well to bear in mind that electric furnace design has been entirely in the hands of electrical engineers. Furnaces have been designed, built and sold before the refractories engineer has even had an opportunity to see whether satisfactory linings and roofs could be made up or not. In some cases conditions imposed by the designer were impossible, but under the conditions there was no other course but to make the best of a bad job. It must be remembered too that not only was the refractories manufacturer called upon to supply satisfactory linings and roofs for the standard makes of furnaces, but during the war dozens of "home-made" furnaces were built and put into operation, each one of which presented its own problems.

RAW MATERIALS

The manufacturer of refractories is always limited by his raw materials, earths or minerals in nearly every case. It is therefore impossible to produce finished products having qualities that the raw materials do not possess. In other words, he is bound within comparatively narrow limits.

So far as electric furnace refractories are concerned, the following materials are available:

Basic: Magnesite, dolomite, zirkite, alundum or carborundum, bauxite.

Neutral: Chromite, zircon, carbon, fireclay.

Acid: Silica.

MAGNESITE

Magnesite is a carbonate of magnesia and is found naturally in two forms: The amorphous or massive, and crystalline. The amorphous type is entirely unsuited for refractories purposes, but during the war, after the Austrian ore was cut off, this was the only material available, the source of supply being California. The fact that the metallurgical industry was forced to use this unsuitable material accounts for much of the trouble encountered during the war period. In 1917 the crystalline magnesite from Washington began to come into use. This material is much like the Austrian, except that it is higher in lime and silica and lower in iron. In order to give it a bond it is necessary to add iron. This addition, together with the higher silica content, reduces its fusion point and basicity and lowers its efficiency considerably in comparison with the Austrian mineral. In recent months the Austrian ore has been gradually coming into the country in increasing amounts, but as yet has not reached a point where the supply nearly equals the demand.

There can be no question whatever that in electric furnace work the Austrian material is so superior as to be in a class by itself, and as soon as there is a sufficient quantity imported to supply the demand much of the electric furnace user's trouble with basic linings will disappear.

Magnesite is prepared for use by first dead-burning the crude ore, or driving off all of the CO_2. This is done in rotary kilns at a temperature of approximately 3,000 deg. F. When the material comes from the kiln it is sintered and in the form familiar to furnace men as dead-burned grains.

In manufacturing brick and shapes this dead-burned grain is ground and molded either in a heavy press or by hand. Undoubtedly the press-made product has very great advantages in electric furnace work on account of the great density obtained. When the product is well made and hard burned it will show practically no slag absorption. In cases where special shapes in small quantities or shapes impossible to make up on a mechanical press are required the hand-molding process is used. Magnesite is not suited to the manufacture of difficult or very large shapes, due to its tendency to crack or "squat" in the kiln at high temperatures. After coming from the molds the product is dried and burned in standard brick kilns and is then ready for shipment.

FUSED MAGNESIA

Fused magnesia has found use recently in the linings of induction furnaces. Little is yet known of its commercial value, but experiments would indicate that it may become extremely useful for certain purposes.

Calcined or dead-burned magnesite is fused electrically in manufacturing this product.

CHROMITE

None of the neutral refractories have come into wide use in electric furnace work.

Chromite, or more commonly "chrome," as the sesquioxide of chromium ($FeO.Cr_2O_3$) is called, is the best known of the neutrals. Since the Turkish, Grecian and

*Paper read before the Columbus meeting of the Electric Furnace Association, Oct. 7, 1920.

†Production Manager, American Refractories Co., Pittsburgh, Pa.

Rhodesian ores were cut off by the war, this country has had to depend upon the deposits of California and Oregon. Most of these deposits produced ores that ran only between 30 and 40 per cent Cr_2O_3 and contained a combination of other elements which gave them an extremely low melting point. The failure of brick made from domestic ores to stand up has caused the gradual discontinuance of their use. At the present time the foreign ores are coming on the market and a much better product, in fact one equal to or better than the pre-war product, is being manufactured.

Zircon

Zircon is here classed as a neutral, although it is questionable whether or not it should be considered as in the acid class. Its use is still in the experimental stage, but the few refractories that have been produced have been turned out by the same processes as used for magnesite.

Zircon does not have so high a melting point as zirkite, but it does not produce the carbide under reducing conditions in the presence of carbon. It is questionable whether it will ever come into general use.

Carbon

Carbon is used as a lining for special purposes, such as in the production of ferromanganese. The amorphous carbon is mixed with the binder, such as tar, and molded into shapes in presses or by hand and then burned in standard kilns. Very naturally the use of carbon refractories will be limited.

Dolomite

Dolomite is a carbonate of lime and magnesia. Before using it is usually dead-burned in rotary kilns and when properly prepared is mixed with a small percentage of iron, which aids its bond. Because of its high lime content it is unstable and will slake into powder upon exposure to damp atmosphere. Thus it is impossible to make dolomite brick and this refractory is, therefore, used only for patching bottoms.

Zirkite

Zirkite is a carbonate of zirconium. Zirkite brick and shapes are made by the same process as that used in the manufacture of magnesite brick. While zirkite is classed as a base, the ore has usually been so high in silica as to give it a neutral or acid reaction. It has not as yet come into wide use as a refractory and may be said to be still in the experimental stage. It is rather questionable whether this refractory will ever come into wide use on account of its affinity for carbon at high temperatures. Under such conditions it forms a carbide which has a low melting point.

Carborundum and Alundum

Carborundum and alundum would undoubtedly become very popular as electric furnace refractories were it not for their high cost. They have a very high melting point and low coefficient of expansion. Heretofore their use has practically been limited to jamb tile and roof brick. In jambs they have been quite successfully used.

Bau ite

Bauxite has been little used for electric furnace work, due principally to its general failure in metallurgical work. Some other high-alumina refractories have found a little favor in cases where furnaces were turning out special products, but none of this class have been able to replace magnesite in basic practice.

Products made from these materials are usually hand molded, dried and burned in the ordinary manner.

Fireclay

Fireclay is the most widely used of all refractory raw materials and naturally refractories made from it find their greatest use in the metallurgical field. Fireclay products have not, however, become popular in electric furnace work, due principally to the high temperatures encountered. While there is little difference between the melting points of high-grade fireclays and ganister, the fireclays begin to soften considerably below their melting point and as a rule have a high slag and metal absorption.

Fireclays or clays used for refractories purposes are found in almost every state in the Union.

The methods of manufacture vary with the type of clays and their proposed use; fireclay brick are made by the auger machine, dry press, soft mud machine, and hand methods. They are dried and burned in ordinary brick driers and kilns.

Silica

Silica or ganister rock is used for the manufacture of the well-known silica or acid refractories. Deposits containing the proper silica content and having the required physical properties are located principally in Pennsylvania, Wisconsin, Alabama, Montana, Colorado and Utah. The rock from Wisconsin and Pennsylvania has been used almost altogether in electric furnace refractories and of the two the Wisconsin rock seems to give the best results, especially in roof work.

Silica refractories are made by the hand process and dried and burned by ordinary methods.

Recommended Refractories for Electric Furnaces

The selection of the proper refractories for electric furnace work depends on several factors:

(1) The product of the furnace.
(2) Whether basic or acid process.
(3) The type of furnace.
(4) Whether furnace is operated continuously or intermittently.

In considering the first of these factors—the product of the furnace—it will be well to take up first the hearth and lining recommended for various products.

Steel Ingots and Castings.—Magnesite when high-grade steels are required. Silica when there are no special requirements on steel or when selected pure scrap is used.

Alloy Steels.—Magnesite exclusively.

Ferromanganese.—Magnesite or carbon.

Ferrochrome.—Magnesite or chrome.

Ferrosilicon.—Silica.

Cast Iron.—Fireclay brick when low temperatures are used and cupola practice simulated. Silica when high temperatures are used in rapid melting. Magnesite on irons of special low sulphur and phosphorus requirements.

Copper.—Magnesite on bronze scrap or pig containing lead. Silica or magnesite on refined pig (over 99 per cent Cu) and pure scrap.

Bearing Metal (Copper, Lead, Tin, Antimony).—Magnesite, as low as possible in SiO_2, especially with high lead content.

Monel Metal (Copper, Lead, Zinc, Tin).—Magnesite preferably, but silica can be used.

Bronze (Copper, Zinc, Tin).—Silica preferable, but mganesite can be used, where zinc is not too high.

Lead.—Magnesite exclusively.

Silver.—Silica.

Aluminum and Alloys.—Magnesite exclusively.

The recommendations are based upon the best practice of this country and Europe. There are naturally some cases where other linings would give better service, as the conditions in different furnaces can be so easily varied.

Refractories for Steel Furnaces

In the steel foundry the selection of the lining is, of course, limited to either silica or magnesite, depending upon whether the acid or basic process is used. This applies also to any other metal or metals.

The refractories used can be varied to suit the type of furnace only in a very limited way. In the bottom contact furnace, for instance, a metal cased magnesite brick has been tried out to a very considerable extent. The idea was that the metallic casings would aid the current flow from the charge to the contact bars on the shell. So far as it went the idea was good, but as the cases were filled only with dried dead-burned magnesite and not reburned there was little or no resistance to the molten metal penetrating to the shell. Far better results can be obtained by using burned brick and inserting between them thin metal sheets or strips.

In some types of furnaces a hot spot is developed on one section of the wall due to the location of the electrodes. In such cases, when a magnesite lining is used, a section will sometimes fall out when the furnace is tilted. This trouble can often be overcome by inserting a patch of silica brick in the hot section.

The continuous or intermittent operation of a furnace has a very important bearing on the refractories. This is especially true of the roof, which will be discussed later, but also applies to a lesser extent to the hearth and lining.

Silica and magnesite are both affected by rapid changes of temperature, but the latter to a much greater extent. In a basic operation it is, therefore, unwise to carry magnesite above the slag line, as the spalling action on silica will be much less.

When a furnace is operated intermittently, especially with prolonged shut-downs, the use of dolomite in any great thickness is unwise because it will slake to a powder upon exposure to the atmosphere.

Roof Brick and Its Laying

In the matter of roofs the furnace man is practically limited to the use of two refractories—silica and fireclay.

A roof properly built of high-grade silica refractories will undoubtedly give longer life than any other provided the furnace is operated continuously, but nothing will prevent spalling and short service when the furnace is operated intermittently. This latter fact has been extremely hard to impress upon the furnace users, with the result that the refractories manufacturer has been blamed for many roof failures for which he was not responsible. It is extremely hard to heat up an electric furnace slowly and avoid spalling the silica brick, and it is therefore necessary to determine by experiment whether a fireclay roof will serve better under the conditions. It is simply a question of whether the fireclay will melt or the silica spall faster, a matter easily determined by a comparison of the number of heats.

Most of the roof spalling that has been encountered in furnaces that have been operated continuously has not been due to temperature changes but to faulty construction. When a roof is laid up, either of shapes or 9 in., the proper expansion joints are usually left. On the first heat the wood expansion strips are burned out and the top is then thoroughly grouted with silica cement. This grouting fills all open joints and when the roof cools down the brick or shapes settle down into a fairly tight job. The expansion joints have practically disappeared, either through the settling together of the brick or by being filled with grout, and therefore upon the next heat the brick, having no chance to expand, begin to crush one another, the natural result being that the lower or small end is crushed off first and drops into the bath. This crushing or spalling does not take place over the entire roof but only between the skewback and electrode rings. It is in this area that the greatest thrust is encountered. Many efforts have been made to devise a means of overcoming this difficulty, but the only one that has met with success is the Griffin patent. This patent covers a roof containing special shaped brick in the rings between the skew and the electrode rings. Each of these brick has an offset or shoulder near the upper or top side which in practice prevents the grout from penetrating beyond it, thus leaving the original expansion joint free to come and go at the bottom.

In practice this roof is giving splendid results, the life under continuous operation being from 100 to 200 per cent greater than for straight brick.

There is no part of the furnace that receives harder treatment than the roof and no part that presents greater difficulties for fair comparisons. The difference of only a few inches in the distance from slag line to roof will make a very great difference in the life. One instance was noted where a Heroult roof ring was raised 6 in., with the result that the silica roof gave twice the number of heats.

The handling of the arc also has a very considerable bearing on the roof life.

Another very important cause of short roof life has been the lightness or instability of the roof ring. Sometimes this ring has been constructed of such light material that when a roof was picked up to be placed on the furnace the weaving effect was great enough to loosen all of the brickwork, the result being that some of the brick or shapes would drop out entirely, or at least drop down out of place, with the loss of a number of the important expansion strips. Many lining and roof failures blamed upon the refractories have been entirely due to the lack of rigidity in furnace construction.

Treatment of Refractories

All refractories are injured by exposure to the weather. The manufacturer uses every care to prevent his product from being exposed, only to note that many users pay no attention to this important point. Freezing is very injurious to any refractory, but is probably most damaging to silica brick on account of its porosity. Dampness in itself will not greatly injure a refractory, but the damage is done in using wet brick in a lining and then not taking sufficient time to thoroughly dry them out. There is absolutely no safe rule to follow in

the rate of heating a damp wall. It is a guess at best and the furnace man who uses wet brick should be willing to accept the results if his guess is wrong. Magnesite brick should never be wetted and should be laid up with dry cement. These brick give up moisture slowly, and if it is present and the heat is raised fast enough to convert it to steam, the brick will be disintegrated to a powder. At least 99 per cent of the complaints received by magnesite brick manufacturers on their product are due to the use of wet brick or the attempt to lay them up with a wet mortar.

Not enough attention is paid to proper expansion joints when using magnesite brick. A full $\frac{3}{16}$ in. per ft., or 1½ per cent, should be allowed and it is always the best practice to allow for expansion between brick. This can easily be done by using pasteboard strips.

A special effort should be made to handle magnesite and chrome brick with extreme care, not only because of their high cost but because they are laid up with very small quantities of dry cement and chipped and broken edges and corners will not make a tight job. Brick should always be laid up with the cement recommended by the refractories manufacturer. Many patching cements and refractory mortars are extremely injurious to brickwork under certain conditions and none now on the market should be used in contact with magnesite brick.

The use of a course of chrome brick between the magnesite and silica has been common practice in metallurgical furnaces, but in the past few years has been found to be unnecessary. The presence of chrome is naturally objectionable when making many steels.

Finally, skill in furnace operation has much to do with the life of the refractories in the furnace walls and roof. The most critical period of the heat is just before the arc is veiled by the froth from the slag. At this time the section of the lining nearest the electrodes is exposed to an intense heat. Close attention by the operator at such times will add many heats to the life of the lining.

Substitute Belting in Germany

By C. A. Heise

DURING the war, while Germany was cut off from the world's markets, the want of various raw materials formerly imported from abroad made itself increasingly felt and though, in spite of the blockade, supplies were flowing in from neutral countries they cannot be said to have relieved the situation to any feasible extent. The German industries were thus thrown upon their own resources and immediately set to work on the utilization of all kinds of substitute materials.

Leather for belting was one of the many materials which became scarce and for which the need for efficient substitutes made itself severely felt. Though the pre-war consumption of leather for belting amounted only to ½ per cent, and for packing, etc., to 1 per cent, it should be remembered that practically every available ounce of leather was commandeered by the government for munition and other war industries. The textile industry might have come to the rescue but for its own shortage of raw materials. The need for suitable substitutes having become pressing, extensive experiments with belting made of wood pulp products were carried out; belts built up of wire, with wooden or pasteboard members, similar in construction to a driving chain, were also subjected to extensive tests. Many patents were granted for paper belts reinforced by an interior wire netting, etc., and reports at hand tend to show that on the whole they gave satisfactory results, being particularly adapted for horizontal drive, though it would appear that for agricultural machinery they were less suitable.

Use Continued After the War

With the lifting of the blockade Germany was once more enabled to replenish her depleted stores of some foreign raw materials. The use of substitute belting, however, is being continued because of the depreciation of German currency, which has almost prohibited the purchase of leather abroad.

For decades to come Germany will, for purely economic reasons alone, have to reduce her consumption of imported materials to a minimum while developing her productive capacity to a maximum. The truth of this statement has already been acknowledged by her manufacturers, with the result that their engineers are beginning to pay special attention to the redesigning and reconstruction of machinery with a view to adapting substitute belt drives. The experience gained during the last few years makes rather interesting reading. The instructions given by substitute-belting manufacturers will doubtless be read with equal interest in America inasmuch as some of them apply equally to leather belting—especially when of poor or medium quality—the careless handling of which is a costly factor in the maintenance of otherwise well-managed shops.

Limitations in Its Use

The difficulties and obstacles encountered in the initial stages were due not only to the lack of experience but to the fact that all available data on belting as contained in engineering handbooks and catalogs were applied to leather belting and could be used only for substitute materials of similar quality. The educational value of up-to-date trade journals was perhaps never more apparent than at this initial stage. Substitute belting proved in all cases inferior in strength to leather and it was accordingly found necessary to increase the standard widths of pulleys. As to crowning of pulleys—a subject on which there was always a divergence of opinion among engineers—it was definitely established that excessive crowning proved rather disadvantageous. Low speeds were also condemned, it being suggested that a speed of less than 3 ft. per second should be avoided, and tests carried out with a view of furnishing data on pulley diameters showed that the efficiency of pulleys having a diameter of less than 8 in. was rather poor. Particular attention has to be paid to proper alignment of shafts and pulleys in order to insure steady and quiet running and avoid transversal movements of the belt. Flange pulleys should not be used, the tendency of the belt to rub against, or crowd upon, the flanges having injurious effects upon the belt. For a similar reason it is suggested that belt shifters should be provided with rollers. Sharp edges on belt shifters or cone and step pulleys should be rounded off, their knife-like action being liable to destroy the best material within a short time.

Berlin, Germany.

Efficient Hydraulic Laboratory Press

The 21-ton hydraulic testing press shown in Fig. 1 is capable of handling an unusually wide range of materials and is quick and convenient to operate.

The base is solid steel, into which the two forged-steel strain rods are screwed. These rods are supported at the top by a cast-iron yoke through which runs a long screw. The screw has square threads and is operated by a handwheel.

The platen slides on brass-bushed bearings on the strain rods. It has a rim around the edge and spout for catching and draining off any juices that may flow over the sides. The platen is cast with a 3½-in. ram which extends into the steel base and which serves the purpose of a hydraulic cylinder into which a ram works that is forced forward by means of a screw and hand-operating device as shown by the left-hand projection in Fig. 1.

To operate the press the material to be pressed is placed on the platen and the swiveled head on the screw is then screwed down tight against the material. The other screw shown on the lower left of the illustration is then operated, thereby bringing pressure to bear on the liquid that fills the cylinders and forces the main ram upward, thus compressing the material. When the pressure reaches 4,200 lb. per sq.in. as indicated by the gage a total force of twenty-one tons is exerted between the swivel head on the screw and the platen.

Various containers to accommodate different classes of materials are provided. These include two sizes of curb type containers each with steel plates drilled and grooved to facilitate drainage. These plates are used

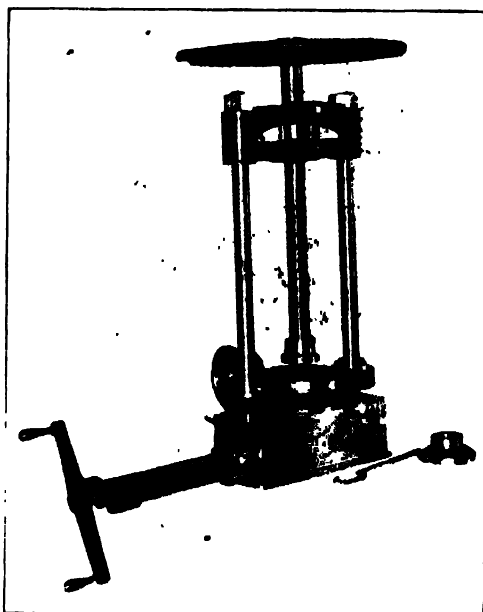


FIG. 1. HYDRAULIC LABORATORY PRESS

in pairs with the grooved faces together. Another type is the ring or Büchner container. This consists of a series of ten rings bolted together and so grooved and drilled that the expressed juices readily drain. A special plunger fits in the center of the rings on top of the material and the pressure is applied to this plunger. Solid test curb and test ring type containers are shown in Fig. 2. Still another type is the filter pot container which is highly satisfactory for use with substances that are in a liquid or semi-liquid state.

Clearance or daylight space of this press is 20 in. from platen to swivel head when at its highest point. Inside measurement between rods is 9 in. The press is built by the Hydraulic Press Manufacturing Co. of Mount Gilead, Ohio.

An almost unlimited range of experimental work can be handled in this press, including extraction, filtering, briquetting, extruding and small forming and forcing jobs. In the latter uses a record of the pressure

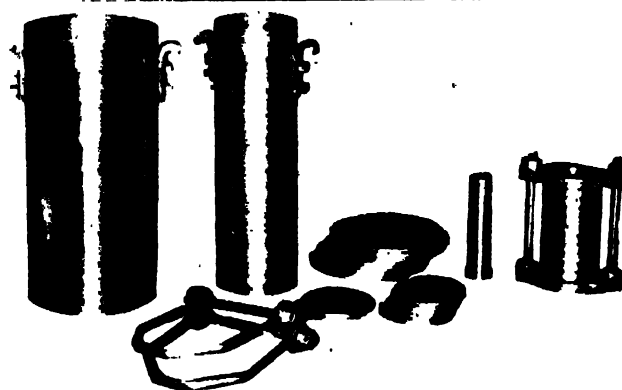


FIG. 2. CONTAINERS FOR LABORATORY PRESS

required for any operation may be made, since the gage accurately shows the tonnage brought to bear on the material under pressure.

Such materials as flavoring extracts, tinctures from herbs, etc., are representative of the class of materials to which the extraction method would apply. Both the rack and cloth methods and curbs are used in this work.

For briquetting, dies may be arranged to press from one or both sides. Dies for extruding metal and other substances may also be used in this press.

Products that may be tested by the filtering process include dyes, clays, cocoa, oil extraction, etc. For the last, the containers are made very thick so that when heated they retain the heat during the period under pressure.

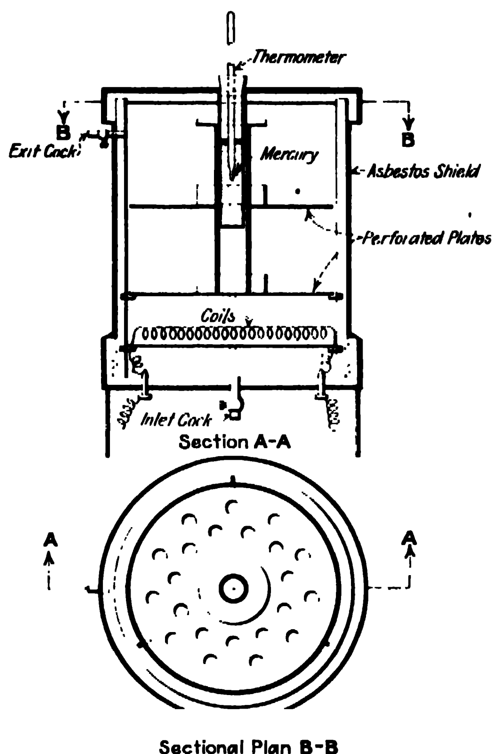
A Furnace for the Determination of Moisture in Dry CO_2-Free Air

BY J. A. MONTGOMERY

In determining the percentage loss of moisture at 110 deg. C. it is usual in quantitative analysis to heat the material in question in an ordinary gas oven. Should the material which is being analyzed have any great tendency to hydrate and absorb CO_2, as in the case of portland cement, the loss obtained at 110 deg. C. will very likely be erroneous. The difficulty has been overcome in this laboratory by the use of a small electric furnace through which a stream of dry CO -free air is conducted. A cross-section of the furnace, which has been producing satisfactory results for the past three years, is shown in the accompanying diagram. It was designed by Dr. E. O. Harder.

It consists of an iron cylinder 6 in. in diameter and 8 in. long. One end of the cylinder is threaded, and a heavy iron cap, which forms the bottom of the furnace, is tightly screwed to it as shown in the illustration. The furnace is supported by four iron legs screwed into the bottom. The legs are of sufficient length to permit the connection of an air line with the inlet cock and also to provide space for the two electric terminals. Spark

plugs serve as electric terminals. The top or lid consists of an iron cap with a machined groove ⅛ in. deep and sufficiently wide to permit the walls of the furnace to extend up into the lid as indicated. This arrangement is employed to afford a more closely fitting cover. An iron well through the center of the lid and extending



Sectional Plan B-B

down into the center of the furnace is half filled with mercury, which affords a bath for the thermometer. A suitable stand of two perforated plates (see sectional plan) with a capacity of sixteen porcelain crucibles rests upon four lugs which are screwed into the wall of the furnace. The plates are attached to each other by means of a central column. This is hollow in order to permit the mercury well to extend down within it. One outlet cock, which serves as an air exit, is provided in the upper portion of the furnace wall. The heating unit consists of 32 ft. of No. 17 nichrome wire in ten coils (these are embedded in fireclay) and secured to an asbestos board. The unit is heated by means of a 110-volt circuit, while external resistance is employed to control the temperature. Compressed air, which is passed through a train of towers containing sulphuric acid, soda-lime and calcium chloride to remove the H_2O and CO_2, enters the inlet cock at a moderate rate. This furnace is adapted for temperatures up to 250 deg. C. and can easily be controlled within five degrees. The entire furnace is covered with several coatings of heavy abestos paper.

Structural Materials Research Laboratory.
Chicago, Ill.

Excess Temperature Cut-Out

To prevent the overheating and consequent burning out of heating windings in electric furnaces, a new device has been introduced and provisionally patented by the Automatic & Electric Furnaces, Ltd., the manufacturers of the Wild-Barfield Furnace described in CHEMICAL & METALLURGICAL ENGINEERING for Oct. 6, 1920, p. 699. This consists of a replaceable loop of low-resistance wire which enters the furnace for a short distance connected in series with the heating current. So long as the loop is intact current will heat the furnace. Should, however, the temperature of the furnace, due to neglect, become excessive and so endanger the heating winding, the wire loop melts and interrupts the heating current and at the same time a red pilot lamp or other warning signal is put in operation. A loop having a melting point of 960 deg. C. has been found very useful in protecting furnaces wound with base-metal alloys.

Soda Ash Airveyor

The increasing difficulties in obtaining common labor to unload and handle bulk materials from cars and barges, together with the high cost of wages, are felt all over the country, and this is especially the case where powdery materials, such as cement, soda ash, powdered lime and material of similar nature have to be carried. The injurious effect of the dust makes laborers refuse the work.

The Guarantee Construction Co. of New York, pioneer in the field of building pneumatic conveyors, gave this question considerable thought and study, the result of which was the installation of a portable airveyor at the plant of the Federal Plate Glass Co. in Ottawa, Ill., to handle soda ash, salt cake and powdered lime from cars to bins in an adjacent storage house. Specially designed dust collectors for the purpose have proved very efficient, so that the disposition and loss of dust were overcome in a way entirely satisfactory.

The system used is a suction system, whereby the material is drawn from the car through a flexible hose into a vacuum tank designed to recover a large percentage of the dust floating in the air. This tank, together with a motor-driven positive rotary exhauster and another special dust collector of the double shell type connected to the exhaust line, is mounted on a movable platform running above the storage bins and



SODA ASH AIRVEYOR

delivers the material through a rotary airlock feeder directly to storage. The dust recovered in both tanks is collected separately and also delivered through rotary feeders to the bins, so that there is very little dust shown at the exhaust.

The airveyor has been in successful operation for about six months, and enables the purchaser to unload material with one man in the car, working under much more agreeable conditions. The inside of car, as well as the storage house, is entirely free from the

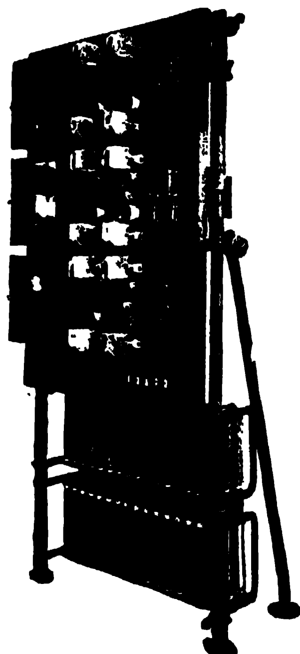
obnoxious dust, thus allowing other work to be done on the premises during unloading, which was impossible before.

The airveyor is handling material at the rate of ten tons per hour, and its capacity could have been greater if building conditions had not made it impossible to increase the size of apparatus. Airveyors can be built to handle quantities up to twenty tons per hour for movable units, while when stationary, a capacity of forty tons can be obtained without making the installation too costly and cumbersome.

Electric Arc-Furnace Regulator

High electrode operating speed and close precision of regulation with absolute freedom from hunting are the two important features of the electric arc-furnace regulator just placed upon the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Speeds 2½ to 3 ft. per min. depending upon the amount the quantity being regulated is from normal and 5 per cent precision are claimed.

The ability of this regulator to incorporate high speed with a narrow current zone is due to the fact that the electrode speed tapers all the way from full to zero as the regulated current approaches its normal value. In other words, within certain limits the restoring speed is approximately proportional to the amount the current in the electrode deviates from normal. This permits the greatest possible electrode speed for a given current variation. This feature is particularly appreciated during the melt-down of cold scrap. For small variations in current the speed is slow enough to prevent continuous breaking of the arc and at the same time, when the solid metal begins to cave into the pools of molten metal under the electrodes, sufficient speed is available to permit the regulator to extricate the electrode before the time relay allows the breaker to trip. When the current is turned on a furnace charged with cold scrap, it is necessary only to throw the regulator control to the automatic position. Regardless of the position of the electrodes at this time, the regulator will allow each one to run down at full speed until it touches the steel, when complete automatic regulation will commence. It is absolutely impossible for an electrode to get into the steel, and practically no attention is required from the operating personnel.



ELECTRIC ARC-FURNACE REGULATOR

One very important feature of the regulator is its utilization of the arc voltage as well as the arc current to control the motors. This device absolutely prevents the electrodes getting into the steel under automatic regulation. Under-voltage relay trips on the control circuits are unnecessary. With any purely current actuated device, it is impossible to maintain equal arc lengths in furnaces using two or more electrodes, particularly when operating at reduced power. In the regulator, the arc voltage, as well as the electrode currents, is maintained balanced.

The voltage coils also make the control of each electrode independent of the others in the surface. In fact, one electrode may be entirely withdrawn without disturbing any of the others. In a regulator dependent upon current control exclusively, any movement of one of the electrodes causes the elements of all other electrodes to change their positions.

Synopsis of Recent Chemical & Metallurgical Literature

Coal-Saving in the Chemical Industry.—A detailed study of the sixty typical steam boiler installations in English chemical plants has been completed recently by DAVID BROWNLIE. The results are given in a series of articles in the *Chemical Trade Journal and Chemical Engineer* (Aug. 21, p. 247; Sept. 4, p. 311; Sept. 11, p. 343). Since these results form part of a comprehensive survey of steam generation methods in British industry as a whole, it is possible to compare the figures for the chemical industry with corresponding data for a group of installations representative of all industries.

The articles cover the methods used in making the tests, a tabulated summary of the results obtained at each of the sixty plants, a detailed discussion and analysis of this table, a summary of the results, and recommendations as to methods for promoting fuel economy in these plants. Since it is almost impossible to summarize adequately a paper of this character, the following excerpts serve merely as an indication of the scope of the article, and the reader is referred to the original for details.

Contrary to what might naturally be expected, the efficiency of steam generation in the chemical plants studied was found to be slightly below the average. In commenting on this, Mr. Brownlie added that he had been struck very forcibly by the lack of organizing and engineering ability displayed in many chemical works. As regards general factory organization and modern methods of costing, many industries such as the motor car trade are so far ahead of the methods generally used in the chemical trade that the comparison is painful. From the point of view of welfare of employees, canteens, lavatories, rest rooms, etc., the chocolate industry and many engineering concerns are in another world compared with most chemical works. As regards engineering, a trained engineer from a steel works, shipbuilding yard or almost any large engineering shop would be considerably staggered at the general engineering of the average chemical plant. Several interesting points will be noted in the detailed analysis of results.

Out of the sixty plants, in only two cases was the fuel analyzed in an accurate manner, so that the quality of the fuel was known. In certainly over 90 per cent of cases the fuel was used without the slightest knowledge of its heating value. As is, of course, well known to steam users today, the fuel supply is so complicated that the consumer is glad to get hold of any kind of coal and there appears to be no control over the quality.

Before the war, however, steam users had a very extensive choice of coal, but in the chemical industry there were certainly not 10 per cent of steam users who analyzed the coal and purchased accordingly.

With regard to scale troubles, there were twenty-seven plants which either had no trouble at all or only slight trouble, twenty-one which might be described as "moderate" and twelve which can only be described as "chronic." It is rather astonishing to find that over 50 per cent of the boiler plants in the chemical industry are in trouble with the feed water, in spite of the fact that in most cases efficient chemists are employed in the plants. The general principle seems to be to leave the boiler plant to the engineering department, which has no time to attend to it, and the interference of the chemist seems to be resented. It is further astonishing to find how many chemical plants buy "quack" boiler compositions and pay exorbitant prices for them.

Of the sixty plants, fifty-five were not equipped with CO_2 recorders and only two plants can be described as fitted with CO_2 recorders in good working order and regularly used. The tests show that the average CO_2 obtained is only about 8.5 per cent. The figures can be divided as shown in Table I.

Only nineteen plants were fitted with superheaters. In these the average temperature of the steam was 340 deg. F. before superheating and 450 deg. F. after—that is, 110 deg. F. superheat. The value of superheating seems to be very little realized. Superheating can be of two kinds. First of all, there is the question of partial superheating (say, 75 to 100 deg. F.), with the idea of completely drying the steam so as to avoid condensation losses in the pipes. Most chemical works have an extensive system of steam pipes, and partial superheating is of particular value in such cases. High superheating (200 deg. F.) is used to increase the efficiency of the steam utilization plant.

TABLE I PER CENT CO_2 IN FLUE GASES

Classification	—60 Chemical Plants— No. of Plants	Per Cent	250 Plants Typical of All Industries, Per Cent
Very good, over 12 per cent	4	6 7	1.6
Good, 10 to 12 per cent	14	23 3	6.8
Medium, 8 to 10 per cent	17	28.3	25.6
Poor, 5 to 8 per cent ...	22	36.7	57.6
Very bad, under 5 per cent	3	5 0	8.4
Total			100 0

The true average net working efficiency for the whole sixty plants was found to be approximately 58 per cent—that is to say, 42 lb. out of every 100 lb. of coal fired is wasted. The average is slightly worse than that for all industries (60 per cent). The efficiencies are divided as shown in Table II.

TABLE II EFFICIENCIES OF BOILER PLANTS

Classification	—60 Chemical Plants— No. of Plants	Per Cent	250 Plants Typical of All Industries, Per Cent
Over 80 per cent.	0	0	0.8
75 to 80 per cent.	4	6.7	3.6
70 to 75 per cent.	3	5 0	5 2
65 to 70 per cent	12	20 0	12 0
60 to 65 per cent	9	15 0	17.6
55 to 60 per cent	13	21 6	24.8
50 to 55 per cent	9	15 0	18 8
Less than 50 per cent	10	16 7	17.2
Total	60	100.0	100 0

It will be noted that 53.3 per cent of the plants are working with an efficiency of less than 60 per cent and only 11.7 per cent of the plants exceed 70 per cent.

The general conditions of steam generation seem to be much the same all over the world and the average efficiency of boiler plants is probably less than 60 per cent. In the United States the general performance was found to be very poor on investigation by the Fuel Economy Department and opportunities for substantial economies were glaringly evident. An examination by the author of thirty or forty boiler plants in France has shown that although water-tube boilers are in more extensive use and fuel is more expensive and difficult to obtain, it is very doubtful whether the results obtained are any better than in England.

If a boiler plant is considered as a factory in itself, the methods necessary for scientific control are easily vizualized. The raw materials are essentially coal, labor, water and air, and the finished product is steam at a given temperature and pressure. Hence, in order to keep an efficient production record, it is necessary to have continuous data on the amount of water evaporated, the amount of steam used in the various processes or departments, the amount of coal burned, the calorific value of the coal and the percentage of CO_2 in the flue gases.

A typical boiler plant of six Lancashire boilers burns 12,000 tons of coal a year, valued at, say, £24,000. The cost of a complete set of instruments, including water meters, automatic coal weighers, CO_2 recorder, coal-testing outfit, pyrometer installation, recording draft- and steam-gages, is less than £1,000. Taking the cost of a skilled attendant at £350 a year, interest at 6 per cent and depreciation at 15 per cent, the total annual expenditure will be about £600. The saving due to efficient control is, on a most conservative estimate, 10 per cent, or £2,400 a year.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Extracting Metals.—Ores, concentrates, furnace dust and the like, preferably finely divided, are mixed with sodium chloride, preferably in finely divided form or in solution, and the mixture is heated to the volatilization temperature of sodium chloride, whereupon metals are volatilized and may be collected. The process is applicable, for example, to the treatment of lead-zinc ores, lead and silver being volatilized, and to the extraction of other metals such as copper, bismuth and molybdenum. (Br. Pat. 144,728—1919. KRUPP AKT. GES. FÜR GRUSONWERK, Buckau, Germany, Aug. 11, 1920.)

Frosted Glass.—Relates to a process for producing a mat surface on glass. According to the invention, the glass surface is coated with a composition containing a substance which, when heated, reacts on the glass to form an acid-decomposable product. The composition also contains a relatively inert substance and a binding agent. The coated surface is heated to the required extent and, after cooling, the acid-decomposable matter is removed by an acid other than hydrofluoric. As an example, a composition consisting of basic lead silicate,

pulverized porcelain and a binder such as gum is described. (Br. Pat. 144,737—1919. T. UEDA, Kyoto, Japan, Aug. 11, 1920.)

Electric Endosmose.—Before separation by electric endosmose of mixtures of colloids, ions and non-ionized bodies, ions which are unsuitable for the process are replaced by more suitable ones—for instance, chloride, sulphate, or phosphate ions by inorganic or organic ions of the same or different valency, or calcium, magnesium or aluminum by ammonium, sodium, or potassium. If a mixture containing ammonium sulphate and albumin is treated in a three-compartment cell, even the most electro-positive diaphragms do not prevent more rapid migration of the ammonium ions and consequent acidity of the mixture in the middle compartment; but after treatment of the mixture with barium acetate and removal of barium sulphate, the mixture on electrolysis with a positive diaphragm at the anode remains feebly alkaline and albumin is not precipitated. If barium chloride is similarly used, the mixture keeps feebly acid. Both anions and cathions can be replaced; for instance, if aluminum sulphate is present, the aluminum can be replaced by ammonium and the sulphate ion by a monovalent one. (Br. Pat. 144,710—1919. ELEKTRO-OSMOSE AKT. GES., Berlin, Aug. 11, 1920.)

Organic Metallic Compounds, Arsine Derivatives.—Amides and acids of the general formulæ $R_2AsCONH_2$ and $R_2AsCOOH$, when R = a fatty or aromatic radical, are prepared by hydrolysis of the corresponding nitriles R_2AsCN. According to examples, dimethylarsinoformic acid and diphenylarsinoformic acid are obtained by treating cacodyl nitrile and diphenylarsine nitrile with dilute sulphuric acid; diphenylarsine nitrile is converted into the corresponding amide by hydrogen peroxide, and the amide converted into diphenylarsinoformic acid by sodium nitrite and sulphuric acid. Dimethylarsinoformic acid forms salts with sodium, calcium, magnesium, manganese, iron, cerium, mercury, quinine, strychnine, etc. (Br. Pat. 144,806—1919. A. JOB and H. GUINOT, Paris, Aug. 18, 1920.)

Lecithin.—Lecithin is separated from animal or vegetable matter containing it, or from crude lecithin, by dissolving the raw material—e.g., egg yolk or fish roe—in an organic solvent, treating the solution with hydrogen in the presence of a hydrogenating catalyst such as palladium or nickel, interrupting the hydrogenation when the lecithin has been saturated, as shown by test extraction with cold ethyl acetate, then evaporating off the solvent, and dissolving the residue in hot ethyl acetate, from which, on cooling, the lecithin separates out. (Br. Pat. 144,895—1919. C. BAUMANN and J. GROSSFELD, Recklinghausen, Aug. 18, 1920.)

Cuprammonia Cellulose Solutions; Artificial Threads.—Solutions of cuprammonia cellulose, which are permanent and capable of being satisfactorily spun, are obtained by the addition of sugars both of the grape-sugar group and of the cane-sugar group; the former are added to prevent oxidation of the cupric salt and of the cellulose, and an amount of 0.25 per cent of the cellulose taken is sufficient; the sugars of the cane sugar group and of which refined beet sugar is the most suitable, are added to effect or maintain the hydration of the cellulose, and of these sugars it is sufficient to add 2 per cent of the weight of cellulose taken, or a little more if the cellulose has not been decomposed. By the addition of a reducing sugar, it is stated that the solubility of cupric oxide in ammonia is increased, and the solution of the cellulose in such solution rendered more rapid and complete. (Br. Pat. 145,035—1919. GLANZFARBEN AKT. GES., Petersdorf, Germany, Aug. 18, 1920.)

Dental Cements.—Colloidal silicic acid in the form of hydrogel, acetogel or alcogel, is added to dental cements of the kind in which a phosphoric acid or acid phosphate is an ingredient to prevent the liberation of acid after the cement has set. The silicic acid may be added to the powder before it is mixed with the phosphoric acid, or the powder may be mixed with a solution of the silicic acid in phosphoric acid or an acid phosphate. In an example, to a solution of magnesium and aluminum sulphates in molecular proportions is added sodium silicate and caustic soda lye until the magnesium aluminum silicate is precipicated. Colloidal silicic acid is added and the precipitate is filtered, dried and mixed with phosphoric acid and an acid phosphate. (Br. Pat. 145,052—1919. S. SCHIFF, Karlsruhe, Aug. 18, 1920.)

Preparation of Urea.—Urea is prepared by forcing a mixture of carbon dioxide and ammonia into an autoclave and maintaining the melt formed for a sufficient time at the temperature required for the transformation of ammonium carbamate into urea. The process may be carried out in a continuous manner by forcing the gases into an autoclave and keeping the melt at 135 deg. C. for two hours, then slowly releasing the reaction mass through a bottom valve to a column still in which it is distilled, urea solution running off from the bottom of the still while unchanged ammonia and carbon dioxide pass off to a dephlegmator and thence back to the compressor. More ammonia and carbon dioxide are supplied to the autoclave, or an aqueous solution of ammonium carbamate or carbonate is supplied to the top of the column still. The amount of moisture in the gases led back to the compressor may be controlled by keeping the temperature at the outlet of the dephlegmator at say 60 deg. C. The expansion of the melt may be allowed to take place in two stages to save compression energy. (Br. Pat. 145,060—1919. BADISCHE ANILIN UND SODA-FABRIK, Ludwigshafen-on-Rhine, Aug. 18, 1920.)

Separating Suspended Impurities From Gases.—In the electrical separation of impurities suspended in gases, there is employed an undamped pulsating unidirectional voltage having a frequency considerably higher than about 50—the frequency ordinarily employed with alternating current—and preferably having a medium frequency of the order of 250-1,500 periods; a frequency of 500 is particularly advantageous. It is stated that such a pulsating voltage may be super-imposed on "a constant direct-current voltage pulsating with low frequency." (Br. Pat. 145,477—1919. METALLBANK UND METALLURGISCHE GES., Frankfurt-on-Main, and J. E. LILIENFELD, Leipzig, Sept. 1, 1920.)

Deodorizing Soap.—Liquid soap is deodorized by treating it under pressure—e.g., in an autoclave at a temperature above 100 deg. C. with steam. The autoclave may be heated by direct firing or by admission of superheated steam. Hot water or steam, as the case may be, is admitted so as to keep the concentration of the soap solution approximately the same during the operation. After some hours a valve in the autoclave is opened, and odoriferous impurities are carried off by the escaping steam. (Br. Pat. 145,502—1919. PERSAPOL GES., Hanover, Germany, Sept. 1, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Conservation of Timber by Chemical Treatment

On Friday evening, Nov. 5, the American Section of the Society of Chemical Industry met at the Chemists' Club for a conference on conservation of timber by chemical treatment. Sumner R. Church presided. Herman von Schrenk spoke on the preservative treatment of wood and forest resource conservation. About 65,000,000 gal. of creosote oil is used annually at present. The supply can be increased greatly if the practice of burning the crude coal tar at the coke and steel plants ceases. About 43,000,000 lb. of zinc chloride, the second most important preservative, was consumed last year and ample supplies are available to meet any demand. Mercury and fluoride salts are exceptionally good for these purposes, but comparatively are too costly. Interesting and instructive slides were displayed showing graphically the amount of timber available, and the excess of consumption over production. Mr. von Schrenk drew conclusions showing how preserving would assist in overcoming this discrepancy between consumption and production.

Mr. Kuehn spoke on the outlay and operation of a modern wood preserving plant. He discussed very fully the methods of treating wood in the preserving plants. There are in the United States 132 such plants. The output of these plants has been only 160,000,000 cu.ft. of wood, a very small percentage of the wood utilized. Mr. Kuehn said that the development of the industry was being held back by the shortage of coal tar and other preserving chemicals. He discussed fully the most approved methods of handling the wood and piling it in the storage yards. He called attention to the necessity for proper seasoning of the material before treatment and he also gave a thorough explanation of the methods of treatment, calling particular attention to the difficulties encountered and the means by which they were overcome. His talk was fully illustrated with slides showing the various processes in actual operation.

At the close of the meeting a buffet lunch was served in the rooms of the Chemists' Club. About two hundred members and guests of the society were present at the session. Suggestions for topics for forthcoming meetings were asked by the directors, who are making every effort to make the sessions both interesting and instructive to the members.

Consulting Chemists Named for C.W.S.

To form the nucleus for his consulting staff General Amos A. Fries, the Chief of the Chemical Warfare Service, has designated each member of his advisory committee a consulting chemist of the bureau. The chemists thus designated are W. D. Bancroft, R. C. Tolman, A. B. Lamb, E. P. Kohler, F. M. Dorsey, W. K. Lewis, L. T. Sutherland, L. C. Jones, C. L. Reese, William H. Walker, Bradley Dewey, Reid Hunt, A. S. Loevenhart and Julius Stieglitz.

The advisory committee has been asked by General Fries to designate other chemists who may be induced to assist the bureau in a consulting capacity.

Composition of Automobile Exhaust Gases

A. C. Fieldner, speaking before the Chemical Society of Washington on Oct. 28, reported an extensive series of investigations made by the Bureau of Mines on the composition of automobile gases in relation to ventilation of vehicular tunnels. This work has demonstrated a number of important conclusions as to the extent of incomplete combustion in automobile engines. An average of about 6.4 per cent carbon monoxide in the exhaust gases from all types of machines tested for all conditions of test is reported. With the proposed vehicle tunnel from Manhattan to New Jersey this represents at the full capacity of the tunnel a discharge of about 400 cu.ft. of carbon monoxide per minute, which would require for proper elimination the movement of approximately 1,000,000 cu.ft. of air per minute.

The percentage of carbon monoxide in the exhaust varies widely with the adjustment of the carburetor and the conditions of driving. The largest percentages of carbon monoxide are formed when accelerating or climbing grades—that is, at the time of greatest power demand. The point of maximum power production from an engine is quite different from the point of maximum thermal efficiency. At the point of maximum power richer mixture is used than corresponds either to the point of maximum thermal efficiency or to the point of theoretical air-gasoline ratio. As a practical matter, the best remedy for gasoline losses caused by inefficient operation is, in the opinion of Dr. Fieldner, to be accomplished only through more extensive use of dash control devices so that the richness of the mixture can be adjusted by the driver according to the power demands.

To Get More Data on Gas Wounds

In order that all available information on gas casualties in the American Expeditionary Forces may be compiled, the Surgeon General of the Army is having all information with regard to such casualties segregated from the records. One of the significant developments of the war is the fact that gas caused a large percentage of the casualties, comparatively few of which resulted fatally. It is claimed that no single case of tuberculosis can be traced directly to injury from gas. One of the the objects of the present inquiry is to verify this assertion.

New Haven Section of A.C.S. and Bridgeport Chapter of A.S.M.E. Hold Joint Meeting

The New Haven Section of the A.C.S. and the Bridgeport Chapter of the A.S.M.E. held a joint meeting at the Seaside Club in Bridgeport, Friday evening, Oct. 19, 1920.

John R. McGregor of the Eagle-Picher Lead Co. gave a very interesting and instructive lecture, illustrated by moving pictures, on the prospecting, mining and smelting of lead ore and the manufacture of lead products from pig lead, which was enjoyed by all present.

Future of International Catalog of Scientific Literature Considered at London Conference

An international conference of delegates from important scientific academies to consider the future of the International Catalog of Scientific Literature has just been held in London at the invitation of the Royal Society. Representatives were present from fourteen countries. The American delegates were Dr. R. M. Yerkes, Prof. L. E. Dickson, Prof. L. P. Eisenhart, G. C. Gunnell and Dr. S. I. Franz, representing the National Academy of Sciences, the National Research Council and the Smithsonian Institution.

Up to the time of the war, more than thirty countries were joined in undertaking the indexing and publishing the index of the scientific literature of the world. Fourteen annual issues, each of seventeen volumes, have been published covering the literature from 1901 to 1914. The results of the war, together with the much increased cost of printing and publishing, have interrupted the undertaking and no index of scientific literature published since 1914 has been issued. The conference decided that even though a change may be made in the future in the method of indexing and of publishing the index, as has often been suggested, it is imperatively necessary to continue the present method until the scientific literature published up to the end of 1915 and possibly also that up to the end of 1920 has been catalogued.

Business Conditions of Ohio Chemical Industries

In a majority of the industries of Ohio production is at a low ebb. Manufacturers feel that they are facing a period of readjustment and a move toward lower price levels. There is no feeling of pessimism in the reports emanating from the various centers—in fact, operators feel confident of a stimulated demand with a return to a more normal basis.

In the Akron district the production of tires and other rubber products is at its lowest point and manufacturers are taking advantage of the situation to conduct inventories. On Nov. 1 the Goodyear Tire & Rubber Co. resumed operations on a four-day weekly basis with daily production at about 6,000 tires. The Firestone factories are operating on a five-day weekly basis. The outlook for the tire industry is not of the best. Most of the larger companies are operating on a 20 to 25 per cent of normal production basis.

Annual inventories showed that the larger companies were hard hit by high prices on raw material. Accustomed to buying in the open market in large quantities, they are reported to have large stocks of raw rubber and cotton which were purchased at the peak of high prices. Now that prices on both have dropped considerably, it is only the smaller companies that can take advantage of present prices, having bought on a closer margin.

On the other hand the paper mills of the Miami Valley district report much better conditions. During the past few weeks they have been able to maintain maximum production through firmer supplies of pulp and fuel. Few of them, however, have a reserve supply, but no curtailment is expected because of shortage of raw material in the immediate future.

The Champion Coated Paper Co. has let contracts for a new building 720 x 55 ft. to house the sizing and bleaching departments and to provide additional clay storage space. Work will be started about Dec. 1.

Iron and steel operators in the Youngstown district report slightly reduced production. The inflow of new business is not up to the rate of shipments, which means, of course, slowing up of operations unless buying revives shortly. There is a general feeling in this district that the industry will encounter readjustments and move toward a lower price level before the big overhanging demand for steel makes itself fully felt. There is no evident indication to be pessimistic over the outlook, but rather a feeling of relief among the leading producers that a return to more normal conditions is in sight. Opinion among local bankers and business men is that the district is in an exceptionally comfortable position for any readjustments that may come.

The fuel situation is acute in the East Liverpool pottery district. Most of the potteries are from six months to a year behind in production and no promises are being made for future deliveries. The transportation situation is especially acute and little coal is being received. Because of gas shortage many of the potteries are substituting fuel oil for kiln firing as the most feasible solution of the fuel problem.

Bureau of Mines to Push Co-operative Work

During the next few months L. I. Shaw, the Assistant Chief Chemist of the Bureau of Mines, will be attached to the Columbus Experiment Station of the bureau to conduct intensive work looking to the formation of co-operative agreements with ceramic industries.

The Bureau of Mines now has in effect with state institutions and private companies co-operative agreements which make available more than half a million dollars annually as a supplement to the Congressional appropriations allowed the bureau. One of the conditions of these co-operative agreements is that the results of these experiments are to be made public so that the entire industry may have the benefit of the work. Due to the success which has attended this form of activity on the part of the bureau it is expected that considerable expansion of this activity will take place in the future.

General Staff May Be Ousted

One of the probable effects of the change in the national administration will be the appointment of a new Chief of the General Staff of the Army. The present Chief of Staff opposed the continuance of Chemical Warfare Service and is believed to regard the development of military gases as a matter of small importance. Despite the very decided manner in which Congress overruled the recommendation of the General Staff in regard to chemical warfare there are evidences that the new service has not been accorded the same sympathetic consideration as have certain of the older branches. There is a feeling among chemists that the Chemical Warfare Service will fare much better under nearly any officer likely to be appointed Chief of Staff.

Portland a Distributing Center for Sulphur

Portland, Ore., is gaining increasing prominence as a distributing point for sulphur. Shipments totaling about 10,000 tons of this mineral have recently been landed at Portland by steamers from Galveston and Sabine, Tex. Much of the sulphur is used by the paper mills in the neighboring towns of Oregon City and West Lynn, Ore., and Camas, Wash.

Imports and Experts of Chemicals

Heavy increases in chemical imports took place in September as indicated by the figures which just have been assembled by the Bureau of Foreign and Domestic Commerce. The imports of chemicals on the free list are at a rate double that of last year, as shown by the figures for the first nine months of 1920. During September of 1920 the importations of duty free chemicals aggregated $13,229,907. This compares with $7,054,012 in September of 1919. The imports of dutiable chemicals decreased in September of this year as compared with the corresponding month of last year.

Fertilizers during the first nine months of the current year are being imported at about eight times the rate of importation during the corresponding period of last year. During September, just past, fertilizers to the value of $4,195,848 were imported. In September of 1919 the value of the imports was $890,097. Imports of coal-tar products increased from $512,004 in September, 1919, to $870,057 in September, 1920. Potash imports in September, 1919, were valued at $25,200. This year in September $445,083 worth was imported. Comparative figures as to the importation of certain chemicals which come in in smaller volume, are as follows:

	September	
	1919	1920
Ammonia, muriate of	$40,395	$38,930
Arsenic, sulphide of...	36,043	33,813
Glycerine, crude.....	50,882	160,866
Iodine..............	2,275	7,972

Exports of chemicals in 1920 ran a million dollars higher than they did in September of 1919. Acid exports increased from $425,160 in September of 1919 to $483,043 in September, 1920. Dye exports increased from $1,425,983 in September, 1919, to $3,119,295 in September of 1920. Our exports of dyestuffs to China have tripled. The United Kingdom is buying much more heavily in the American dye market. Mexico's increased buying power is reflected in its greater purchases of American dyes. India and nearly all the South American countries took American dyes during September. The total soda exports in September of 1919 were valued at $1,845,715. The exports in September of this year were valued at $2,131,347. Some of the chemicals exported in lesser amounts are as follows:

	September	
	1919	1920
Formaldehyde	$155,833	$302,150
Chlorate of potash	36,407	28,229
Chloride of lime	47,636	180,719
Sulphur	763,346	700,841
Petroleum jelly	213,806	205,281

World Trade Club Formed in St. Louis

The recent organization of the World Trade Club of St. Louis, with over 100 members, by the Foreign-Trade Bureau of the Chamber of Commerce, the local representative of the United States Bureau of Foreign and Domestic Commerce and export managers representing the largest exporting industries is another indication of the interest being taken in foreign trade by manufacturers located in the interior cities.

The object of the club will be the promotion of foreign-trade interests of the city of St. Louis and the Mississippi Valley. It will work along the same line as the Export Managers' Club of New York, the Exporters' Round Table of Boston and the foreign-trade clubs of Chicago and San Francisco. Regular meetings will be held in the form of a round-table discussion in order that export managers may have an opportunity to discuss their problems and secure practical advice and assistance from members who have had experience along similar lines. From time to time authorities on certain phases of export trade will be brought to St. Louis to give the local men the benefit of their studies and experience.

The largest exporting firms and the various foreign-trade promotive agencies are represented on the executive committee in order to co-ordinate in one organization all industries and associations active in foreign trade. The officers of the club are: President, F. Ernest Cramer; vice presidents, R. P. Block, W. E. Tarlton and A. H. Boette; secretary and treasurer, J. A. Troy.

New Motor Fuel in South Africa

In addition to natalite, which is manufactured in Natal from the refuse of the sugar-cane mills and used extensively in propelling motor cars in South Africa, there has recently been produced another motor fuel to meet the shortage and high cost of gasoline in that country, reports Vice-Consul Pisar of Cape Town. The basis of this new fuel, which is called "acetol," is alcohol and ether, which comprises 90 per cent. The other ingredients are treated as a secret until the patentee receives his patent rights.

It is said that this fuel apparently solves the question of the air-cooled engine. No carbon sediment is formed in the cylinder, and the fuel is claimed to be non-injurious to the carburetor and engine. No special carburetor is required. Acetol mixes with gasoline. The inventor claims that it has a wider explosive range than the ordinary marketed gasoline—i.e., both a weaker and an over-rich charge in the cylinder heads will fire when gasoline fritters out or chokes. Tests made with this fuel are said to have produced very satisfactory results.

It is claimed that acetol can be manufactured much more cheaply than the present cost of gasoline in South Africa. The retail selling price of gasoline at the coast ports of that country, which is fixed by the government, is $1.12 per imperial gallon (1⅕ American gallons) if purchased in cases of two cans containing 4 gal. each, and $1.22 per gal. if purchased in smaller quantities. Natalite now sells for 60c. per gal.

Non-Metal Industries Looking Up

After a visit to the principal centers of production of non-metals in the Mississippi Valley, R. P. Ladoo of the Bureau of Mines has returned to Washington with the report that a new spirit seems to characterize this industry. Businesslike methods are being adopted by even the smallest operators. Waste is being eliminated and economies of various natures are being adopted. In many cases the most improved machinery is being installed.

The most important single activity seems to be in bauxite production. In that industry there is a decided tendency to undertake large preliminary expense so as to achieve ultimate economies and maximum production. The labor shortage is being met by the employment of Mexicans, who are reported to be giving entire satisfaction.

The market for tripoli is widening, with the result that greater activity is being manifested in its mining and treatment. The success with which the flour of this material is being used as a filler for rubber and in

foundries as a parting for molds has added importantly to the demand.

While some of the smaller fluorspar operations are closed, all of the large companies are operating at a maximum capacity. Mr. Ladoo believes this to be largely because the more highly organized companies produce a more uniform grade of product. An indication of the promising outlook for that industry is the recent decision to erect a $1,000,000 mill on the Rosiclare vein in southern Illinois. Mr. Ladoo also found the flint clay and diaspore industries enjoying general prosperity.

New Italian Process for the Manufacture of Synthetic Ammonia

In the manufacture of synthetic ammonia by the Haber process the great difficulty encountered is that the catalyzers soon become poisoned. The correction of this difficulty constitutes the essence of the new Italian process for producing synthetic ammonia. After long experimentation, a catalyzer has been found which continues to function despite any impurities in the hydrogen and nitrogen gases. Further, an extremely simple apparatus for its employment has been developed. Nature herself many be said to employ a species of catalytic process in rendering atmospheric nitrogen available to the soil. Certain leguminous plants, as cowpeas and clovers, appropriate atmospheric nitrogen and store it up in their root nodules, transferring it thence to the soil.

In the synthesizing plant at Terni, about sixty miles north of Rome, the only raw materials used are the air and water. With a limited equipment it produces about 300 kilos (kilo = 2.2 lb.) of ammonia per day. Water power in abundance is furnished by the adjacent falls at Terni. The energy of the falling water is converted into electricity and the water, in turn, is acted upon by the electric current to produce hydrogen. This gas is then piped to the apparatus which extracts nitrogen from the air. Being a trade secret, the process of this extraction cannot be explained fully. It is carried on in a large steel cylinder resembling the upright boiler of a 50-hp. double-drum, stationary hoisting engine. The apparatus works automatically, running for days without attention. The nitrogen-hydrogen mixture is led from the boiler-like receptacle, heated, and passed under low pressure into a tube-like cylinder, where it is conducted through the catalytic substance. Here the desired combination takes place. The ammonia thus produced is condensed into liquid form by a refrigerating apparatus and drawn off from time to time in steel cylinders. It is put on the market in these cylinders at prices which are said to be at least 100 per cent above the cost of production. The whole apparatus, aside from the cells for producing the hydrogen, easily can be made to occupy a space of about 625 sq.ft. Just now the plant is undergoing enlargement, its capacity by Dec. 1 to be at least 1,000 kilos of pure ammonia per day.

Dr. Casale, the Italian inventor of the process, has gone even further in his work of synthesizing ammonia, having practically completed a process of utilizing this product in the manufacture of urea. This substance, by reason of its high nitrogen content of 45 per cent and carbon dioxide remainder, is a most valuable source of soil fertilizer and is chemically classed with that ancient restorer, barnyard manure.

The development of this new Italian process from a purely theoretical to a commercially fruitful status has been made possible through the interest and financial backing of an American capitalist. Some time ago this American secured a concession from the Italian Government for water-power rights at Terni, and is now negotiating for other concessions which will enable him to duplicate the Terni facilities.

Industrial Nurses Convene at New Haven

A convention of industrial nurses, the first of its kind, was held this fall at the New Haven School for Public Health Nursing. Fifty-four registered public health nurses from eight states attended. The varied industries represented and the discussions of the nurses brought out very clearly the fact that, while no fixed rules can be worked out to fit all places, it is possible to state definitely the fundamental principles of industrial nursing.

There were representatives from a university mercantile department, a state department of health, visiting nurse associations; canning, packing, chocolate and soap industries; woolen and cotton mills; brass and iron foundries; wire and paper mills; manufacturers of leather and rubber goods; monument, typewriter and corset works; roller bearings, sporting goods, tools and electrical appliances; printing and oil plants. The states represented were Connecticut, Massachusetts, New York, Rhode Island, New Jersey, New Hampshire, Illinois and Michigan.

The program lasted ten days and included lectures and round tables on Public Health Nursing, Industrial Nursing, Industrial Hygiene, Industrial Diseases, Records, Ethics of Industrial Nursing and Medicine, Industrial Relations, Social Problems, Industrial Psychology, Nutrition, Health Education, as well as excursions to manufacturing plants. Four periods were given over to lectures on recreation and other methods for counteracting industrial monotony. Play demonstrations were given and every one joined in folk dancing and simple games.

Book Reviews

MANUAL OF CYANIDATION. By *E. M. Hamilton.* 278 pages, illustrated. New York: McGraw-Hill Book Co. Price $3.

In this excellent little text of 253 reading pages Mr. Hamilton presents in very readable form and with little surplus verbiage the essential features of the cyanide process as now practiced. The book is written in a suggestive style, with many definite references to original sources, and should prove useful to those practically engaged in cyanidation, and also as a textbook for technical schools giving instruction in the metallurgy of gold and silver. The typographical work is good, the book of convenient pocket size and well bound in flexible cloth, an improvement over the flexible leather of a few years ago.

The chemistry of cyaniding is presented in Chapter I, and the control of operations by testing of various kinds in Chapters II and III, the former dealing with the tests required on solutions, and the latter with general testing of ores as to their suitability for treatment by cyaniding, and best conditions of treatment. The chief methods of employing the process are then taken up under the headings of "Sand Leaching," "Slime Treatment" and "Milling in Cyanide Solution." These chapters constitute a very satisfactory description of the ordinary apparatus and principles and conduct of the several processes. The causes of

discrepanices between actual recovery and theoretical extraction are discussed in Chapters VI, VII and VIII with a view to their relative seriousness and control. Telluride and other ores presenting special difficulties are discussed in a separate chapter. The recovery of gold and silver from solutions is covered in Chapter I on "Precipitation" and Chapter II on "Cleaning Up and Melting." In the last two chapters are given representative plant costs and data and a considerable number of tables of miscellaneous information, the data in both chapters being well chosen for their practical value and suggestiveness. S. L. GOODALE

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HANDBOOK OF ORE DRESSING. By *A. W. Allen*. 242 pages, illustrated. New York: McGraw-Hill Book Co. Price $3.

In this book Mr. Allen has brought together a great deal of information and presented it in small compass and easily accessible form. There are 230 pages of reading matter, tables and illustrations, and a short bibliography. The book is of pocket size, well bound in flexible cloth, and the presswork is good, the type even in the tables large enough to be easily read. Most of the data are presented in tabular or diagrammatic form with directions for use of the tables and diagrams. There are a large number of excellent cuts of machinery and apparatus, with short description accompanying each, but not going into minute detail. Comparative data as to machines and processes are frequently presented and should prove of real value. The theoretical matter of interest in ore dressing is taken up as fully as the space of the volume permits, and it seems that the book should find much use in the libraries of all engineers who handle ore-dressing problems. S. L. GOODALE.

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LABORATORY MANUAL OF ELEMENTARY COLLOID CHEMISTRY. By *Emil Hatschek*. Philadelphia: P. Blakiston's Son & Co., 1920. 133 pp., with 20 illustrations. Price $2 net.

In this welcome little manual there are compressed a large number of practical exercises in colloid chemistry, involving simple and inexpensive apparatus and modified by the author's teaching experience. "- ——the guiding principle has been to provide for the wants of those students of numerous branches of science who are finding some training in colloid chemistry an indispensible part of their equipment, and are able to devote a limited time only to acquiring its technique. For the guidance of readers desirous of going beyond the limits of this manual a number of references to recent literature are given at the end of each section."

The chapters are: General remarks on apparatus, materials and procedure; dialysis; suspensoid sols; suspensions; organosols; emulsoid sols and gels; egg albumin sol; emulsions; ultra-filtration; optical methods of examination; cataphoresis; electrolyte precipitation of suspensoid sols; mutual precipitation of suspensoid sols; protection; viscosity measurements; absorption (qualitative experiments); capillary analysis; determination of an adsorption isotherm; the Liesegang phenomenon.

There are many bits of simple but necessary advice such as to avoid pouring a viscous sol into a thin solvent during dilution; for although common sense and "kitchen experience" should indicate the reverse order, the beginner is apt to proceed hastily and get into trouble.

The instructions are for the most part very clearly and concisely given. But on p. 32 the author says regarding the preparation of colloidal silver by Carey Lea's method: "The color of the sol, and in fact the success of the whole method, depends a good deal on the quality of the dextrine, which can be determined only by experiment." It seems to the reviewer that it should be easy to give specifications for the quality and kind of dextrine best suited for this purpose.

The author adheres to Wo. Ostwold's classification of colloids into "suspensoids" and "emulsoids," but Zsigmondy's classification into "reversible" and "irreversible" colloids seems more desirable. Thus on p. 35 (footnote) the author says regarding ferric hydroxide sol: "Although this sol has some emulsoid properties, it is classed here with the suspensoids on account of its behavior to electrolytes, etc." On p. 41 some specification should be given as to the kind of commercial waterglass to be used, for the commercial grades vary widely in their ratio of SiO_2 to Na_2O. It is interesting to note that ammonium thiocyanate exercises marked protective action on colloidal SiO_2. A very simple optical method for determining the setting point of gelatine solution is based on the fact that during the last stage of setting the surface of the sol forms a network of wrinkles (which are not due to drying). On p. 64 reference is made to Stokes' formula, but the formula is not given, as it should be, to save the student the trouble of looking it up. The size of the chapter on "protection" is not commensurate with the importance of the phenomenon.

Regarding Liesegang's rings, it is stated: "To produce really good rings the gelatine must contain a small amount of acid and of gelatose (a product of hydrolysis which does not gelatinize on cooling)." This would indicate that the reaction takes place in the diffusion paths formed by the dispersion medium, where the protective action of the gelatose should be a factor.

The book fills a want not only because of its intrinsic merit, but also because it is the first of its type.

JEROME ALEXANDER.

Personal

A. W. AMBROSE will become chief petroleum technologist of the Bureau of Mines on Nov. 15. He succeeds J. O. Lewis, who has resigned to enter private employment. Mr. Ambrose is a native of California and is a graduate of the College of Mining at Stanford University. He spent a number of years on work dealing with the relation of geology to drilling and production in the California, Texas and Louisiana oil fields. He has been with the Bureau of Mines since 1917. Since Feb. 1 he has been superintendent of the bureau's petroleum station at Bartlesville, Okla.

C. W. BATES has recently accepted a position in the engineering department of the Anaconda Lead Products Co., East Chicago, Ind.

WARREN F. BLEECKER, metallurgical engineer, of Boulder, Col., was in New York last week on a business and professional trip.

General Sir ARTHUR CURRIE, former commander-in-chief of the Canadian army in France and now principal of McGill University, Montreal, visited Chicago recently and was entertained at luncheon by David R. Forgan. He later addressed a joint meeting of the Canadian Club and McGill Alumni at the Morrison Hotel, and outlined McGill University's need of additional funds to make up for losses during the war. A campaign will be launched on Nov. 15 for $5,000,000, to include building equipment for the university and living wages for McGill's faculty.

Dr. F. L. DEBEUKELAER, who received his Ph.D. degree from the University of Chicago last summer, is now employed as research chemist in the glue and gelatine department of Swift & Co., Chicago, Ill.

GORDON FOX, formerly with the Fort Wayne works of the General Electric Co. and lately electrical engineer of the Mark plant of the Steel & Tube Co. of America, has joined the staff of Freyn, Brassert & Co., engineers, Chicago, Ill., in the capacity of electrical engineer. Mr. Fox is chairman of the Chicago Section of the Association of Iron and Steel Electrical Engineers.

LOUIS D. HUNTOON and G. D. VAN ARSDALE have formed a partnership under the name of Huntoon & Van Arsdale, and will engage in consulting engineering in mining, metallurgy and geology. As previously announced, Mr. Van Arsdale will be in Los Angeles, while Mr. Huntoon will remain in New York City.

I. O. JUVRUD has been appointed chief chemist for the Portland Flouring Mills Co. of Portland, Ore. His former

work in this line has been with the Kansas Milling Co. of Wichita, Kan., and the Atkinson Milling Co. of Minneapolis.

HARLAN S. MINER of the Welsbach Co. addressed the Eastern Section of the American Chemical Society at Union College, Schenectady, N. Y., on Nov. 5, on the subject of "Thorium, Mesothorium, Cerium and Other Rare Earths."

ABRAHAM A. ORLINGER, holder of the New York Chemists' Club Hoffman scholarship for 1919-20, has been awarded the scholarship for 1920-21. Mr. Orlinger is completing the chemical engineering course at the Massachusetts Institute of Technology.

D. L. SCOLES, who has been at the Iowa State College at Ames, Iowa, for five years, has resigned as assistant professor of chemistry to accept a position as head of the department of chemistry at Illinois Wesleyan University, Bloomington, Ill.

Dr. LEE IRVIN SMITH, who was formerly an instructor in chemistry at Harvard University, is now instructor in organic chemistry, University of Minnesota, Minneapolis, Minn.

NEWTON W. SPEECE, who served two and one-half years during the year as a Captain of infantry, with over a year's service in France, is now instructor of chemistry at the University of Minnesota, Minneapolis, Minn. Mr. Speece is a graduate and post-graduate of Dickinson College, Carlisle, Pa.

R. B. STRINGFIELD, formerly superintendent of the chemical department of the Pacific Minerals & Chemical Co. and chemical engineer with the Arthur R. Maas Laboratories of Los Angeles, has accepted a position as chemical engineer with the Goodyear Tire & Rubber Co. of California, Los Angeles.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Pa., Nov. 5, 1920.

Pig iron production in October was at a slightly lower rate than in September by the merchant furnaces, but at a materially greater rate by the steel works furnaces, so that on the whole there was a slight increase. Many furnaces blew out late in October, however, so that the rate at the close of the month was well below the average rate in September. In the rate of steel ingot production there was probably a decrease from September to October, taking the months entire, while the rate now is well below the October average, being probably between 10 and 15 per cent below the rate of 42,700,000 tons per annum in ingots shown for both September and August.

The Steel Corporation's output has not decreased, but if anything has increased. One or two large independents seem to be operating at as heavy a rate as formerly, but nearly all independents are at reduced rates. In some cases the reductions are small, in other cases large. Not a few plants are operating at less than 60 per cent. In all cases it is a matter of order books. The volume of business on books is in inverse ratio to the prices charged. Independents that were relatively conservative in the matter of prices have such order books that, despite cancellations and postponements, they can operate at fair rates, say above 75 per cent. Others, with lean order books, must be contented with lower rates, even though they seek new business at cut prices. There is not much business to be drawn out by cutting prices, and the cuts proceed by easy stages.

In not one case thus far is an independent selling any steel product at the Steel Corporation or Industrial Board price. The expectation is practically universal that the independent market will decline to the Steel Corporation level, and the whole market will then be equalized, except for such cutting as some independents may be forced to indulge in so as to regain lost customers. The chief question debated is how long the process of equalization will require. Some say by January, some by April, the readjustment will be completed.

A possible objection to the prediction is that it is so universal. Some say "majorities are always wrong." On the other hand, it may be urged that if a buying movement occurs in steel after a period of dullness it takes care of itself, the buying producing a stiffening in the market, and the stiffening producing additional buying. It is said that what is needed is "confidence," and if every one expects the steel market to decline to the Steel Corporation level and then stop, certainly there should be confidence in the market when it gets to that point.

STEEL PRICES

There are no longer any delivery premiums, except as it may be said that independent prices represent delivery premiums on account of their being above Steel Corporation prices, with the Steel Corporation very well sold up. Purchases are not being made from independents for extended deliveries, so that the prompt market is all there is in the independent market. Prices are roughly as follows, the Steel Corporation price being named first and the independent price next: Bars, 2.35c. and 3c.; shapes, 2.45c. and 2.90c. or 3c.; plates, 2.65c. and 3c.; nails, \$3.25 and \$4.25; standard steel pipe, 57½ and 54 per cent off list; blue annealed sheets, 3.55c. and 5c.; black sheets, 4.35c. and 6.25c.; galvanized sheets, 5.70c. and 7.75c.; tin plate, \$7 and \$8.50. In the case of sheets and tin plate the corporation is not a seller, but it will open its books next month for first half contracts with regular customers, to be filled after the carried-over business is completed, this requiring approximately the first three months of the new year.

PIG IRON

Pig iron having reached such a remarkable height, and the last of the advances, in August, having been accompanied by such light sales, the market is simply yielding a competitive amount almost every time an inquiry for an important tonnage arises. Foundry has shown no important inquiry, hence remains quotable nominally at \$45 valley. Basic, which was \$40 valley, yielded, on a 2,000-ton transaction, to \$38.50. An interesting feature of this transaction was that the buyer was entirely out of valley territory, being in the East. Apparently the Eastern furnaces were not quick enough to reduce their quotations. Bessemer has declined from \$45 to \$42 valley, through a furnace interest voluntarily electing to offer iron at the lower price, to avoid bessemer and basic prices being too completely estranged from each other.

Conjectures are now being made as to where pig iron will find its resting or turning point. While steel prices are expected to land at the Industrial Board schedule, the case of pig iron may be different. The Industrial Board prices were: Basic, \$25.75; foundry, \$26.75; bessemer, \$27.95. The furnaces adopted these prices, but under more or less protest, claiming they were too low, relative to steel. The Industrial Board schedule became effective March 21, 1919, and a trifle more than six months later pig iron began to advance, being made scarce by the iron and steel strike. However, a price of \$28 or \$29 in the Industrial Board schedule would have satisfied the furnacemen at the time, as being in suitable relation with steel. Coke, however, not mentioned in the Industrial Board schedule, was obtainable by furnaces to make iron at Industrial Board prices at between \$3.50 and \$4, whereas on account of coal conditions coke seems quite unlikely to decline to anything like that figure. In the past three weeks Connellsville furnace coke for spot shipment has declined from \$17 to \$9, but the decline is beginning to show signs of halting. Coke and pig iron must both find their levels, but the question which is going to control the other proves much more serious than the query as to priority between the chicken and the egg. Common guesses are that pig iron will land somewhere between \$30 and \$35 and coke somewhere between \$6 and \$8.

The Chemical Allied and Industrial Markets

New York, Nov. 6, 1920.

The general condition of the chemical market is hardly active, but is distinctly optimistic—as a result of the election. Price changes, with few exceptions, have continued to favor buyers. *Caustic soda* showed a tendency to resist the downward movement and supplies in the past week have become very light. Manufacturers were quoting $3.75 per cwt., basis 60 per cent, on contract over next year, with large business transacted among the leading soap makers. The spot market was firm at $4.30@$4.40 per cwt. Another item meriting interest is *bleaching powder.* Rolling material was very scarce, with prices ranging from 6½@6¾c. November shipment from works could be obtained at 6c. lb. Manufacturers reported sales to large paper mills over next year at 3¾c. per lb. in large drums f.o.b. works. *Soda ash* seemed to be moving along in sympathy with *caustic soda.* Contracts over next year were placed at $1.85 per cwt., basis 48 per cent, f.o.b. works. *Bichromate of soda* remained quiet, with a few small sales made at 11½c. per lb. *Bichromate of potash* was one of the weak items with sales recorded as low as 22½c. per lb.

Coal-Tar Products

Trading in the coal-tar products market was along quiet lines, and what little business was obtainable was considerably interfered with by election talk. In a great many quarters the general tone is very optimistic, and the hope of an early resumption of activity was more favorably expressed. There were only a few changes in the price list, with *pure benzene* quoted at 35@40c. per gal., and the 90 per cent at 33@38c. per gal. *Cresylic acid* was in easy supply, with the market ranging from 95c.@$1.15 per gal. Intermediates were in light call with *paranitraniline* as a leading feature. Large orders were on the market at $1.10 per lb., but holders seemed to expect an active market and were holding for $1.15 per lb. *Beta naphthol* was quoted over next year at 48@52c. per lb., with very little business obtainable. *Benzoic acid* is in fair demand and supplies are available at 80@85c. per lb.

Crude Rubber

The optimism which is being generally manifested over the outcome of the recent presidential election is utterly lacking in the crude rubber market. *First latex crêpe* is quoted at 21c., while the price in January, 1920, was 54c. per lb. This represents a loss of $660 per ton in less than a year. This condition has been brought about by a combination of circumstances—overestimation by tire producers of this year's consumption, the speculative element that entered the market early in the year and the continued rise in the cost of production of rubber goods. During the last ten months it is estimated twenty firms have failed, some of that number being old-established firms and others fly-by-night speculators that infested the industry. The Rubber Trade Association has seven firms under consideration regarding the settlement of their affairs before entering bankruptcy and ten other cases will come up next week.

In India conditions are still worse. The cost of production to the plantation owner is said to be 27c., while the same material is being offered on the local market at 21c. per lb. The amount of unsold and unused material is estimated at 200,000 tons, which is equivalent to two-thirds the yearly consumption. This surplus is distributed among tire manufacturers, who hold 65,000 tons, local market 35,000 tons, England 30,000 tons and the remainder held in the Far East.

Miscellaneous Materials

There has been a big drop in *coke* during the last two weeks owing to the sudden falling off in demand. Foundry is listed at $11@$11.50 and furnace at $10@$10.50 per net ton f.o.b. ovens. *Tungsten* ore has been quiet for some time, with offerings of $6 per unit for scheelite and $4.50@$5 for wolframite. These prices do not meet with the approval of buyers, who have been consistently holding out for lower levels.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	...... -	$0.65 - $0.75
Acetone	lb.	$0.15¾-$0.16½	.16½- .17
Acid, acetic, 28 per cent	100 lbs.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent	100 lbs.	7.50 - 8.00	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboy	100 lbs.	11.50 -12.00	12.50 - ....
Boric, crystals	lb.	.15½- .16	.16½- .19
Boric, powder	lb.	.15½- .16½	.17 - .20
Citric	lb.	.55 - .56	.57 - .58
Hydrochloric (nominal)	100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	.16½- .18
Lactic, 44 per cent tech	lb.	10 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½- .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		...... -	...... - ......
Nitric, 40 deg	lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg	lb.	.07½- .08	.08½- .09½
Oxalic, crystals	lb.	.27 - .28	.29 - .31
Phosphoric, Ortho, 50 per cent solution	lb.	.19 - .20	.21 - .22
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	11.00 -12.00	...... - ......
Sulphuric, 60 deg., drums	ton	...... -	...... - ......
Sulphuric, 66 deg, tank cars	ton	16.00 -17.00	18.00 - 20.00
Sulphuric, 66 deg, drums	ton	21.00 -22.00	...... - ......
Sulphuric, 66 deg., carboys	ton	.. - ..	.. - ..
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 -30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 -30 00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 -35 00	40.00 - ......
Tannic, U. S. P.	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.)	lb.	.60 - .70	.80 - .90
Tartaric, crystals	lb.	.53 - 55	.56 - .57
Tungstic, per lb. of WO	lb.	...... -	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 - 5.75	...... - ......
Alcohol, Methyl (see methanol)		...... -	
Alcohol, denatured, 188 proof (nominal)	gal.	...... -	1.12 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	...... -	1.05 - 1.10
Alum, ammonia lump	lb.	.04½- .04¾	.05 - .05½
Alum, potash lump	lb.	.05½- .06	.06½- .07
Alum, chrome lump	lb.	.14½- .15	.16 - .17
Aluminum sulphate, commercial	lb.	.03½- .03¾	.04 - .04½
Aluminum sulphate, iron free	lb.	.04½- 05	.05½- .06
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08¾- .09½	.09½- .10½
Ammonia, anhydrous, cylinders (100-150 lb)	lb.	.33 - .35	.36 - .38
Ammonium carbonate, powder	lb.	.14½- .15½	.16 - .16½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.14 - .14½	.14½- .15
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .13	.13½- .14½
Ammonium nitrate	lb.	...... - .10	.11 - .14
Ammonium sulphate (f.o b New Orleans)	lb.	.05 - .05½	.06 - .06½
Amylacetate	gal.	...... -	4.50 - 5.00
Amylacetate tech	gal.	...... -	4.00 - 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	.14 - .14½	.15 - .16
Arsenic, sulphide, powdered (red arsenic)	lb.	.18 - .19	.19½- .20
Barium chloride	ton	90.00 -95.00	100.00 -105 00
Barium dioxide (peroxide)	lb.	.24 - .25	.26 - .27
Barium nitrate	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip) (blanc fixe)	lb.	.04½- .05	.05½- .06
Bleaching powder (see calcium hypochlorite)		...... -	...... - ......
Blue vitriol (see copper sulphate)		...... -	...... - ......
Borax (see sodium borate)		...... -	...... - ......
Brimstone (see sulphur, roll)		...... -	...... - ......
Bromine	lb.	.70 - .80	.85 - .90
Calcium acetate	100 lbs.	3.50 - 3.55	...... - ......
Calcium carbide	lb.	.05½- .06	.06½- .06¾
Calcium chloride, fused, lump	ton	30.00 -32.00	33.00 - 35.00
Calcium chloride, granulated	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	lb.	.06 - .06½	.07 - .07½
Calcium peroxide	lb.	...... -	1.50 - 1.70
Calcium phosphate, monobasic	lb.	...... -	.75 - .80
Calcium sulphate, pure	lb.	...... -	.25 - .30
Camphor	lb.	...... -	1.10 - 1.15
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.13 - .14	.16 - .17
Carbonyl chloride (phosgene)	lb.	...... -	1.25 - 1.50
Caustic potash (see potassium hydroxide)		...... -	...... - ......
Caustic soda (see sodium hydroxide)		...... -	...... - ......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.40 - .43	.44 - .47
Cobalt oxide	lb.	...... -	4.00 - 4.10
Copperas (see iron sulphate)		...... -	...... - ......
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	...... -	.65 - .70
Copper sulphate, crystals	lb.	.07½- .08	.08½- .09
Cream of tartar (see potassium bitartrate)		...... -	...... - ......
Epsom salt (see magnesium sulphate)		...... -	...... - ......
Ethyl Acetate Com. 85%	gal.	...... -	1.05 - 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		...... -	...... - ......
Formaldehyde, 40 per cent (nominal)	lb.	.27 - .28	.29 - .30
Fusel oil, ref	gal.	...... -	4.25 - 4.50
Fusel oil, crude (nominal)	gal.	...... -	3.25 - 3.50
Glauber's salt (see sodium sulphate)		...... -	...... - ......
Glycerine, C. P. drums extra	lb.	...... -	.27½- .28
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	...... -	.15 - .25
Iron sulphate (copperas)	100 lbs.	2 00 - 2.25	2.35 - 2.75
Lead acetate, normal	lb.	...... -	.13½- .16
Lead arsenate (paste)	lb.	.13 - 14	.14½- .15
Lead nitrate, crystals	lb.	...... -	.90 - 1.00
Litharge	lb.	.12 - .12½	.13 - .13½
Lithium carbonate	lb.	...... -	1.50 - ......
Magnesium carbonate, technical	lb.	.11½- .12	.12½- .13
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.25	...... - ......
Magnesium sulphate, commercial	100 lb.	...... -	3.50 - 3.60
Methanol, 95%	gal.	...... -	2.70 - 2.75
Methanol, pure	gal.	...... -	2.90 - 3 00
Nickel salt, double	lb.	...... -	.14 - .16
Nickel salt, single	lb.	...... -	.13 - .14
Phosgene (see carbonyl chloride)		...... -	...... - ......
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	...... -	.35 - .37
Potassium bichromate	lb.	.23 - .24	.24½- .25

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$0.49 – $0.50	$0.51 – $0.53
Potassium bromide, granular	lb.	..... –	.50 – .55
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.18½ – .19	.19½ – .20
Potassium chlorate, crystals	lb.	.18 – .18½	.19 – .20
Potassium hydroxide (caustic potash)	lb.	.18 – .19	.19½ – .20
Potassium iodide	lb.	..... –	3.20 – 3.30
Potassium nitrate	lb.	.14 – .16	.16½ – .17
Potassium permanganate	lb.	.63 – .68	.70 – .75
Potassium prussiate, red	lb.	.73 – .75	.78 – .80
Potassium prussiate, yellow	lb.	.36 – .37	.37½ – .38½
Potassium sulphate (powdered)	ton	$240.00 – 255.00	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	52.00 – 55.00
Silver cyanide (nominal)	oz.	..... –	1.25 – .....
Silver nitrate (nominal)	oz.	..... –	.60 – .62
Soda ash, light	100 lb.	2.15 – 2.25	2.30 – 2.50
Soda ash, dense	100 lb.	2.75 – 2.90	3.00 – 3.25
Sodium acetate	lb.	.08½ – .09	.09¼ – .09½
Sodium bicarbonate	100 lb.	2.90 – 3.00	3.25 – 3.50
Sodium bichromate	lb.	.11¼ – .11½	.12 – .12½
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ – .07½	.08 – .09
Sodium borate (borax)	lb.	.09½ – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.10	2.15 – 2.25
Sodium chlorate	lb.	.14½ – .15	.15½ – .16
Sodium cyanide, 96-98 per cent	lb.	.28 – .30	.31 – .32
Sodium fluoride	lb.	.20 – .20½	.21 – .22
Sodium hydroxide (caustic soda)	100 lb.	4.30 – 4.40	– ..
Sodium hyposulphite	lb.	..... –	.04 – .04½
Sodium molybdate	lb.	2.50 –	3.25½ – .....
Sodium nitrate	100 lb.	3.00 –	3.25 – .....
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.50 – .51	.51½ – .52
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.37 – .38
Sodium prussiate, yellow	lb.	.22½ – .22¾	.23 – .23½
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	100 lbs	2.15 – 2.50	2.60 – 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	.07 – .07½	.07½ – .08
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb	.20 – .20½	.21 – .22
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	..... –	3.70 – 4.35
Sulphur, roll (brimstone)	100 lb.	..... –	3.40 – 3.90
Tin bichloride, 50 per cent	lb.	.18 – .19	– ..
Tin oxide	lb.	..... –	.50 – .51
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.12 – .13	.13½ – .14
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, XX	lb.	.11 – .11½	..... –
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10	— $1.15
Alpha-naphthol, refined	lb.	1.45	— 1.50
Alpha-naphthylamine	lb	.50	— .52
Aniline oil, drums extra	lb.	.27	— .30
Aniline salts	lb.	.33	— .34
Anthracene, 80% in drums (100 lb.)	lb.	.90	— 1.00
Benzaldehyde (f.f.c.)	lb.	2.00	— 2.10
Benzidine, base	lb.	1.15	— 1.20
Benzidine sulphate	lb.	1.10	— 1.15
Benzoic acid, U.S.P.	lb.	.80	— .85
Benzoate of soda, U.S.P.	lb.	.80	— .90
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35	— .40½
Benzene, 90%, in drums (100 gal.)	gal.	.33	— .38½
Benzyl chloride, 95-97%, refined	lb.	.35	— .40
Benzyl chloride, tech.	lb.	.25	— .35
Beta-naphthol benzoate (nominal)	lb.	3.50	— 4.00
Beta-naphthol, sublimed (nominal)	lb.	.90	— .95
Beta-naphthol, tech (nominal)	lb.	.53	— .55
Beta-naphthylamine, sublimed	lb	2.25	— 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	— .19
Ortho-cresol, in drums (100 lb.)	lb.	.23	— .25
Cresylic acid, 97-99%, straw color, in drums	gal	1.10	— 1.15
Cresylic acid, 95-97%, dark, in drums	gal	1.05	1.10
Cresylic acid, 50%, first quality, drums	gal.	.65	— .75
Dichlorbenzene	lb.	.07	— .10
Diethylaniline	lb.	1.45	— 1.50
Dimethylaniline	lb.	1.00	— 1.05
Dinitrobenzene	lb.	.30	— .37
Dinitroclorbenzene	lb.	.27	.32
Dinitronaphthalene	lb.	.42	— .45
Dinitrophenol	lb.	.40	— .45
Dinitrotoluene	lb.	.38	— .40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	— .40
Diphenylamine (nominal)	lb.	.80	— .85
H-acid (nominal)	lb.	1.65	— 1.70
Meta-phenylenediamine	lb.	1.25	— 1.30
Monochlorbenzene	lb.	.18	— .20
Monoethylaniline	lb.	1.75	— 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09	— .09½
Naphthalene, flake	lb.	.09	— .09½
Naphthalene, balls	lb.	.09½	— .10
Naphthionic acid, crude	lb.	.70	— .75
Nitrobenzene	lb.	.12	— .15
Nitro-naphthalene	lb.	.40	— .50
Nitro-toluene	lb.	.18	— .25
Ortho-amidophenol	lb.	3.20	— 3.75
Ortho-dichlor-benzene	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.75	— .80
Ortho-nitro-toluene	lb.	.25	— .40
Ortho-toluidine	lb.	.32	— .35
Para-amidophenol, base	lb.	2.50	— 3.00
Para-amidophenol, HCl	lb.	2.50	— 3.00
Para-dichlorbenzene	lb.	.10	— .15
Paranitroaniline	lb.	1.15	— 1.20
Para-nitrotoluene	lb.	1.25	— 1.40
Para-phenylenediamine	lb.	2.50	— 2.65
Para-toluidine	lb.	1.85	— 2.00
Phthalic anhydride	lb.	.60	— .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	— .14
Pyridine	gal.	2.00	— 3.50
Resorcinol, technical	lb.	3.25	— 3.50
Resorcinol, pure	lb.	4.50	— 5.00
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35	— .38
Salicylic acid, U. S. P.	lb.	.40	— .45
Salol	lb.	.85	— .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30	— .35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	— .22
Sulphanilic acid, crude	lb.	.32	— .35
Tolidine	lb.	1.75	— 1.80
Toluidine, mixed	lb.	.45	— .55
Toluene, in tank cars	gal.	.35	— .....
Toluene, in drums	gal.	.41	— .42
Xylidines, drums, 100 gal.	lb.	.50	— .65
Xylene, pure, in drums	gal.	.45	— .47
Xylene, pure, in tank cars	gal.	.45	— .....
Xylene, commercial, in drums, 100 gal	gal.	.37	— .38
Xylene, commercial, in tank cars	gal.	.30	— .....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.30	— $0.32
Beeswax, refined, light	lb.	.34	— .37
Beeswax, white pure	lb.	.55	— .60
Carnauba, No. 1. (nominal)	lb.	.90	— .95
Carnauba, No. 2, regular (nominal)	lb.	.75	— .80
Carnauba, No. 3, North Country	lb.	.25	— .26
Japan	lb.	.18	— .20
Montan, crude	lb.	.12	— .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	— .09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.08½	— .09½
Paraffine waxes, refined, 118-120 m.p.	lb.	.10½	— .10
Paraffine waxes, refined, 125 m.p.	lb.	.11	— .11½
Paraffine waxes, refined, 128-130 m.p.	lb.	.12	— .12½
Paraffine waxes, refined, 133-135 m.p.	lb.	.15	— .15½
Paraffine waxes, refined, 135-137 m.p.	lb.	.16	— .16½
Stearic acid, single pressed	lb.	.17½	— .17¾
Stearic acid, double pressed	lb.	.18½	— .19
Stearic acid, triple pressed	lb.	.22½	— .23

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.	.35
Pine tar oil, double ref., sp gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$12.75	—
Rosin E-I	280 lb.	12.75	— ...
Rosin K-N	280 lb.	12.75	— ...
Rosin W. G.-W. W.	280 lb.	13.00	— 13.25
Wood rosin, bbl.	280 lb.	11.00	— ..
Spirits of turpentine	gal.	1.28	— .
Wood turpentine, steam dist.	gal.	1.22	— ....
Wood turpentine, dest. dist.	gal.	1.18	— ....
Pine tar pitch, bbl	200 lb.	.....	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	.	— 15.00
Retort tar, bbl.	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.70	— ...
Rosin oil, second run	gal.	.73	— .
Rosin oil, third run	gal.	.90	— .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.26	— $0.26½
Upriver coarse (nominal)	lb	.17	— .18
Upriver caucho ball (nominal)	lb.	.17½	— .18½
Plantation—First latex crepe	lb.	.21	— ...
Ribbed smoked sheets	lb.	.20	— .
Brown crepe, thin, clean	lb.	.17	—
Amber crepe No. 1	lb	.19	— .

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	— $0.18
Castor oil, AA, in bbls.	lb.	.15	— .16
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.16	— .16½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15½	— .16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17¼	— .17½
Corn oil, crude, in bbls.	lb.	.12	— .13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½	— .11
Cottonseed oil, summer yellow	lb.	.13	— .14
Cottonseed oil, winter yellow	lb.	...	
Linseed oil, raw, car lots (domestic)	gal	1.07	
Linseed oil, raw, tank cars (domestic)	gal.	1.00	
Linseed oil, boiled, car lots (domestic)	gal.	1.09	

Olive oil, commercial	gal.	3.00	— 3 50
Palm, Lagos	lb.	.10½	— .10¾
Palm, bright red	lb.		— ...
Palm, Niger	lb.	.09½	— .10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10½	— .12½
Peanut oil, refined, in bbls	lb.	.17	— .18
Rapeseed oil, refined in bbls	gal.	1.30	— 1.45
Rapeseed oil, blown, in bbls	gal.	1.60	— 1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14	— .14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10	— .11

FISH

Light pressed Menhaden	gal.	$0 80	— $0 90
Yellow bleached Menhaden	gal.	.83	— .84
White bleached Menhaden	gal.	.86	— .87
Blown Menhaden	gal.	.90	— 1.00

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—$30 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	- 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10 00	- 12.00
Barytes, floated, f o b St Louis	net ton	26 50	- 28 00
Barytes, crude, first grade, Missouri	net ton	10.00	-
Blanc fixe, dry	lb	.05½	— .06
Blanc fixe, pulp	net ton	60 00	80 00
Chalk, domestic, extra light	lb.	.05	- .06
Chalk, domestic, light	lb	.04½	- .05½
Chalk, domestic, heavy	lb	.04	— 05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb	.05	- .06
Chalk, English, dense	lb.	.04½	.05
China clay, (Kaolin) crude, f o.b mines, Georgia	net ton	9 00	- - 12.00
China clay (Kaolin) washed, f.o.b Georgia	net ton	12 00	- 15 00
China clay (Kaolin) powdered, f.o b Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f o.b. Virginia points	net ton	8 00	- - 12 00
China clay (Kaolin) ground, f.o.b. Virginia points.	net ton	15 00	—- 40 00
China clay (Kaolin), imported, lump	net ton	25 00	35 00
China clay (Kaolin), imported, powdered	net ton	30.00	- 60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8 00	— 14.00
Feldspar, crude, f.o.b. Maine	net ton	7 50	- - 10.00
Feldspar, ground, f.o.b Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	— 21.00
Feldspar, ground, f.o.b. N Y State	net ton	17 00	— 21.00
Feldspar, ground, f o b Baltimore	net ton	27.00	-- 30 00
Fuller's earth, granular, f.o.b. Fla.	net ton	25 00	—
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	- - .
Fuller's earth, imported, powdered	net ton	35.00	- 40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	...	-- .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	07	- 09
Graphite, higher lubricating grades	lb	11	— 40
Pumice stone, imported, lump	lb	.04	- 50
Pumice stone, domestic, lump	lb	.06	—
Pumice stone, ground	lb.	.04	— .07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	. .	-- 10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore.	net ton	..	- 14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	— 17.00
Quartz, lump, f o.b. North Carolina	net ton	5.00	— 7.50
Shellac, orange fine	lb.		- ..
Shellac, orange superfine	lb	1.05	- - 1.10
Shellac, A. C. garnet	lb.	.90	95
Shellac, T. N	lb.	.85	- .95
Soapstone	ton	15.00	— 25.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00	- 22.00
Talc, roofing grades, f.o b. Vermont	ton	9.50	-- 15.00
Talc, rubber grades, f.o b. Vermont	ton	12.00	— 18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	— 15.00
Talc, imported	ton	60.00	- - 70.00
Talc, California Talcum Powder grade	ton	20.00	-- 35 00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100-110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	—$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	— .19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	— .21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00	— 175.00
Ferro-manganese, 76-80% Mn, English	gross ton	165.00	— 170.00
Spiegeleisen, 18-22% Mn	gross ton	75.80	— 80.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00	— 2.50
Ferro-silicon, 10-15%	gross ton	60.00	— 65.00
Ferro-silicon, 50%	gross ton	80.00	— 90.00
Ferro-silicon, 75%	gross ton	150.00	— 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.75	— .90
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	— .....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	— 8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20¼% silica, not more than 14% moisture	gross ton	$10.00	— $11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70	.75
Chrome ore, 50%, max., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.75	.85
Coke, foundry, f.o.b. ovens	net ton	11.00	11.50
Coke, furnace, f.o.b. ovens	net ton	10.00	10.50
Coke, petroleum, refinery, Atlantic Seaboard	net ton	....	...
Fluor spar, lump, f o b. Tonuco, New Mexico	net ton	17.50	.
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	27.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	.01½
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	.60	.70
Manganese ore, chemical (MnO_2)	gross ton	70.00	80.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.65	.70
Monazite, per unit of ThO_2	unit	35.00	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½—	.....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	6.00 —	.
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50 --	5.00
Uranium Ore (Carnotite) per lb of U_3O_8	lb.	2.75 —	3 00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	2.00 —	. .
Zircon, washed, iron free	lb.	.05 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	14.75
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and J.	7 25
Nickel, ordinary (ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5-ton lots	39.00
Lead, New York, spot	7.00-7.25
Lead, E. St. Louis, spot	6.80-7.05
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.60

OTHER METALS

Silver (commercial)	oz.	$0 91½
Cadmium	lb.	1 40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	95.00@100 00
Iridium	oz.	400.00@450 00
Palladium	oz.	85.00
Mercury	75 lb.	60.00@62.50

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	25.50
Copper bottoms	35.00
Copper rods	30.00
High brass wire and sheets	28.50
High Brass rods	20.25
Low brass wire and sheets	31.25
Low brass rods	25.00
Brazed brass tubing	37.25
Brazed bronze tubing	42.50
Seamless copper tubing	29.00
Seamless high brass tubing	28.00

OLD METALS --The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 50	17 00	12 00	13.50
Copper, heavy and wire	12 00	16 00	11 75	12.50
Copper, light and bottoms.	10 00	14.00	10.00	11.00
Lead, heavy	5.50	4.75	5.50	6.00
Lead, tea	4.50	3.75	3.75	5.00
Brass, heavy	7.00	10 50	8.00	12.50
Brass, light	5 50	7.50	5.00	6.50
No. 1 yellow brass turnings	7.00	10.00	6 00	6.75
Zinc	4.50	5 00	3.75	5 00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	Current	One Month Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.30	$4.47	$3.44	$3.37	$4.08	$3.47
Soft steel bars	4.75	4.62	3.84	3.27	3.98	3.37
Soft steel bar shapes	4.75	4.62	3.84	3.27	3.98	3.37
Soft steel bands	6.43	6.32	6.25		....	...
Plates, ¼ to 1 in. thick	4.50	4.67	3.64	3.57	4.28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

NEW HAVEN—H. Kasden, 19 Hone St., has awarded the contract for the construction of a 1-story, 50x80-ft. addition to his foundry on Mill River St., to J. Skolnick, 159 Columbus Ave. Estimated cost, $10,000.

PORTLAND—The Wilcox Crittenden & Co., Inc., 8 South Main St., Middletown, plans to build a 1-story foundry. Estimated cost, $50,000.

Florida

JACKSONVILLE—The William Toomer Fertilizer Co., Viaduct, plans to build a plant to replace the old one recently destroyed by fire. Cost to exceed $1,000,000. B. M. G. Prange, mgr. Noted June 16.

Illinois

CHICAGO—The Illinois Glass Co., 402 West Randolph St., has awarded the contract for the construction of a 1- and 2-story, 215x270 ft. factory, at 2601 North Crawford Ave., to Dahl Stedman Co., 11 South La Salle St.

CHICAGO—Stearns Bros. & Co., 619 South La Salle St., will soon award the contract for the construction of a 3-story, 100x160-ft. printing plant, on East Huron St. and Fairbanks Court. Estimated cost, $200,000. Berlin, Swern & Randall, 19 South La Salle St., archts.

ROCKFORD—The city plans to construct intercepting sewers at a cost of about $600,000 and settling tanks and chlorination plant at a cost of about $220,000.

Indiana

ANDERSON—The Lavelle Foundry Co. is building a factory for the manufacture of gray iron castings. General foundry equipment and pattern shop machinery will be installed in same. J. F. Stanley, 1225 North Alabama St., Indianapolis, engr.

ELKHART—The Wawasee Tire & Rubber Co. will soon award the contract for the construction of a 4-story, 175x175-ft. factory. Estimated cost, $500,000. R. L. Simmons, archt.

FORT WAYNE—Griffith & Goodrich, archts., Physician's Defense Bldg., will receive bids about Nov. 25 for the construction of a 1- and 2-story, 60x180-ft. factory on Cochrane St., for the Amer. Textile Art Printing & Dyeing Co., 403 West Jefferson St. A water filtering and softening plant to have a capacity of 10,000 gal. in 8 hours will be installed in same. Estimated cost, $40,000.

Maryland

BALTIMORE—The H. B. Hearn Co., 41 South Gay St., plans to build a plant for the manufacture of chemical mixtures, etc., electrically operated, to turn out about 25 bbl. of sweeping mixture daily. H. B. Hearn, pres. and mgr.

Massachusetts

BOSTON—The Amer. Can Co., 120 Bway., plans to build a factory. Estimated cost, $250,000.

BOSTON—K. J. Quinn & Co., Inc., 80 Batterymarch St., will soon award the contract for the construction of a 2-story, 30x60-ft. addition to shoe polish factory. Cost, between $18,000 and $20,000.

HOLYOKE—The Amer. Writing Paper Co., 9 Main St., will build a 1-story, 25x75-ft addition to its paper factory. Estimated cost, $25,000. Work will be done by day labor.

HOLYOKE—The Worthington Pump & Machinery Corp., 37 Appleton St., will soon award the contract for remodeling old schoolhouse into pattern plant, on North Bridge and East Dwight Sts. Estimated cost, $30,000.

Michigan

CADILLAC—The Mercy Hospital is having plans prepared for the construction of a 3-story addition to present hospital. A chemical laboratory will be installed in same. Estimated cost, $100,000. E. Brielmaier Sons, University Bldg., Milwaukee, Wis., archts. and engrs.

Minnesota

FRIDLEY—The Walsh Tie Co., 951 McKnight Bldg., Minneapolis, has awarded the contract for the construction of a creosoting plant to include an office building, factory, power house, retort tanks, etc., to C. F. Haglin & Sons, 226 Lumber Exch., Minneapolis.

LONG PRAIRIE—Indian School Dist. 11 will soon award the contract for the construction of a 2-story, 75x160-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $200,000. W. M. Barber, secy., C. Howard Parsons, 600 Builders Exch., Minneapolis, archt.

MANKATO—The Carney Cement Co. is having plans prepared for the construction of a cement plant, to include a mill building, machine shop, blacksmith shop, chemist's building, 16 steel kilns to measure 60 ft. high and 18 ft. in diameter, etc., north of here. Estimated cost, $150,000. R. K. Meade, 11 East Fayette St., Baltimore Md., engr.

Nebraska

CHADRON—The City Council will receive bids until Nov. 15 for the construction of a complete sewage disposal plant, to include a septic tank, sand filter, etc. Estimated cost, $50,000. R. D. Salisbury Co., 1600 Downing St., Denver, Col., engr.

LINCOLN—Alvord & Burdick, engrs., 8 South Dearborn St., Chicago, are preparing plans for the installation of a sewage disposal plant here. Estimated cost, $330,000.

New Jersey

MAURER—The Barber Asphalt Paving Co., 233 Bway, New York City, has awarded the contract for the construction of a 2-story asphalt plant, to Levering & Garrigues, 552 West 23d St., New York City.

TRENTON—The Star Porcelain Co., Muirhead Ave., has awarded the contract for the construction of a 2-story, 40x80-ft. addition to its factory, to C. R. Randall, 43 North Hermitage St. Estimated cost, $6,500.

New York

BROOKLYN—The Grand Corrugated Paper Co., 30 Crosby St., has awarded the contract for altering its factory on 32d St. to the Gabler Constr. Co., 402 Hudson St., New York City. Estimated cost, $50,000. Noted Oct. 13.

NEW YORK—Paul Schuldeberger will alter the 5-story factory for the manufacture of bristles at 52 Cliff St. Estimated cost, $35,000. Work will be done by day labor.

North Carolina

GREENSBORO—The Carolina Steel & Iron Co. plans to build an 80x180-ft. foundry. Estimated cost, $25,000.

WILMINGTON—The Fisheries Products Co. plans to build a fertilizer plant. Estimated cost, $100,000.

Ohio

CLEVELAND—The Malay Rubber Co., 1035 Guardian Bldg., plans to build a 3-story factory on East 172d St. and St. Clair Ave. Estimated cost, $100,000.

CLEVELAND—Parish & Bingham Co., manufacturers of castings, 11600 Madison Ave., has awarded the contract for the construction of a 1-story, 24x45-ft. heating room, to the E. C. Gaspard Constr. Co., Engineers Bldg. Estimated cost, $10,000.

KENT—The Bd. Educ. is having plans prepared for the construction of a 2-story, 160x200-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $275,000. Mills & Millspaugh, 67 East Long St., Columbus, O., archts.

MANSFIELD—The Superior Brass Mfg. Co. is building a 40x60-ft. addition to its foundry. Estimated cost, $11,000. E. K. Bacon, secy. Althouse & Jones, engrs.

YOUNGSTOWN—The Reserve Iron & Steel Co. plans to build two blast furnaces and a 2,000,000 puddling plant. Estimated cost, $1,000,000.

Pennsylvania

PHILADELPHIA—Baeder & Adamson Co., Richmond and Allegheny Sts., will alter and build a 1-story, 50x120 ft. addition to its present factory for the manufacture of glue. Estimated cost, $56,000.

PHILADELPHIA—Clark & Dudnick, archts. and engrs., Drexel Bldg., will soon award the contract for the construction of a 1-story foundry and woodworking shop on 62d and Walnut Sts. Owner's name withheld.

PITTSBURGH—The Pittsburgh Malleable Iron Co., 57th St. and the Allegheny River, plans to build a 202x322-ft. foundry. Estimated cost, $500,000. F. Chase, 615 North Michigan Ave., Chicago, archt.

Texas

DALLAS—The Lincoln Paint & Color Co., Detroit, Mich., has awarded the contract for the construction of the first unit of its paint factory to be 2-story, 140x180-ft., on Kentucky and Ash Lane, to E R. Sessums & Sons, Detroit, Mich. Estimated cost, $150,000.

WICHITA FALLS—The State Bd. of Control, Austin, has awarded the contract for the construction of a sewage disposal plant at the Northwest Insane Asylum here, to the James Constr. Co., Dallas, at $47,700.

West Virginia

HUNTINGTON—The International Nickel Co., 43 Exch. Pl., New York City, will build a rolling mill plant. Estimated cost, $3,000,000.

Wisconsin

DRUMMOND—The Rust-Owen Lumber Co. is having preliminary plans prepared for the development of the sewer system, to include the construction of a sewage disposal plant, garage and several small buildings. Estimated cost, $100,000. R. E. Gilchrist, secy. and treas. G. Lister Nason, 641 Endicott Bldg., St. Paul, archt.

RACINE—Alvord & Burdick, engrs., 8 South Dearborn St., Chicago, have submitted a report recommending the abandonment of the present water station and the installation of new pumps, filtration plants and a 36-in. intake from Lake Michigan and about $400,000 of additional distribution system. Estimated cost, $2,000,000.

SCHLEISINGERVILLE—The Zwebell Bros. Co. will soon award the contract for the construction of a 1-story, 60x150-ft. factory for the manufacture of vulcan outfits. Estimated cost, $100,000. Judell & Bogner, 415 Milwaukee St., archts.

Quebec

COLERAINE—The Canada Asbestos and Chrome Co., Ltd., is in the market for equipment.

MONTREAL—The Canada Cement Co., Herald Bldg., Craig St., West, plans to build a 10-story building. Estimated cost, $450,000. Ross & MacDonald, Belmont St., archts.

MONTMAGNY—The Malleable Foundries, Ltd., will receive bids about Nov. 15 for the construction of a foundry. Estimated cost, $75,000.

MONTREAL—Taylor & Arnold Eng. Co., Ltd., 39 Oiler St., plans to build a brass foundry and install equipment in same.

Alberta

EDMONTON—The San Francisco & McMillan Oil Co., Ltd., plans to build a plant. Estimated cost, $500,000.

New Publications

NEW BUREAU OF STANDARDS PUBLICATIONS: Scientific Paper 386, Atomic Theory and Low-Voltage Arcs in Caesium Vapor, by Paul D. Foote and W. F. Meggers; Scientific Paper 387, Permeability of Rubber to Gases, by Junius David Edwards and S. F. Pickering; Scientific Paper 392, A Photographic Method of Detecting Changes in a Complicated Group of Objects, by M. H. Stillman; Tech. Paper 164, Saybolt Viscosity of Blends, by Winslow H

Herschel; Tech. Paper 165, Enamels for Sheet Iron and Steel, by J. B. Shaw.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 182, Casing Troubles and Fishing Methods in Oil Wells, by Thomas Curtin; Tech. Paper 230, Determination of Molybdenum, by J. P. Bonardi and Edward P. Barrett; Tech. Paper 233, The Properties of Some Stoneware Clays, by H. G. Schurecht; Tech. Paper 238, Indicators for Carbon Dioxide and Oxygen in Air and Flue Gas, by L. H. Milligan, D. O. Crites and W. S. Wilson; Tech. Paper 244, Use of Stenches as a Warning in Mines, by S. H. Katz, V. C. Allison and W. L. Egy; Tech. Paper 266, Coke-Oven Accidents in the United States During the Calendar Year 1919, by William W. Adams.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: Mineral Resources of the U. S. in 1919 (Preliminary Summary), introduction by G. F. Loughlin, statistics assembled by Martha B. Clark, published Sept. 8, 1920; I: C, Mineral Production of the U. S. in 1917, introduction by H. D. McCaskey, summary by Martha B. Clark (Mineral Resources of the U. S., 1917, Part I), published June 28, 1920; 1: 24 Gold and Silver in 1918 (General Report), by J. P. Dunlop (Mineral Resources of the U. S., 1918, Part I), published July 15, 1920; 1: 28, Lead in 1917, by C. E. Siebenthal (Mineral Resources of the U. S., 1917, Part I), published May 8, 1920.

NEW UNITED STATES TARIFF COMMISSION PUBLICATIONS: Tariff Inf. Series No. 18, Barytes, Barium Chemical, and Lithopone Industries, Including Costs of Production, 1919.

EMISSIVITY OF HEAT FROM VARIOUS SURFACES, by V. S. Day, Bull. 118, published by the University of Illinois, Urbana, Ill. Price 20c.

THE MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES, NITRATES, published by the Imperial Mineral Resources Bureau, London. Price 9d.

DATA BOOK FOR ENGINEERS, published by the Locomotive Superheater Co., New York. This book has been compiled for the purpose of assisting stationary engineers in their everyday work by furnishing them with useful data. Copies will be sent to anyone actually interested in steam engineering.

Manufacturers' Catalogs

THE GAS PRODUCER & ENGINEERING CORP. OF NEW JERSEY, New York City, has issued Bull. 96, on Galusha Suction Type "L" Stationary Gas Producer. Descriptive matter and illustrations are given.

THE TECHNICAL PRODUCTS CO., INC., New York, dealer in new and used equipment, the latter comprising large purchases from Government munitions plants, has recently issued an attractive folder entitled the A B C's of Refrigeration, describing, under the caption of "The Technical Way," the high-speed vertical single acting ring plate valve compressors, which it is handling. Copies can be obtained by addressing the company at its main office, 501 Fifth Ave., New York City.

THE MAGNESIA ASSOCIATION OF AMERICA, Philadelphia, Pa., has published a new book on heat insulation entitled "Defend Your Steam," by Austen Bolam. The book presents the result of four years of original research by the association and the Mellon Institute and covers every phase of heat- and fuel-saving with 85 per cent magnesia pipe and boiler covering. It is well illustrated and contains a variety of data and information on heat and heat losses.

DRIVER-HARRIS CO., Harrison, N. J., has published an excellent booklet entitled "Case Carbonizing." Chapters are devoted to cyanide hardening, gas hardening, lead tempering and hardening, nichrome containers, etc. The booklet is written in language that will be readily understood by the heat treater and will give him the results of the latest scientific investigations in this branch of metallurgy.

THE WEBSTER MFG. CO., 4500 Cortland St., Chicago, has issued the October, 1920, number of "Webster Method," containing articles on recent interesting installations in the materials-handling field. "Webster Method" has been issued since 1911. Its numbers contain descriptions and photographs of recent installations in the coal, grain, mining, chemical and other fields, in which conveying apparatus form so large a factor in conserving hand labor. The subjects of its articles cover not only installations which solve labor handling problems in the United States but often include installations which have been made in foreign countries. "Webster Method" is published regularly and distributed free to those who are interested in labor conserving methods.

THE ATERITE CO., INC., New York City calls attention to Bull. 7, on "Aterite Rods and Sheets, Cold Rolled—Cold Drawn." Many interesting illustrations are given, with descriptions and tables of weight of rolled Aterite rods, sheets and plates, and a table showing comparison of different gages, together with equivalent in decimal parts of an inch.

WORTHINGTON PUMP & MACHINERY CO., New York, announces Catalog BK-3,000, illustrating and describing Worthington Marine Pumps and Auxiliaries. The catalog consists of one hundred and twenty-five pages of descriptive matter and illustrations, and should be a comprehensive and useful publication to marine circles generally.

CRESCENT SALES & ENGINEERING CO., Detroit, Mich., calls attention to a new catalog on Crescent "Roto-Piston" Vacuum and Pressure Pumps. The booklet contains descriptions of Roto-Piston vacuum pump and blower, pump description and performance, view of assembling department, uses of pumps, description of operation phantom of pumps and parts, vacuum chucks, special pumps, vacuum time curves, pressure curves, vacuum pump data, details of foundation, etc., list of parts and instructions for installing and operating.

THE ACHESON GRAPHITE CO., Niagara Falls, N. Y., announces a new publication entitled "Electric Furnaces." Section I deals with electric furnaces made in the United States and Canada and Section II with electric furnaces made in the United Kingdom and Continental Europe. Illustrations are given of many of the furnaces.

BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y., recently issued an attractive booklet on "Some Recent Developments in Buflovak and Buflokast Apparatus." The booklet covers some recent developments in vacuum driers, evaporators, vacuum pans, chemical equipment, sugar apparatus, etc.

BLAW-KNOX CO., Pittsburgh, Pa., has issued two new folders entitled "Blaw Bulldog Buckets" and "A Discussion of Lever Arms."

ELECTRO BLEACHING GAS CO., New York City, has published a new textile bleaching booklet entitled "Liquid Chlorine." This attractive catalog contains various formulas used for the making up of a bleaching solution from liquid chlorine.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., calls attention to Pub. 860, which takes up in a general way the control of motor-driven pumps and compressors on water and compressed air systems, in mines, on board ships, for hydraulic elevators, etc. Every C-H product used for this class of service is described, including manual and automatic starters and speed regulators, and accessories, such as pressure regulators, float switches, push buttons, etc. A condensed chart is given to aid in the selection of the proper control equipment for each particular class of service.

THE DINGS MAGNETIC SEPARATOR CO., of Milwaukee, Wis., has issued Bull. 81, describing several types of magnetic separators. Among these is included the new Type C magnetic separator, which is designed for separating fine granular material. It is of the medium intensity and cross-belt type, and is used for extracting iron from brass and aluminum borings and turnings, iron from glass sand, abrasive material, rubber buffings, fireclay, cattle and poultry food, phonograph record material, etc. The material to be separated passes through two positive magnetic zones.

THE SPECIAL CHEMICAL CO., of Highland, Ill., has issued a new bulletin on Pfanstiehl sugars, which are used in bacteriology for differentiating various disease-producing micro-organisms.

THE ARTHUR R. MAAS LABORATORIES, Los Angeles, Cal., has issued an attractive catalog on "Chemistry and You," which is published for the purpose of acquainting the reader of its business—chemical service. This booklet contains interesting write-ups on: The Misunderstood Chemist; Yesterday and Tomorrow; Lazy Materials; Sherlock and the Chemist; Counting the Bugs; Buying on Faith; Chemical Specifications; Our National Beverage; Gasoline vs. Coal Oil; The Chemical Alphabet; Exit Snails; Wasted Advertising; Insurance Adjustments; Chemical Gold Bricks; The Wrong Foot First; From Test Tube to Factory; Unhatched Dollars; Profits in Waste; Before Judge and Jury; Chemical Advertising and a Word About Ourselves.

THE DENVER FIRE CLAY CO., Denver, Col., has just received from the press a 32-page illustrated bulletin on Oil Shale Equipment. At first is a brief review of the shale-oil industries in Scotland, and a description showing occurrence of oil shale in the United States. Following this are a number of illustrated methods for the preliminary or field distillation of oil shale, and also lists and descriptions of apparatus used in the oil shale industries, followed by a number of oil shale retorts and plants.

THE AJAX METAL CO., Philadelphia, Pa., calls attention to its new export catalog which has been published in two editions, one English and one Spanish. The text and illustrations are in both cases identical. This book covers all Ajax products from Babbitt metals to car brasses and castings, and ingot metal, and is a comprehensive book on the metal field for export use. The book is illustrated.

MANIERRE ENGINEERING & MACHINERY CO., Milwaukee, Wis., has just issued its 1920 catalog, which contains illustrations of the latest installation of the company's seven different types of loaders, showing the wide application of these machines in the United States and Canada.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN GAS ASSOCIATION will hold its second annual convention at the Hotel Pennsylvania, New York, Nov. 15 to 20.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PETROLEUM INSTITUTE will hold its annual meeting on Nov. 17, 18 and 19, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

FEDERATED AMERICAN ENGINEERING SOCIETIES will hold its first meeting in Washington, D. C., Nov. 18 and 19. American Engineering Council will hold its organization meeting Nov. 20. Headquarters for both will be at the New Willard Hotel.

PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry, and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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The Goose Or the Egg

ABANDONMENT or curtailment of research by certain industrial laboratories is reported or rumored frequently of late. The psychology of the times, both present and recent past, partly explains this; but it is by no means a justification of the tendency. It is simply another instance of killing the goose which lays the golden egg.

During the war period we had a most wonderful demonstration of the effectiveness of industrial research. Many industries profited beyond their wildest dreams from technical investigations then undertaken for the first time. One would think that these at least would have been thoroughly "sold on the idea." It appears, however, that even some such organizations feel that they now know enough to do without further research.

Perhaps one of the most serious causes of research curtailment has been the fact that many inadequately trained, inexperienced chemists have gone into this field and undertaken to do work which was beyond their capabilities.

A generation ago we spoke of a man as a scientist and the term had a definite meaning. A decade ago the term "chemist" was of rather specific significance; today, however, it is necessary to qualify very materially the term "chemist" before one can really comprehend clearly the field to which such professional worker is suited. We not only need to specify whether it be in organic, inorganic, physical or electro chemistry or other similar field, but also we must specify whether it be in so-called "pure" research, industrial research, plant control or other application of the specialized branch of chemistry that the experience and fitness of the worker lies. It is perhaps desirable, certainly inevitable, that those poorly qualified for industrial research organizations should be eliminated at an early date. However, it is to be hoped that a mad campaign of economy will not cut off what should be in the long run one of the most profitable branches of the industry—namely, the research division.

In consideration of a research organization, the industrial executive should understand that it is not at all like other departments which within a short time can be expected to show profit, with discontinuance or reorganization as a penalty for failure. Research requires extended periods of preliminary work, often apparently unprofitable. A great many trials must be made which give only negative results. Often the executive fails to realize that these negative results may be more valuable in avoiding errors of plant design or operation than positive constructive conclusions. In the end, however, well organized, properly directed research will pay. There is no industry which we need to except when making this statement.

We have ample demonstration in large corporate laboratories, such as that of the General Electric Company, that intelligently managed "big business" knows the profit of a research organization working on fundamental problems which sooner or later will be of advantage to the industry. In another branch of electrical operations the tungsten filament lamp is found a product of pure research. This did not come about early in the work; it was rather the outgrowth of long investigation which at many stages was doubtless discouraging. Other industries will have similar experiences and other industries, if they will but be conservative in their urgent demands upon research, will correspondingly profit.

Let us keep the goose alive even if it does mean that we must go and draw a bit from our savings account in order to buy cracked corn and ground bone (or whatever food it is that this kind of a goose may need) in order that we may hope for our golden eggs.

Increasing Output By Preventing Disease

IF THE average business man were to read in his morning paper tomorrow that there had just been discovered 1,000,000 cases of smallpox in the United States, he probably would close up his factory or office and move his family to seclusion in the country and develop a state of panicky interest characteristic of our American people. On the other hand, he reads the statement that there are 1,000,000 cases of tuberculosis in the United States today and it does not excite him a bit. Why? Smallpox is a fatal, quickly developing, acute disease; tuberculosis is a chronic, slowly developing, long-drawn-out malady. And yet the economic loss as well as the loss in other ways from tuberculosis is vastly greater in one year than the loss from smallpox for two centuries.

Consider for a moment what 1,000,000 sick consumptives implies as it relates to industry. While accurate figures are not available, it is a conservative estimate that at least 800,000 of the million are workingmen and workingwomen. Probably the percentage is higher. If everyone of them lost on an average only fifty cents a day in production to themselves and their employers, the total daily loss would be $400,000. That this is a conservative figure any employer of large groups of men will agree. A sick man, whether he is in bed or whether he is at his bench as a producer, costs money to himself, to his employer and to his community.

Take the situation in some of the metal trades for example. Ten per cent more foundrymen and molders die of tuberculosis between the ages of twenty-five and

forty-four than do men generally in the same age periods. This means that in the years of greatest productivity more men die in this industry of tuberculosis than in other groups. Of workers exposed to metallic dust in general, of which there are many thousands between the ages of twenty-five and forty-four, 5 per cent more die of tuberculosis than among workingmen in general and 10 per cent more than among farmers, to contrast them with one of the particularly favored groups. Again, 21 per cent of the deaths in this large group are caused by tuberculosis; or to take a more specific group, among iron and steel workers 16.9 per cent of all deaths are caused by tuberculosis.

Investigations by FREDERICK L. HOFFMAN in this country and by Sir THOMAS OLIVER in England and by many others in various parts of the world have clearly shown that constant exposure of workingmen to metallic dust and to chemical fumes leads to increased tuberculosis.

The reason for this is not far to seek. Tuberculosis is caused by a germ that usually enters the body in early childhood. Most men carry the germs of tuberculosis hidden away in their bodies before they reach the age of twenty-one. Whenever the tissues of the lungs or other tissues of the body become weakened by disease, self-indulgence or by the constant irritation of some substance such as fine metal dust particles or gassy fumes, the soil is prepared and the latent, already-present germ begins to develop an active process and under these favorable conditions the disease known as tuberculosis definitely sets in.

The problem of tuberculosis in industry, therefore, resolves itself into these two definite phases: First, the prevention of infection. This involves safeguards against spitting, sneezing and coughing by providing proper receptacles, by constant education, by periodic medical examination and otherwise. Second, by building up and maintaining resistance to the highest notch of efficiency. This requires not only constant medical supervision and continuous education but the development of the best community activities for recreation. It implies also that the workingman shall have not only proper working conditions but sufficient money with which to buy proper living conditions, including house, food and clothing, for himself and his family. Anything that goes to the building up and making of health increases production and produces more revenue for the employer.

It has been estimated by the National Tuberculosis Association that on an average two and one-half years of life could be added to the mean after life-time of every individual in the United States if tuberculosis could be removed as a cause of death. This would mean a gross saving of at least $25,000,000,000 to the industries and people of this country. To eliminate the disease would cost probably in the neighborhood of $2,000,000,000. Consequently any agency or movement which has this accomplishment as its purpose is worthy of widespread individual and organized support. The purpose of the National Tuberculosis Association and its allied agencies is to unite communities all over the United States, in order to secure the machinery and assistance necessary to prevent tuberculosis. The revenue for this great health- and life-saving movement is provided from the annual sale of Christmas Seals from Dec. 1 to 11.

Every dollar's worth of seals aims a strong blow at this disease.

Industrial Autocracy And the Way Out

WILLIAM B. DICKSON, vice-president of the Midvale Steel & Ordnance Co., is the one man in the steel industry who has spoken out and said, what many no doubt have thought, that the present industrial system represents an autocracy in the control of the employers over the employees. Speaking at the fortieth anniversary of the American Society of Mechanical Engineers, Nov. 5, Mr. DICKSON referred in particular to the policy of the United States Steel Corporation, calling it a benevolent autocracy, benevolent in many splendid ways, but still an autocracy, and saying further: "The autocratic policy of this great industrial corporation is diametrically opposed to American ideals, and if it and similar organizations in other industries continue to grow and to maintain this autocratic attitude, there can be only one result—industrial feudalism, feudalism with a high degree of comfort and safety for the worker, I grant you, but none the less feudalism." The feudal barons owned the land and its appurtenances, the highways, streams, mines, fisheries, etc., while at the present day the corporations own plants.

Mr. DICKSON says American industry has now come to the parting of the ways, one way leading to industrial democracy, the other, camouflaged to appear as the natural continuance of the present road, leading to industrial feudalism, but with a bypath "now being trodden by Russia, and toward which not only our British brethren but a considerable number of American workmen are being tempted to stray."

Feudalism is cited as a horrible example of what the present industrial system represents or is trending toward. If, then, one should set up the problem, "How would you devise a way out of feudalism?" one reasonable suggestion would have been that the barons and workers should go into partnership and should divide the proceeds by shares. In the modern partnership the partners divide the profits according to a predetermined schedule.

Now it chances that the steel mills have had in practice for a long time this very system, only that it is not general. It is curious that Mr. DICKSON did not propose an extension of the system, so successful where it has been used, to all the workers. We refer, of course, to the "tonnage" basis of payment, and particularly to those systems in which the rate per ton varies according to the market or selling price of the material produced. That is vastly better than any so-called system of "profit sharing." Profits may be reduced by the mistake of a purchasing agent and the worker should not be expected to contribute toward the loss. The system is really a very common one. While in some cases the tonnage rate does not fluctuate with selling prices, that is doubtless because the workman does not wish to have it so. The system can be extended. Works managers are certainly ingenious enough to solve the problem. Where the work is collective a total sum could be allotted and the men be permitted to determine how many they desired should divide the pool. A blast furnace could then be operated with fewer men. That would be industrial democracy, a partnership among capital, management and labor, with the public sharing in the general prosperity that would inevitably accompany so happy a solution of the problem.

Why Not Turn The Mold Over?

RECENTLY in these pages the opinion was expressed that the American steel industry, speaking generally, was impelled by a desire for great tonnage rather than great quality. Such a state of affairs opposes the ideals of metallurgists, who quite naturally, by their training, work first for excellence.

Sound steel—free of cavities, cracks, excessive segregation and non-metallic inclusions—is a difficult thing to make and precious. It would be a high goal for the ambition of many steel producers. Yet it is being made in this country in considerable quantity. Its makers realize that steel is not steel until it is successfully cast; given the best furnace practice at their command, making well settled and thoroughly deoxidized steel, they still exercise the most extreme care in getting it into the molds.

Take high-grade forging ingots as an illustration. Metal would probably be tapped into a clean, preheated ladle, running from the furnace somewhat too hot to pour. Fifteen or twenty minutes' cooling in the ladle allows trapped slag to separate cleanly. Ingots would probably be bottom-poured through runners proportioned so that the minimum of air would be drawn in with the steel by injector action, and poured just hot enough and fast enough that the surface of the metal rising in the mold would float islands of chilled metal like films of cream floating on milk. Molds themselves would be prepared and cleaned with the greatest care, so the advantages from complete lack of splattering might not be lost through particles of foreign matter, or the hot ingot sticking to the sides of a roughened mold. The mold itself would doubtless be bigger at the top than at the bottom, with thick bottom walls for great chill, thus insuring progressive freezing from bottom upward. Further to guard against secondary pipe, a sink-head of brick would be built on top the ingot, and charcoal or slag would be placed on top the liquid metal to retain it molten as long as possible. Such ingots would be lifted out of their molds while still red, and buried or soaked to insure slow cooling and prevent shrinkage cracking.

"But," it is objected, "this program is entirely too expensive for cheap products which do not require such high quality." Granted; but where does this idea lead?

You would make the steel in the ladle (or even in the ingot) rather than in the furnace, in order to increase the tonnage of the plant; you would cast fast and cold to enable the ingot to stand more abuse in blooming; the molds would be bigger below than on top because they are easier to strip; you would top-cast because it is cheap, and generally neglect the sink-head or hot top for the same reason; you would strip as soon as possible and remove to a soaking pit to save heat and perchance cure some of the ready made imperfections, and rush the rolling by heavy drafts to avoid reheating. In other words these things are exactly what a maker of quality steel does not do.

Generally speaking, when an American plant must produce sound metal, really sound, such as will make high-explosive shell forgings, it casts dead-melted steel and the Government will accept about 55 per cent of the ingot. If an English plant would cast the same metal it would be done in such a way that 85 per cent would be acceptable by inspectors no less keen to find defects. It is not because we do not know how. Unquestionably the only reason American plants persist in making ingots with internal cavities is because only about one-eighth of their total production is dead-melted steel and of this they are able to work off on unexacting purchasers up to half what is defective and should really be discarded.

Evidently, a seeker for sound ingots—really sound—must disregard particular plant layouts, big outputs and apparent economies. His way unquestionably will be hard, but he will be assisted by the inevitable trend of future demand, and eventually he will succeed.

With so many points of attack it is only necessary for one desirous of increasing ingot quality to select the most vulnerable and the one most likely to yield the greatest results for the energy expended. That appears to be the taper of the molds. Apparently a small point, but it has been so often demonstrated by theory and practice that in a big-end-up ingot the pipe is shorter and higher up, as compared to the same mold inverted, that no discussion of the reasons is necessary here. Big-end-up ingots have been used in France and Germany for forty years or more; their use has always been one of the causes of the excellence of Swedish metal, and, impelled by war's demands, the English have widely adopted the practice in these recent years. Even Americans use the idea to the extent of making perhaps a million tons a year, mostly in highest-grade forging ingots, or high-carbon or alloy steels. But even so, some notable pioneers have even discovered that it pays on the more common grades.

Many special methods of reducing pipe and limiting segregation have been regularly used in American mills for the past five years. But they have all compromised with the big-end-down fetish. Their users have realized that to prevent a pipe you must feed it, and therefore simulate the clay "dozzle" with which the crucible steel melter caps his mold, by making it thin at the top, insulating it with fireclay, building sink-heads, or actually heating the top by outside flame. But they seemingly have dodged the fact that a big-end-up casting provided in itself an upper reservoir of metal hot to the last, and which, if assisted by their ingenious sink-heads, would without peradventure absolutely prevent secondary pipe and give up to 85 per cent "sound" metal, something their half-way steps have not yet insured.

It is not the intention to lecture the American metallurgist on the exact procedure he must follow in furnace, casting, molds and soaking in order to eliminate internal cavities. It is the intention, however, to emphasize as clearly as possible that most of the present defects are due to the lack of discrimination among American steel users, and the insistent demand for tonnage production from the steel-works' management. We hold no brief for HADFIELD, GATHMANN, BRADFORD, or any of those sturdy men, except in our poor way to support their efforts toward getting sound metal. We have tried to point out that American steel-making practice has had the tonnage idea for a goal. It is time now to look for quality. We propose a forward step which need not be postponed years—in case a manager wanted to do it it could be done within a month.

As one might say, "Turn the mold over."

Notes on French Industries

FROM OUR PARIS CORRESPONDENT

Paris, France, Oct. 15, 1920.

A GREAT number of our people persist in qualifying as abnormal our present economic situation. In fact, after the cataclysm we passed through during the last few years, we and all the rest of the world find ourselves today in quite a logically resultant situation. It is wrong to compare our present status with that of the pre-war period, because it is bound to create a pessimistic spirit at a time when we need to be so very optimistic.

These reflections are the more apparent now when we are threatened with a very grave and profound economic crisis. Credit is becoming more and more restricted and the money stringency has already reached a very acute stage. A great number of manufacturers, fearing an endless rise in prices of raw materials, have accumulated enormous stocks at high prices, and have transformed these expensive materials into finished products at high costs; but now when a general decline in prices is expected and the demand for the finished products has fallen until it has quite disappeared, manufacturers and consumers find themselves in a peculiar position. The manufacturers do not wish to sell at a loss, and the consumers delay their buying as long as they can.

The fall in prices has already begun; it started with metallurgical products. The government, which controls the importation of coke, has already limited the price of metallurgical coke to 175 fr. (normal value $35) per ton instead of the former 275 fr. (normal value $55) per ton. This was done in agreement with the officials of steel plants. The consequence was a drop of the prices for hematite pig iron from 850 fr. (normal value $170) to 700 fr. (normal value $140) per ton and a 20 per cent drop in the prices of finished steel products. This is a beginning.

FRENCH HYDRAULIC POWER

According to a very recent study made by the writer on the subject of French hydraulic power, the following data may serve to complete the succinct information given in the preceding letter (see CHEM. & MET., Oct. 20, 1920, p. 764):

Before the war the sum invested in the hydro-electric industry amounted to over a billion francs (normal value $200,000,000). It was estimated that the investments were apportioned as follows: 525,000,000 fr. ($105,000,000) for power and light; 100,000,000 fr. ($20,000,000) for electrochemical and electrometallurgical industries; 75,000,000 fr. ($15,000,000) for electric railways; 300,000,000 fr. ($60,000,000) for sundry small industries.

Taking as an average 800 fr. ($160), the pre-war installation cost per horsepower, it would follow that up to 1914 there was installed in all France about 1,250,000 hydro-electric horsepower.

During the war France made great strides for further hydro-electric development, and from 1914 to 1918 500,000 more horsepower was installed at a cost about double the pre-war cost, so that at present there are in operation hydro-electric power plants installed at an estimated total cost of 2,000,000,000 fr. ($400,000,000).

A government commission is now studying the development of all the French waterfalls not yet used and which are estimated to represent 10,000,000 horsepower. Projects are under way for the installation of plants aggregating 3,000,000 horsepower. This installation will enable France to make important coal economy. (There is under way a project for electrifying 8,000 km. [about 5,000 miles] of railroad, which if realized would result in an annual economy of 3,000,000 tons of coal.) It is estimated that the cost of reclaiming the 3,000,000 horsepower would amount to about 4,000,000,000 fr. ($800,000,000), and could be finished within fifteen years. It is expected that the report of the commission will soon be presented to the French Parliament.

To the above-estimated 10,000,000 hydro-electric horsepower available in France may be added about 400,000 horsepower which could be obtained by using the Rhine falls between Basel and Strassburg as provided in the Versailles treaty. But to reclaim this power it would be necessary to build a canal entirely situated on French soil.

Although this would open direct water communication from Basel to the sea for ships up to 1,200-ton size, the Swiss Government is strongly opposed to the plan and bases its contention on the Oct. 17, 1868, treaty of Mannheim guaranteeing the free navigation of the Rhine. The Swiss ask that instead of a French canal the bed of the Rhine between Basel and Strassburg shall be rendered navigable. It is quite evident that England will back up the Swiss contention.

FRENCH CHEMICAL ENTERPRISES

Due to the depreciation of money, the French chemical enterprises have been forced to increase their capital stock. Thus the Société de Saint-Gobain has increased its capital stock from 60,000,000 fr. ($12,000,000) to 120,000,000 fr. ($24,000,000). This society, founded during the seventeenth century, although quite conservative in its technical processes, is commercially well managed and is one of the strongest mineral chemical enterprises. It has a number of plants in France, a branch installation in Mannheim on the Rhine and is now planning to build a new plant in Strassburg.

The Société de Saint-Gobain has recently become financially interested in the Claude process of synthetic ammonia and contributed to the increase of capital of the society of L'Air Liquide, a company working Claude's processes. If the rumors are right the Saint-Gobain society would absorb entirely the company L'Air Liquide and start on a big scale the manufacture of synthetic ammonia by the Claude process.

During the last month the daily production of synthetic ammonia in Claude's experimental plant has increased tenfold, now producing 1.5 tons per day. It is the Saint-Gobain company's intention to bring up the production to compare favorably with the German 1,000-ton-per-day production by the Haber process.

The Etablissements Kuhlmann has also increased its capital stock to 80,000,000 fr. ($16,000,000). This company grew rapidly during the war. Like the Saint-Gobain company, it manufactures mainly mineral chemicals and has also started in the synthetic ammonia industry, but using the Haber process, which has been bought by the French Government for 50,000,000 fr. ($10,000,000).

The development of these two rival branches will have a great influence on the French synthetic ammonia industry.

Pure Metallic Arsenic

Occurrence—Description of Process in Plant of the Hoskins Process Development Co. of Chicago, Which Produces a Quantity of Metal Equal to the Requirements of the United States—Properties of the Metal—Crystalline Structure—Uses in Metallurgy

By CHESTER H. JONES

THE term "arsenic" in commerce is usually misapplied to the trioxide (As_2O_3) instead of the elementary or metallic arsenic which exists at ordinary temperatures. It is with the latter substance this article attempts to deal. Previous to the late unpleasantness there was an importation of the metal to the United States of about 50,000 lb. (22,720 kg.) per year, principally from Germany, where it had been distilled direct from arsenical ores. Subsequently the production has been developed in a Chicago plant to meet the present demand in this country. The raw material for this plant is the arsenic trioxide, or white arsenic, a byproduct from metallurgical operations at various American smelters.

While metallic arsenic is found in the natural state in some districts, it more commonly occurs in ores in combination with other elements such as:

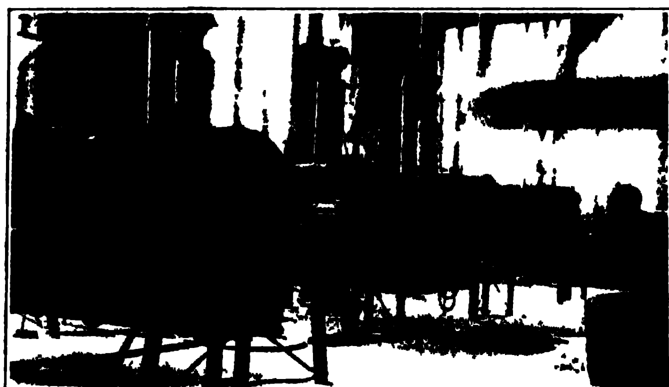


FIG 1 ARSENIC REDUCTION FURNACES

- Cobaltite, CoAsS.
- Mispickel, FeAsS.
- Smaltite, $CoAs_2$.
- Mimetite, $3Pb_3As_2O_8.PbCl_2$.
- Nickel glance, NiAsS.
- Orpiment, As_2S_3.
- Realgar, AsS.
- Scorodite, $Fe_2O_3.As_2O_5.4H_2O$.
- Sperrylite, $PtAs_2$.

Most of these minerals are found in varying quantities in the gold, silver, lead, copper and zinc ores, particularly in our Western mining districts.

Investigations in connection with proposed legislation against smelter fumes in these localities led to belief that the arsenic vapor contained in the fumes issuing from the stacks was largely responsible for the destruction of vegetation and injury to animal life. The operating companies have consequently been forced to recover the arsenic in Cottrell precipitators and bag houses, and on subsequent refining by sublimation have recovered arsenic trioxide. The trioxide obtained from these smelters and plants roasting high-content arsenic ores gives the supply of raw material for the operations described in the following paragraphs.



FIG 2 CHARGING END OF FURNACE

Hoskins Process Development Co. Plant

The one plant in the United States making metallic arsenic of a guaranteed purity over 99.5 per cent is located in the west side manufacturing district of Chicago. Fig. 1 shows the battery of four reduction furnaces, one large and three smaller, having a total capacity of 250 to 300 lb. of metal per day.

The charge with proportions consisting of about 1 lb. of wood charcoal to 4 lb. of arsenic trioxide is placed in a rotary mixer. The mixed batch for charging to the small furnace weighs about 200 lb. and for the large furnace about 450 lb. Fig. 2 shows the charging end of the large furnace in operation.

In Fig. 2 the gas flame may be seen beneath the

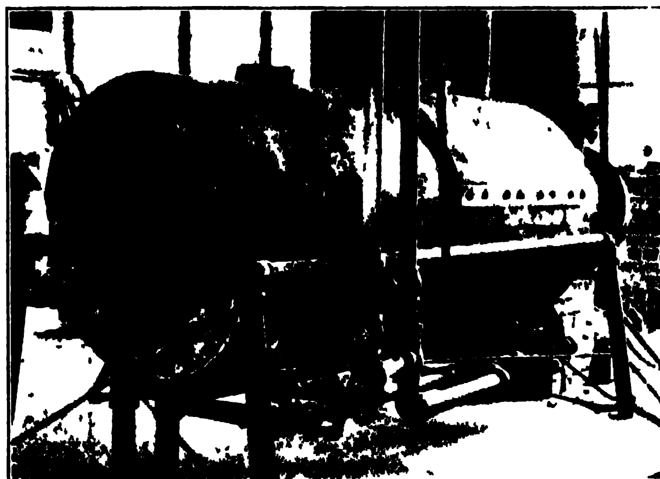


FIG. 3. RIGHT SIDE OF FURNACE

retort and the pyrometer leads coming from the cover. All four furnaces are equipped with pyrometers using nickel-chromium couples and connected through a multiple switchboard to give temperature reading on each furnace. The temperature varies between 1,200 and 1,300 deg. F. (650 and 700 deg. C.).

The reaction in the furnace is



$$2As_2O_3 + 6C = As_4 + 6CO$$

These furnaces are built of large steel pipe surrounded by No. 1 firebrick held in place by riveted steel plates, all supported on pipe framework. Fig. 3 shows the arrangement of gas piping. The water-cooling supply for the charging end cover is conducted through the smaller pipe. This cover is clamped against a clay gasket in which is buried a ¼-in. copper pipe filled with the cooling water. In case of any leak of the arsenic fume it condenses against the cooled surface, rendering the joint tight.

The water supply for both the condenser appearing at the rear end of furnace in Fig. 4 and for the gasket cooling-coil mentioned in the foregoing paragraph consists of a ⅜-in. stream running continuously from the city mains.

The period of operation for the large furnace occupies about ten hours and for a small furnace seven hours. Running under normal conditions the plant produces not

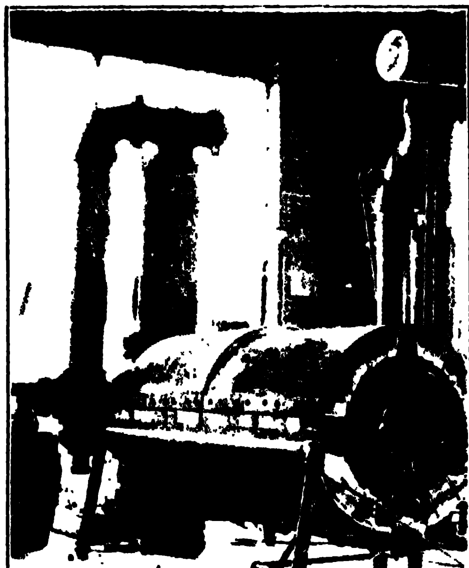


FIG. 4. LEFT SIDE OF FURNACE

less than 4,000 lb. of metallic arsenic of 99.5 to 99.9 per cent purity per month. The small impure fraction consists chiefly of arsenic trioxide.

Fig. 5 shows the rear end of the battery with pans containing the lumps of metal immediately beneath the point of removal. When the run is finished and the furnace has been allowed to cool, the cover clamps are removed, permitting the cover to be taken off. The crystalline metal which has been formed in the tee, by carefully controlling the temperature and pressure during the heat, is taken out with bar and hammer. It is then ready for barreling and shipment.

A feature of safety to prevent poisoning of the operators is the ventilating arrangement and exhaust fan. Two of the small hoods connected to the system are shown just above the discharge end. The operators wear woolen masks over the nose to avoid injury from

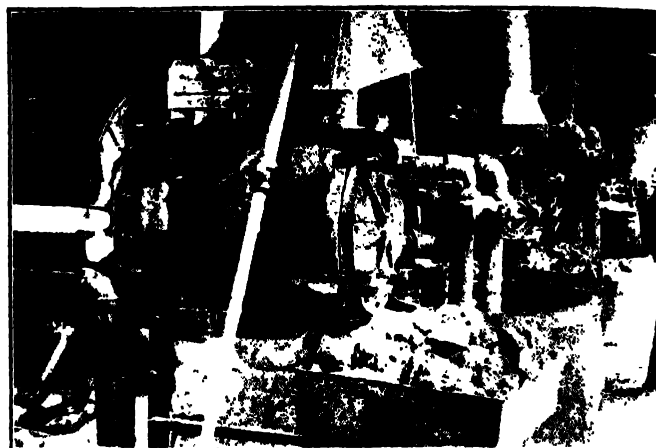


FIG. 5. DISCHARGE ENDS OF FURNACES

the fumes or dust. With these precautions the danger from poisoning is negligible. There are many features of this process which have required a period of several years before the ultimate production in the commercial plant described.

PROPERTIES OF ARSENIC

Metallic arsenic (As_4, molecular weight 300) is classified with nitrogen, phosphorus and antimony in the periodic system. It is chemically analogous to phosphorus, but is more metallic in character. As a metal it behaves like sulphur. Thus the sulphides and arsenides have similar formulas, are isomorphous, and in them sulphur and arsenic can mutually replace each other in atomic ratios—e.g., FeS_2, $FeAs_2$ and FeSAs.

The characteristics of the three metallic varieties when condensed in a glass tube from distillation of arsine in the laboratory are well known. Nearest the flame the crystals form, further on the shining mirror and finally the amorphous. The last is microcrystalline, probably isometric, and black with little luster. It has a specific gravity of 4.71 and when heated to 360 deg. C. out of contact with air sets heat free and reverts to the larger crystalline variety.

The vapor density of metallic arsenic corresponds to the molecular weight, As_4 (= 300), with the lemon yellow vapor at 450 deg. C. At white heat, about 1,700 deg. C., the density falls to one-half, or As_2 (= 150), showing the diatomic molecule.

The crystallized variety, which is the normal product of these furnaces, so far as has been investigated, varies from the hexagonal to acute rhombic octahedra. It has a specific gravity of 5.73, is brittle and may be pulverized without difficulty. The hardness is 3.5 (Mohs

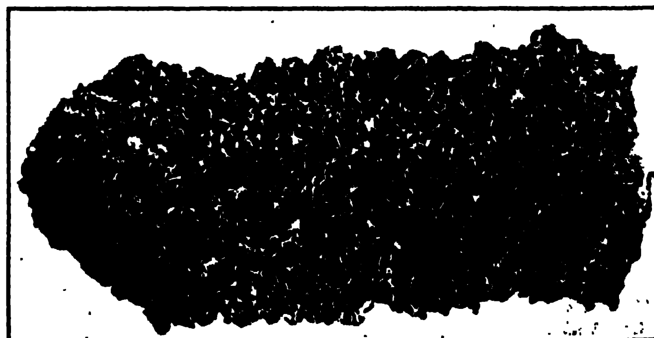


FIG. 6. METALLIC ARSENIC CRYSTALS (SLIGHTLY REDUCED)

scale); the luster is tin-white metallic, tarnishing to black by oxidation in moist air at ordinary temperature and gives a tin-white streak. The cleavage is perfect basal, the fracture granular.

Figs. 6 and 7 show crystals taken at random from the run of furnace and indicate plainly the clean nature of the commercial product. Arsenic in metallurgical classification lies between the true metal and the non-metal. It behaves in certain ways like the one and in other ways like the other. It will form alloys in some cases and is thrown out of the molten mass or forms "speiss" with others. Although a metalloid, it is a good conductor of heat and electricity.

USES

The metal acts in the nature of a flux for other metals, promoting the union of metals which would otherwise be difficult to mix. The trioxide cannot be successfully substituted for the metallic arsenic in the work. Arsenic bronze, now used for railroad brasses, is a good example. (Composition: Copper 80, tin 10, lead 10, arsenic 8.) The structure remains unchanged, but there is a gain in crushing strength and a lower temperature is required to crystallize. A content of 0.65 metallic arsenic increases the resistance to hammering.

The arsenic may be added directly to the molten metal, or a rich alloy of arsenic with copper or lead may be made and proper proportions of it used.

It seems to be the consensus that a small percentage of arsenic added to copper to be used in sheets, tubes, staybolts, etc., for locomotive fireboxes will increase the tensile strength, rigidity, hardness and resistance to action of gases as compared to pure copper. Added to copper for castings it reduces blow-holes and increases fluidity. Copper to be drawn into wire works better in the drawing process and the melting point and conductivity are lowered.

The annealing point of copper is raised by the addition of arsenic, and a tougher metal results. The injurious effect of small quantities of bismuth is counteracted. Arsenic tends to deoxidize the copper.

A higher percentage of lead may be carried in a zinc alloy by the addition of metallic arsenic.

When added to brass for casting up to 0.5 per cent, it increases the fluidity when molten, gives sharper and cleaner castings and increases the strength and elongation. It increases the ductility of Muntz metal (60 copper, 40 zinc).

A finer grain and increased hardness is secured by adding metallic arsenic to white bearing metals.

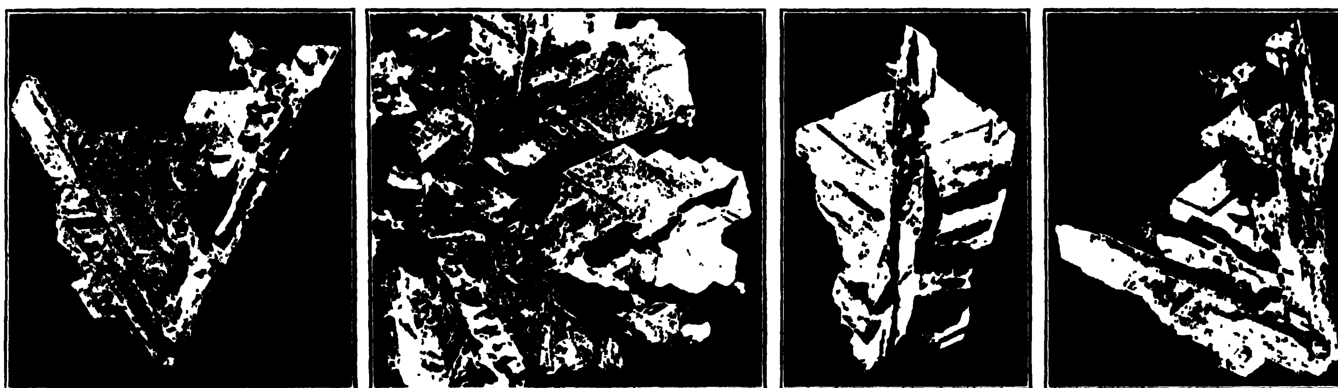
Arsenical lead contains about 2 per cent arsenic. The product is harder, but the more important property of increased mobility of shot when molten is secured. This results in a more uniform output from the shot tower.

Metallic arsenic is also used in the manufacture of speculum metal for mirrors in large telescopes.

CONCLUSION

We have, then, a process and plant perfected by American chemists producing on a commercial scale an element of guaranteed purity and known to be useful in the improving of a few of our metals for important uses. But the field is scarcely touched as yet, the research is only in the preliminary stages, and we may venture to hope for much in future developments. To have at hand a pure metal, to find these new things it will do with other pure metals, its behavior in many eutectic mixtures, and all its meanderings through the wide field of chemistry with ultimate benefit to industry at large—this is a thing worth while.

We are indebted to the Hoskins Process Development Co. for the material contained in this article.



COMMERCIAL METALLIC ARSENIC CRYSTALS (× 3½)

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The Indian Mica Industry

MICA is one of the things, like jute, for which for certain purposes no satisfactory substitute has been discovered, and although it is not, like jute, an Indian monopoly, more than half the world's supply of the mineral comes from that country. In India it is very widely distributed, but the tracts in which it is found in plates of sufficient size to have a marketable value are few and strictly defined. Mica in more recent years has been mined in the Nellore district of Madras, but the main deposit is in a belt about eighty miles long and twelve broad, which lies in the northern part of the Hazaribagh district and stretches into the adjoining districts of Gaya and Monghyr. The main center of the industry is at Koderma, in the Hazaribagh district.

Primitive Methods of Mining

Mica does not occur in thick seams like coal, but in small deposits or "books," and a mica mine or quarry presents the appearance of a huge rabbit warren, the workers burrowing from "book" to "book" by passages that are sometimes just sufficient to admit a small boy. In most cases very primitive methods are used, the lower levels of the mine being reached by roughly made bamboo ladders and the excavated material being passed, hand over hand, from one coolie to another. The bailing out of water is done in the same way by the use of buckets, and during three months in the monsoon operations may be suspended altogether, the mica being under water. In one of the mica districts, before the war, a German firm was the only one of the many agencies at work that employed a steam pump. As the demand for the mineral has increased and the deposits near the surface have been worked out, more scientific methods for extracting the mineral are gradually being introduced, and mica is now being dug by means of shafts 300 to 400 ft. deep.

Use of Mica in the Arts and Medicine

Mica has been extensively used in the native arts of India from time immemorial. The powdered mica is used in calico printing and by washermen to give a sparkle to cloth. It is a substitute for glass in lanterns, and the material out of which "unbreakable" lamp chimneys are manufactured. It fills the peepholes of furnaces, and is used for windows in cases where glass would break on being exposed to extremes of heat or to concussion. It is a glazing material for pottery, for pictures, and for the backs of mirrors. Indian artists have used it largely for paintings.

Mica also has a high reputation in Indian medicine. It is used as a finely ground powder, either by itself or in combination with other drugs; it is said to be a tonic. Indian medicine classifies nearly all drugs and articles of diet into two groups—the "heating" and the "cooling"—and mica is said to be the most efficacious of all the drugs in the latter class. It is said that some Indian practitioners have a secret means of dissolving mica, but this is doubtful. Such solvent would be a great discovery, for it would mean that mica could be used for the manufacture of unbreakable tumblers and decanters.

A Non-Conductor of Heat and Electricity

"Mica paste" or "mica grease" is used as a lubricant and to plaster on boilers to diminish the loss of heat, for mica is a non-conductor of heat. It is believed to be the chief constituent of the preparations that are used for painting the under side of iron roofs to promote coolness and for other similar purposes, and it has been recommended, and actually used, as a lining for sun helmets.

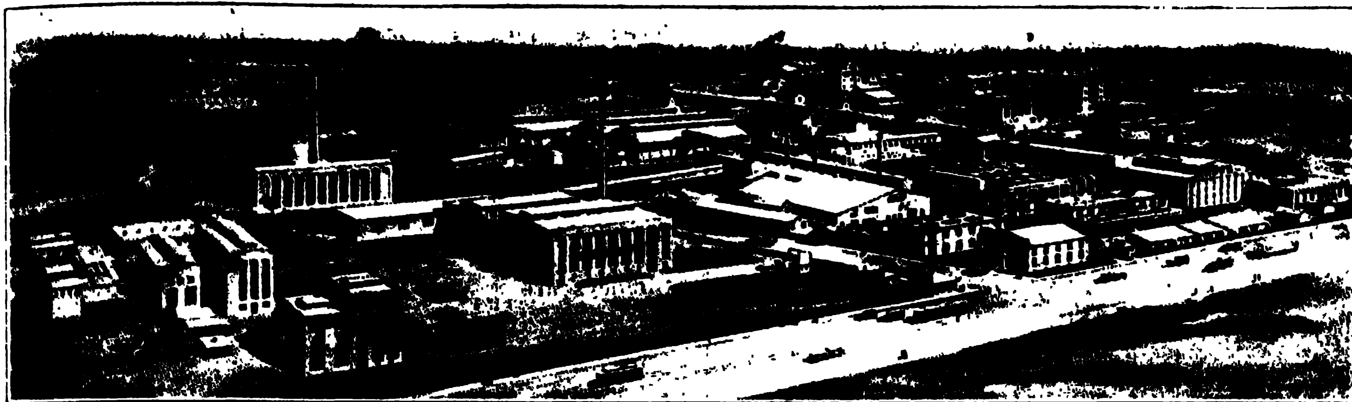
The main importance of mica in modern industry, however, lies in the fact that it is one of the best non-conductors of electricity and is, therefore, indispensable in electrical engineering. On this account the government took over part of the mica field during the war and worked it as a state industry in order to make sure of having a constant supply.

"Micanite"

Impetus was given to the industry about twenty years ago by the invention of a method of cementing small pieces of mica together and molding them into sheets, which are called "micanite." In former days it was said that 80 per cent of the mica which was dug out of the mines was waste, and great waste dumps of the refuse, glittering in the sun, were a conspicuous feature of the mica mines and factories where the splitting was done. Since this process of welding was introduced a considerable amount of marketable mica has been recovered from the waste heaps, and the process also permits the use of a larger proportion of the mineral that is excavated.

Unskilled Labor Employed

The industry gives work to a large number of unskilled laborers. Even the work in the factories, where the thick pieces are split into thin sheets and cut to the proper sizes, is easily learned by women and children, and a daily wage can be earned that is considerably in excess of what is paid for field work.



PLANT OF THE HOOKER ELECTROCHEMICAL CO., NIAGARA FALLS

Chemical Efficiency and Concentration of Caustic and Salt From Townsend Cells*

Brief Description of the Townsend Cell Installation of the Hooker Electrochemical Co.—Some Characteristic Properties of Saturated Cathode Liquors—Concentrations and Equilibriums of NaCl-NaOH Solutions—Chemical Efficiency

BY ALBERT H. HOOKER

DR. BAEKELAND in 1907 described the general principles of the Townsend cell and process of operation in the *Journal of the Society of Chemical Industry* and *Electrochemical and Metallurgical Industry*.[1] Since that time there has been a large development in the production of chlorine from these cells and some material modifications in design and operation have taken place. For that reason it seemed proper to bring before this symposium on electrolytic cells a brief description of the plant of the Hooker Electrochemical Co. at Niagara Falls, where we are producing about sixty-five tons of caustic soda and sixty tons of chlorine daily from Townsend cells.

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

[1]Now CHEM. & MET. ENG.

The heading of this article gives a general view of the plant covering about thirty-eight acres. In the left foreground will be seen the research laboratory; behind that the chlorbenzol plant, where about thirty tons a day of chlorbenzol was made during the war for the French Government to convert into dinitrophenol to modify its picric acid explosive; near that will be seen the plant for the manufacture of a very pure grade of muriatic acid, practically water white. The two larger buildings are the boiler plant, with a modern equipment of mechanically stoked boilers used to supply heat and steam for evaporation and process work, and one of the evaporation houses containing vacuum pans and pots for finishing caustic. The two power houses, five cell buildings, bleach chambers, brine purification tanks, machine and repair shops, office building, general labo-

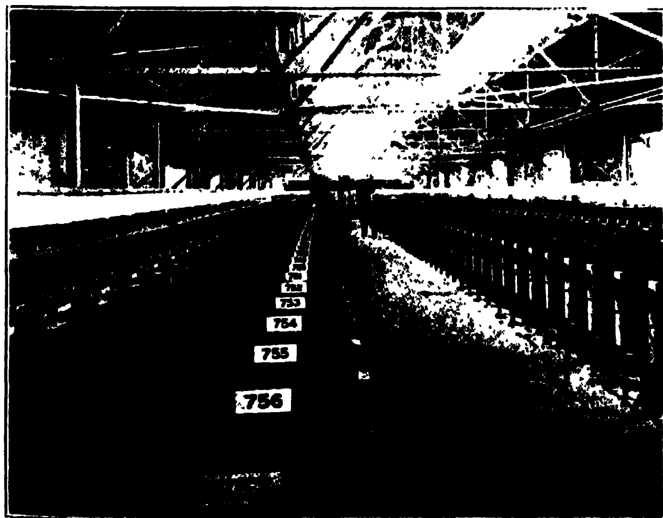


FIG. 1. CELL HOUSE

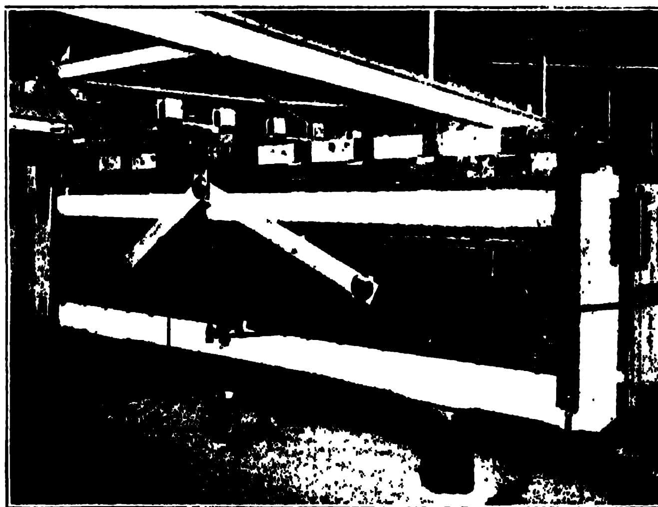


FIG. 2. 4,000-AMP. TOWNSEND CELL

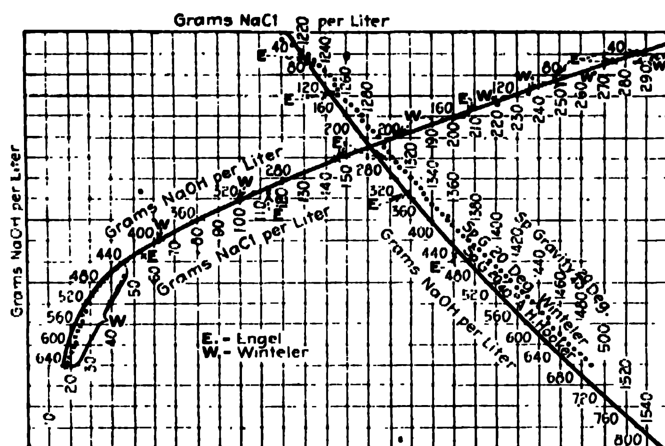


CHART 1. SP.GR. AND GRAM/LITER OF SAT. NaCl-NaOH SOLUTIONS

ratories, liquid chlorine and synthetic chemical units form the general group to the right of the picture, while in the distance can be seen the plant where we made picric acid for the Government from monochlorbenzol during the war.

Types of Townsend Cells

This work all centers around the production and use of chlorine and caustic soda from the Townsend cells.

The power is received from the Niagara Falls Power Co. as three-phase, alternating current at 12,000 volts, and after passing through transformers and rotary converters is delivered to the cell circuits at about 260 volts and 4,000 to 5,000 amp. direct current.

We have several types of Townsend cells in operation, a small circuit of the original 2,500-amp. cell and some of the earlier 5,000-amp. cells. However, Fig. 1 shows one of our more recent cell bays, which consists entirely of 4,000-amp. cells. In the building there are 120 cells, each with a daily output of slightly over 300 lb. of caustic soda, or a total of eighteen tons. Fig. 2 is a more detailed view of one of these cells, which is of the long, low type of large capacity.

We find it expedient at Niagara Falls, with existing power costs, to run at exceptionally high current densities, about 100 amp. per sq.ft. of cathode, and hence use a little over four volts per cell during an average run, and an ampere or current efficiency of between 96 and 97 per cent. Owing to the circulating system which we use to maintain saturation, as well as the novel use of oil in the cathode compartment, we are able to obtain this efficiency with a caustic strength considerably above 125 g. NaOH per liter.

Another interesting group of cells is the corrugated type of low cell. The previous design was intended to give the maximum horizontal surface of cathode consistent with a large unit and the simplicity of the straight side plates. The cell was designed to crimp this plate accordion fashion and thus permit a much greater horizontal surface for the escape of gas within the same ground area. This was intended to reduce materially the voltage of the cell at the same current density.

In this bay of 5,000-amp. cells the result of lower voltage is fully accomplished and a natural saving is made in the cost of both installation and power. The design still requires some perfecting to work out a perfect diaphragm control and simplicity of renewal repairs. Consequently, while power costs are low, the chemical efficiency is not quite as good—say 93 or 94 per cent.

When it comes to a final monthly balance sheet with

CHART 2. PER CENT BY WT. AND GRAM/LITER SAT. NaCl-NaOH SOLUTIONS

Niagara Power costs the two groups run a very close commercial race, but there are other locations where a choice might clearly point to either one of the two types as the better.

A study of the cathode liquors from these different types of cells has led to some interesting results, which it is my hope to bring out in the paper which follows.

Cathode Liquor Data

Solutions saturated with NaOH and NaCl at various temperatures form the products which we are constantly handling in dealing with cathode effluent from diaphragm cells used in the production of caustic soda. Winteler has given a very full table showing the grams per liter of NaOH and NaCl as well as specific gravity of the solutions saturated at 20 deg. C. This table has been very freely used and is found in most of the literature, English, German and French, dealing with this subject. Engel has given a more limited series of observations not so generally used and based on determinations at zero and 15 deg. C.

I had occasion in 1911 or thereabout to use the figures of Winteler reduced to per cent by weight by use of his specific gravity determinations, and from these figures very slightly modified prepared a number of rather complete saturation curves. Some of these I had intended to use in this paper. However, experience has clearly shown that there were some material errors, particularly in the specific gravity determinations of Winteler. I have, therefore, re-determined many of these figures and submit new figures which I hope with your criticisms and corrections may form a substantial basis for future calculation. I might add that Winteler's figures considered only as grams NaOH and NaCl per liter agree closely to my own observations over the important range of the curve. The specific figures offer the serious difficulty. Engel's figures, in general, agree much more closely in all regards, although the range is more limited. Chart 1 shows the essential differences and corrections which I have made and use in subsequent charts. Chart 2 shows both per cent by weight

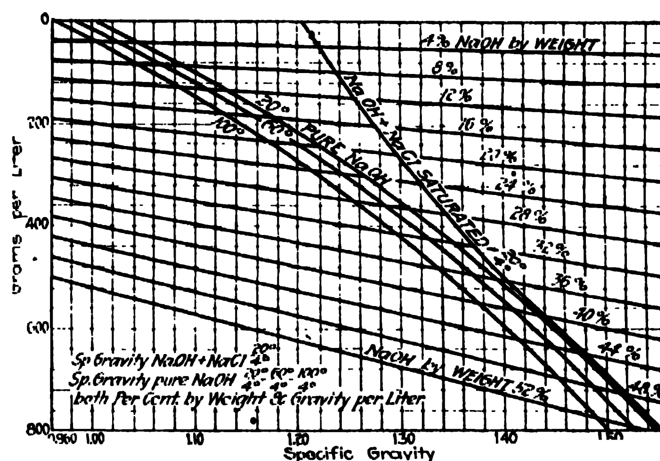


CHART 1. SPECIFIC GRAVITIES OF NaOH AND NaCl-NaOH SOLUTIONS

and grams per liter of saturated solutions of NaOH and NaCl at 20/4 deg., 60/4 deg., 100/4 deg. Chart 3 shows the corresponding specific gravities for these solutions. Chart 4 shows specific gravity 20/4 deg., 60/4 deg., 100/4 deg. for pure NaOH solutions, and, incidentally, for saturated NaOH and NaCl solutions at 20 deg. C. This chart I have purposely ruled to bring out one feature which I found was not generally considered by our chemists in preparing curves and which I find quite useful. If a sheet of cross-section paper is prepared showing grams per liter on the lower margin and specific gravity on the side margin, say with a range in specific gravity from 1.000 to 1.500, obviously a line ruled from 100 g. per liter at 1.000 specific gravity connecting 150 g. per liter at 1.500 specific gravity will represent a 10 per cent solution by weight at any intermediate specific gravity. A corresponding line from 120 g. per liter at 1.000 specific gravity to 180 g. per liter at 1.500 specific gravity will represent a 12 per cent solution by weight at any intermediate specific gravity and to paper ruled in this way can be transferred figures either in per cent by weight or grams per liter at will, and both readings can be made from the same chart. These figures for pure NaOH solutions at 20 deg. agree closely with Lunge's tables at 15 deg. with the necessary temperature correction. However, Lunge has published an extensive table showing the change in specific gravity with temperature. I cannot make my own observations agree with Lunge's as to change in specific gravity with temperature, hence offer these figures at 60 and 100 deg. for criticism and, I believe, correction of Lunge's figures. Chart 5 gives the specific gravity and per cent by weight and grams NaCl per liter over a full range from 20 to 100 deg. C. Chart 6 shows the solubility of chlorine in water and in brine of various strengths and a full range of tem-

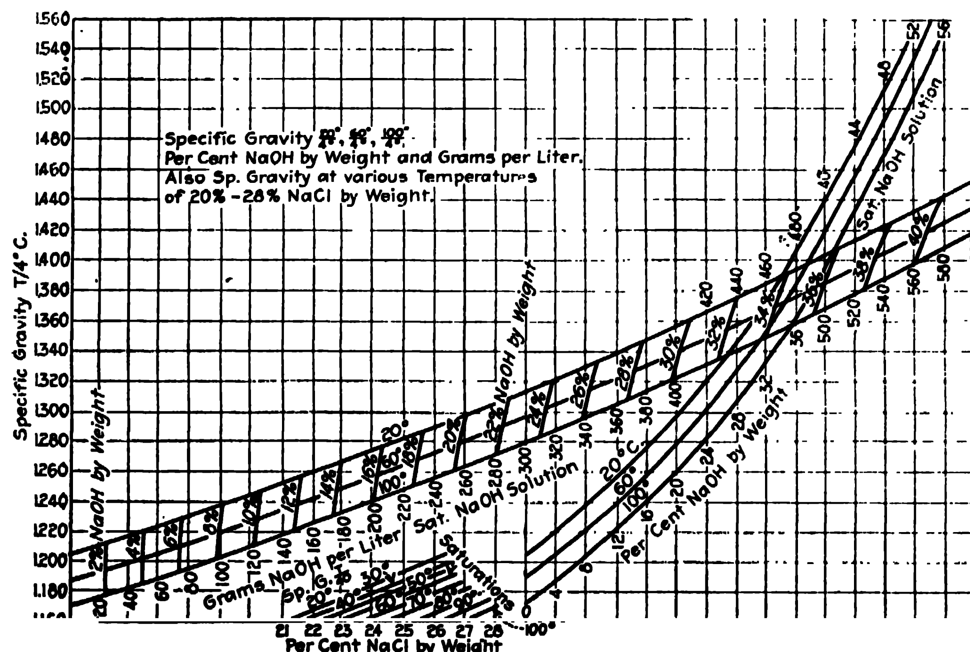
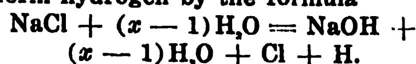


CHART 3. SPECIFIC GRAVITIES AT 20 DEG., 60 DEG. AND 100 DEG. C. OF NaCl-NaOH SOLUTIONS

peratures. Also the solubility in grams of chlorine per liter and the corresponding grams NaOH which would be converted by this chlorine into hypochlorite in the cathode compartment of a cell. These first six charts are presented as the basis for those which are to follow.

Economical Salt Decomposition

If we consider in rather simple terms the reaction which takes place on electrolyzing salt in a diaphragm cell we can express it after the sodium has decomposed water to form hydrogen by the formula



$$NaCl + (x - 1)H_2O = NaOH + (x - 1)H_2O + Cl + H.$$

In ordinary operations there is a certain ratio of salt decomposition which offers the greatest economy for a given cell—giving due consideration to the cost of power, coal, renewals, etc. This range is usually between 40 and 60 per cent salt decomposition. Assuming for consideration an intermediate figure of 50 per cent and the use of 25 per cent brine by weight, also a formula which will express the brine depletion in the anode compartment without resorting to transport numbers, we have the following:

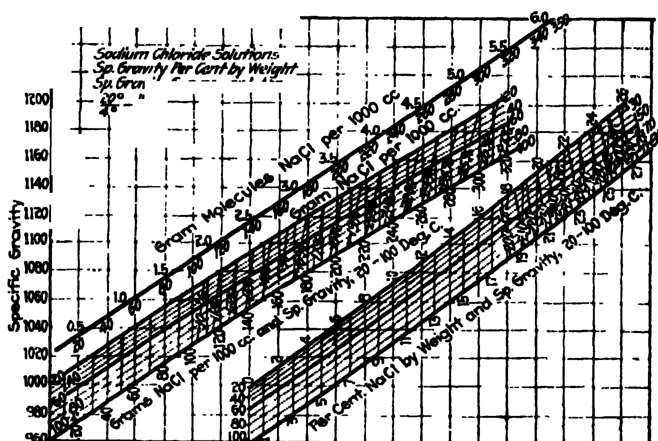
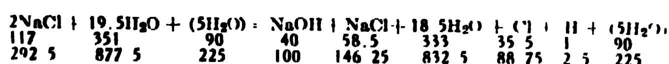


CHART 5. SPECIFIC GRAVITIES OF NaCl SOLUTIONS



$2NaCl$ +	$19.5H_2O$ +	$(5H_2O)$ =	$NaOH$ +	$NaCl$ +	$18.5H_2O$ +	Cl +	H +	$(5H_2O)$
117	351	90	40	58.5	333	35.5	1	90
292.5	877.5	225	100	146.25	832.5	88.75	2.5	225

FEED BRINE

292.5 NaCl = 25 per cent by weight
877.5 H_2O = 75 per cent by weight

1170.0 = 981 c.c = 298 g. per liter

CATHODE NaOH

100 NaOH = 9.27 per cent by weight 111.8 g. per liter
146.25 NaCl = 13.56 per cent by weight
832.50 H_2O = 77.17 per cent by weight

1078.75 = 894 c.c.

ANODE BRINE WITHIN THE CELL

292.5 NaCl = 20.96 per cent by weight
1102.5 H_2O = 79.04 per cent by weight

1395.0 243 g. per liter

We can entirely disregard efficiency in this formula and express the result in terms of product, and efficiency as the time or amperes needed to produce 100 g. NaOH.

Water and Salt Content of Cathode Liquor

Turning now to chart 7 we have charted the results of 20, 25 and 26 per cent solutions of NaCl by weight at any rate of decomposition in terms of H_2O and NaCl per 1,000 NaOH, which represent the simplest values for a direct commercial valuation of cathode liquors in terms of coal or evaporation costs.

Next on this same chart from our previous saturation curves are plotted saturated solutions of NaCl + NaOH at 20, 60 and 100 deg. Now, it is well known that the Townsend cell as operated at our Niagara Falls plant uses an extensive circulating system both to remove impurities in the brine and therefore increase the life and efficiency of the diaphragm and to maintain the desired degree of saturation within the cell at all times. We can thus obtain a cathode solution that is fully saturated at 20 deg. In fact, with a temperature of 60 deg. within the cell we can readily exceed this point, but care must be taken not to do this except to a slight degree, otherwise trouble results from salt deposits at various points.

Turning now to our chart we find the following results:

50 per cent decomposition	50 per cent decomposition
25 per cent brine	Brine circulated and saturated
1,000 NaOH	1,000 NaOH
1,462.5 NaCl	1,462.5 NaCl
8,325 H_2O	6,250 H_2O

This difference then is 2,075 lb. water per 1,000 lb. NaOH produced. Nor is this the only difference. We have seen that there was required 981 c.c. of 25 per cent brine to supply 292.5 g. of salt for 100 g. NaOH. In the original equation with the saturating system only 750 c.c. of brine would be supplied; the remaining salt would be added in the solid state to the saturating vault to be dissolved in the slightly depleted anode circulation.

Effect of Dissolved Chlorine

Now turning to our chart relative to the solubility of chlorine in brine we find that 1,000 c.c. of 21 per cent brine will dissolve 280 c.c. chlorine (760 mm.) = 0.8876 g. This, in turn, corresponds to 1 g. NaOH. Hence 981 c.c. would carry chlorine = 0.981 g. NaOH to the cathode compartment, thus reducing the product or efficiency by practically 1 per cent (the greater the feed of brine—viz., the lower the decomposition with a given brine—the greater the loss). Also 1,000 c.c. 25 per cent brine will dissolve 170 c.c. chlorine at 60 deg. = 0.539 g. = 0.60 g. NaOH; hence 750 c.c. = 0.45 g. lost NaOH — 0.45 per cent drop in efficiency; hence we are better off by fully ½ per cent in efficiency by maintaining saturation. These chlorine losses are also shown on chart 7 relative to efficiency.

Chemical Efficiency

There is another and much more vital factor in efficiency that this form of chart, which I believe is

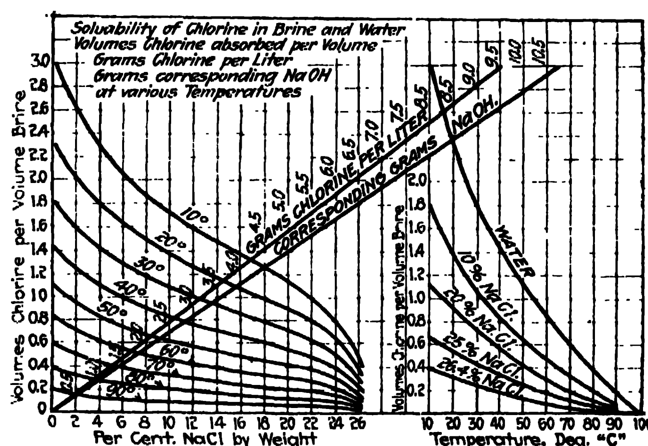


CHART 6. SOLUBILITY OF CHLORINE IN BRINE AND WATER

rather unique, permits of bringing out, and which permits of a very rational comparison of different cell performances—a study of diaphragm and general structural difficulties.

It is well known that over the ordinary working range of commercial operations with the same feed brine an increase in concentration of cathode caustic results in a decrease in efficency, other conditions being equal. (At extreme dilutions this curve reverses, owing to the solubility of chlorine in brine.) I have sometimes used as an entirely empirical formula from the observation of 33⅓ per cent decomposition—viz., 292.5 NaCl per 100 NaOH, 98 per cent ampere efficiency; 50 per cent decomposition—viz., 146.25 NaCl per 100 NaOH, 96 per cent ampere efficiency; 60 per cent decomposition—viz., 97.50 NaCl per 100 NaOH, 88 per cent ampere efficiency.

We must calculate our loss of absorbed chlorine separately as previously shown by the volume and strength of brine within the cell and the operating temperature. For example, an experimental cell operating at 20-30 deg. will have a much greater chlorine loss than a large cell maintained at a high temperature.

Taking all these factors into consideration our curves indicate an ideal efficiency of, say, 95 per cent with 60 per cent decomposition (a result I never have obtained), 97-97.5 per cent at 50 per cent decomposition and 97.5-98 per cent at 40 per cent decomposition. The intermediate curves point to commercial results of various

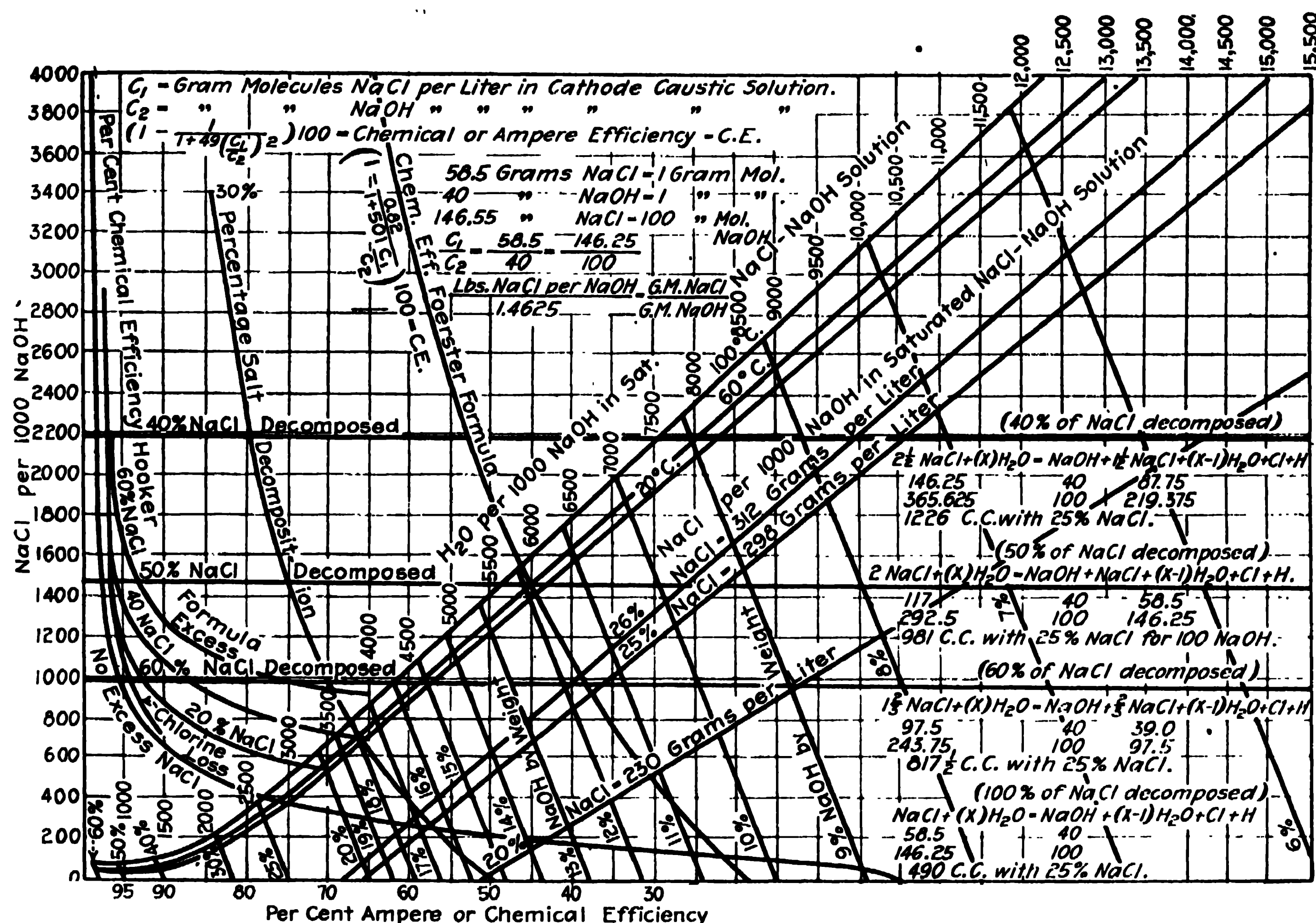


CHART 7. WATER AND SALT RATIOS TO NaOH. CHEMICAL EFFICIENCY

This, however, contains two variables working in opposite directions—viz., increase in inefficiency, due to increase in salt ratio, and decrease in efficiency, due to increase in volume of brine with dissolved chlorine as a loss. Hence I submit the following formula for chemical or ampere efficiency, with a perfect diaphragm and uniform percolation over its entire surface (this, of course, is only an approachable ideal):

C_1 = gram molecules NaCl in effluent cathode caustic
C_2 = gram molecules NaOH in effluent cathode caustic

$$\left(1 - \frac{1}{1 + 49\left(\frac{c_1}{c_2}\right)^2}\right) 100 = \text{chemical effi.}$$

40 per cent decomposition 60/40 = c_1/c_2 = 3/2 $(3/2)^2$ = 9/4 = 2.25, hen

$$\left(1 - \frac{1}{1 + 49\left(\frac{c_1}{c_2}\right)^2}\right) 100 = 99.1 \text{ chemical effic}$$

50 per cent decomposition 50/40 = c_1/c_2 = 1/1 $(1/1)^2$ = 1, hence 98 per cent chemical efficiency.

60 per cent decomposition 40/60 = c_1/c_2 = 2/3 $(2/3)^2$ = 4/9, hence 95.6 per cent chemical efficiency.

types and imply a mixed decomposition at various parts of the cell.

If we assume that for 100 g. of NaOH produced in unit time we feed 292.5 g. of NaCl—146.25 g. are decomposed and 146.25 g. remain with the effluent caustic at 50 per cent decomposition. This should result 97-97.5 per cent amp. efficiency according to whether we figure on a 25 per cent brine feed or saturation of the cathode caustic. Now suppose we find only 95 per cent amp. efficiency corresponding to 60 per cent decomposition, or 97.5 lb. NaCl per 100 NaOH; this means that 146.25 — 97.5 = 48.75 NaCl per 100 NaOH has passed through the diaphragm to the cathode caustic performing no really useful purpose. This would mean 194 lb. of 25 per cent excess brine to handle for every 100 lb. NaOH produced. There are many commercial cases far worse than this that could be cited. Probably no original diaphragm is at its best until a true "Schmutz Decke," as the water filtration people say, is formed,

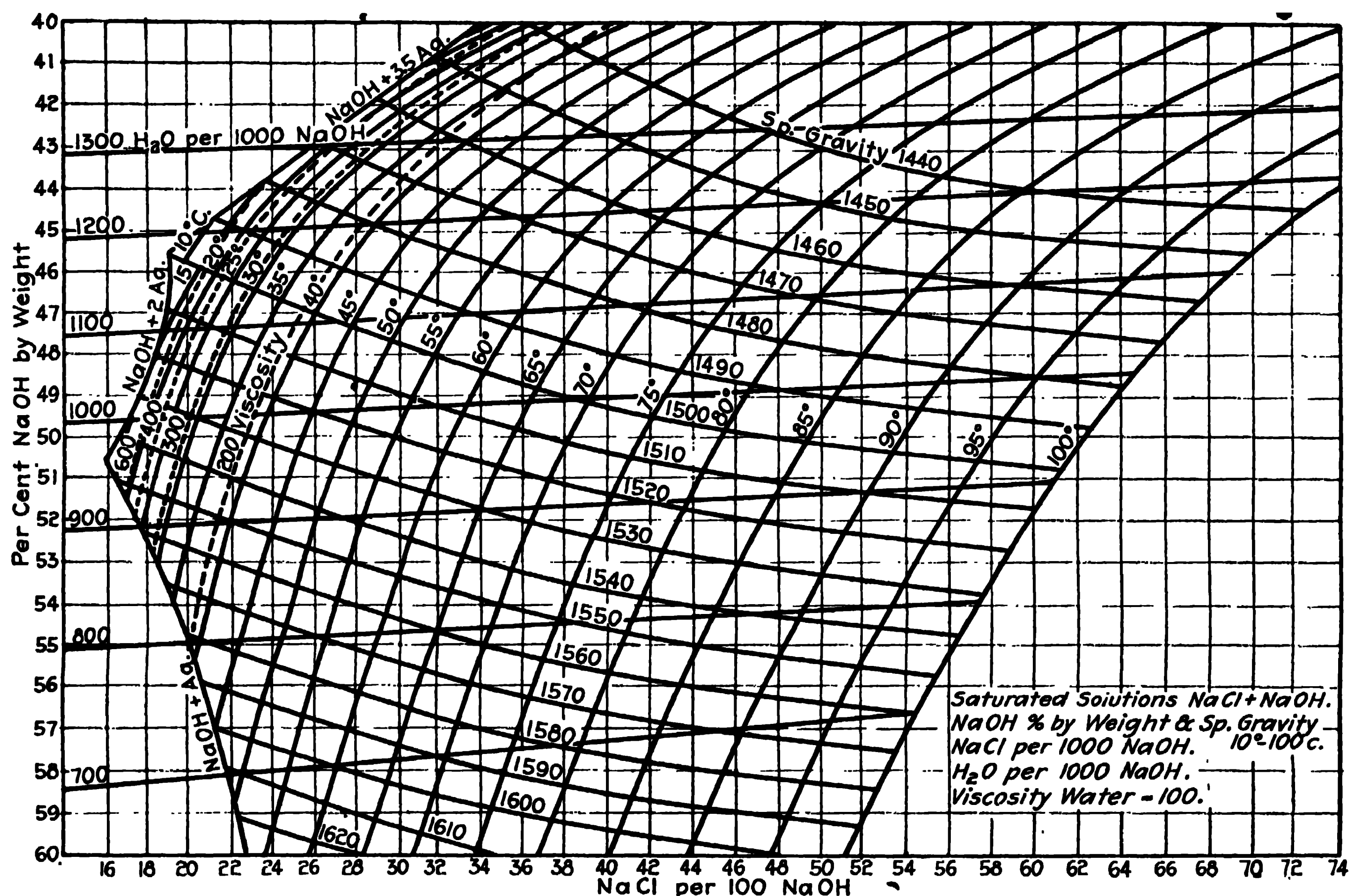


CHART 8. CONCENTRATION OF NaCl IN NaOH SOLUTION

and certainly it makes a material difference whether there is a varied flow and consequently varied decomposition at different heights of the same cell. I offer these provisional curves as a new basis for study in cell efficiency and performance.

Another useful function of chart 7 will, I think, appeal to Hugh K. Moore. I refer particularly to its use in connection with caustic evaporator problems such as he so ably described at the St. Louis meeting in 1917. This chart permits of following directly any caustic solution at any temperature from start to finish through the vacuum pans if we start with the product of 50 per cent decomposition and 25 per cent brine having a composition of 1,000 NaOH, 1,462 NaCl, 8,325 H_2O. We concentrate until we reach 1,000 NaOH, 1,462 NaCl, 5,600 H_2O—loss 2,725 lb. H_2O—before any salt separates out. After this there is a constant removal of salt and water in the proportion of about 2,800 lb. water per 1,000 lb. salt until we reach about 30 per cent NaOH by weight. Here the rate of salt to water changes, although we now have only 200 lb. salt left from our original 1,462 lb. per 1,000 NaOH.

Data on Concentrated Cathode Liquor

At about 50 per cent concentration we have approximately 60 lb. salt left for 1,000 NaOH and this cannot be materially reduced (as will be seen by the abrupt turn of the curve) by further concentration in the evaporators. However, commercial grades of finished caustic require a material reduction beyond this point. A glance at the curve shows that nearly two-thirds of the salt present at this stage at 100 deg. can be removed by cooling to 20 deg. As this is a somewhat critical operation, it becomes desirable to magnify the small fraction of our curve between 40 per cent NaOH and 60 per cent NaOH. I prepared an interesting curve on this order in 1911. I believe Mr. Barton of the Berlin Mills has a copy which I gave him. I am not sure that any other copies were given out. I know that Mr. Mantius of the Zaremba Co. used one of our copies on our work. This chart was quite complete, as you will see by the blueprint which I am circulating, and contained, in addition to the figures on chart 9 which I am showing, the resulting analysis from finishing certain grades of caustic liquor. I have purposely left these figures from the present chart, which is materially corrected to correspond to more recent results which have gradually accumulated showing some variation from the original. While it is true that lines can be introduced showing the finished grade, these will depend upon individual plant practice, partly as regards sulphate and carbonate, but particularly as to chlorate in the final liquors, hence are not constant. The figures for viscosity I prefer to use, not as I did on the old chart, but in a final chart which I will introduce.

Relative Percentages of Caustic and Salt

This chart 9 shows per cent NaOH by weight and per cent NaCl by weight, also specific gravity and pounds water per pound NaCl. It should be borne in mind that in cooling a saturated solution of salt and caustic the caustic water ratio remains constant while the salt ratio varies. Hence if we start at, say, 100 deg. with 1,000 NaOH, or 51 per cent NaOH, 900 H_2O, and 3.1 per cent NaCl, and cool to, say, 40 deg. we will still have 1,000 NaOH, but with 52 per cent NaOH, 900 H_2O and 1.18 per cent NaCl.

While this chart gives all the necessary information, I much prefer to use this information in the form shown in chart 8, which, I believe, is quite original in

CATHODE LIQUOR TABLES

20 Deg. C.

Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H_2O by Weight	Sp. G. 20°/4°	G. NaOH per Liter	G. NaCl per Liter	G. H_2O per Liter	NaCl per 100 NaOH	H_2O per 100 NaOH
0	26.4	73.6	1204		313	886		
2	24.73	73.27	1211 5	24 23	299.6	887.67	1236 48	3663.22
4	23.05	72.95	1219 5	48.78	281.09	889.63	576.24	1823.76
6	21.3	72.7	1228	73.64	261.56	892.76	354.96	1211.67
8	19.6	72.4	1237	98.96	242 45	895.59	244 99	904 80
10	18.05	71.95	1245 5	124.55	224.8	896.1	179 7	719.5
12	16.5	71 5	1255	150 6	207 08	897 3	137 5	595 8
14	14.98	71 02	1265	177 1	189 5	898 4	107	507 3
16	13.45	70.55	1275	204	171 5	899 5	84 1	440 9
18	11.9	70.1	1285 5	231 39	152.97	901 14	66 7	393 7
20	10 45	69 55	1296	259 2	135.4	901.4	52 2	347 7
22	9.05	68 95	1307 25	287.60	118.31	901.1	41 1	313 3
24	7 75	68 25	1318 5	316 44	102 2	899 9	32 3	286 2
26	6.5	67.5	1331	346.06	86.5	898 4	25	259 6
28	5 3	66 7	1343 5	376 18	76 5	895 1	19 0	237 9
30	4 29	65.71	1358 25	407 48	58 27	892 5	14 3	219
32	3.27	64.73	1373	439 36	44 9	888 74	10 2	202 1
34	2.6	63.4	1389	472 26	36 1	880 64	7 6	186 5
36	2 07	61.93	1405	505.80	29 1	870 1	5 7	172 2
38	1.75	60.25	1422 5	540.5	24 9	857.1	4 6	158 5
40	1 44	58.56	1440	576	20 7	843 3	3 6	146 5
42	1 26	56 74	1460	613 2	18 40	828 4	3 0	135
44	1.09	54.91	1480	651 2	16 1	812 7	2 4	124 8
46	1.01	52 99	1499 5	689 8	15 1	794 6	2.1	115 2
48	0.94	51 06	1519	731 1	14 3	773.6	1.9	105 8
50	0 91	49.09	1538	769	13 9	755 1	1 8	98 2
52	0 89	47.11	1559	810.68	13.9	734 42	1.7	90 59
54	0.87	45.13	1580 5	853 47	13 9	713 13	1.6	82 38
56	0.86	43.14	1603	897.68	13.9	691.42	1.55	77 01
58	0.85	41.15	1625 5	942.79	13.9	668 81	1 47	70 94
60	0.84	39.16	1649	989.4	13.9	645.7	1 40	65 26

60 Deg. C.

Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H_2O by Weight	Sp. G. 60°/–°	G. NaOH per Liter	G. NaCl per Liter	G. H_2O per Liter	NaCl per 100 NaOH	H_2O per 100 NaOH
0	27.0	73	1187		320.49	866.51		
2	25.3	72.7	1194 75	23 90	301.26	869.59	1260 50	3635.0
4	23 61	72 39	1202 5	48 10	283 91	870 49	590 24	1809.75
6	21 94	72 06	1210 5	72 63	265 58	871.29	365 66	1201
8	20 27	71 73	1219	97 52	247.09	874 39	253 37	896 62
10	18 7	71 3	1228	122 80	229 64	875 56	187 00	712.91
12	17 13	70 87	1237	148 44	211.90	876 66	142 75	590 59
14	15 61	70 39	1246 5	174 51	194.58	877 41	111 49	503 07
16	14 09	69 91	1256	200 96	176 97	878 07	88 06	437 43
18	12 6	69 4	1266	227 88	159 52	878 6	70 0	385 77
20	11 11	68 89	1277	255 4	141 87	879 73	55 54	344 45
22	9 76	68 24	1287 5	283 25	124·46	879 79	44 4	310 60
24	8 42	67 58	1299	311.76	109.37	877 87	35 08	281.58
26	7 20	66 88	1312	341.12	94 46	876.42	27 39	256 89
28	5 98	66 02	1325	372	79 24	873 76	21 30	234 67
30	4 97	65 03	1338	401 4	66 5	870 1	16.56	217 26
32	3 97	64 03	1352 5	432 8	53 69	866 01	12.40	200 09
34	3 37	62 63	1367 5	464 95	46 08	856 47	9.91	184.20
36	2 77	61.23	1384	498 24	38 34	847 42	7.51	170 08
38	2 46	59.54	1401	532 38	34 46	834 16	6 47	156 68
40	2 15	57 85	1419	567 60	30 51	820 89	5 37	144.45
42	1 98	56 02	1437.5	603 75	28 46	805 29	4 71	133.38
44	1 81	54 19	1457	641 08	26 37	789.55	4 11	123.16
46	1 74	52 26	1476.25	679 07	25 69	771.49	3 77	113.60
48	1.67	50.33	1496	718 08	24 98	752.94	3 48	104.85
50	1 64	48 36	1516	758	24 86	733.14	3 28	96.72
52	1 61	46 39	1536.25	798 85	24.86	712.54	3.11	89.19
54	1 59	44.41	1557	839 78	24.86	692.36	2 96	82.44
56	1 57	42.43	1578.5	883.96	24.86	669.68	2 81	75.75
58	1 55	40.45	1601	928 58	24.86	647.56	2 66	69 73
60	1.53	38.47	1624.5	947.70	24.86	614.94	2.55	63.11

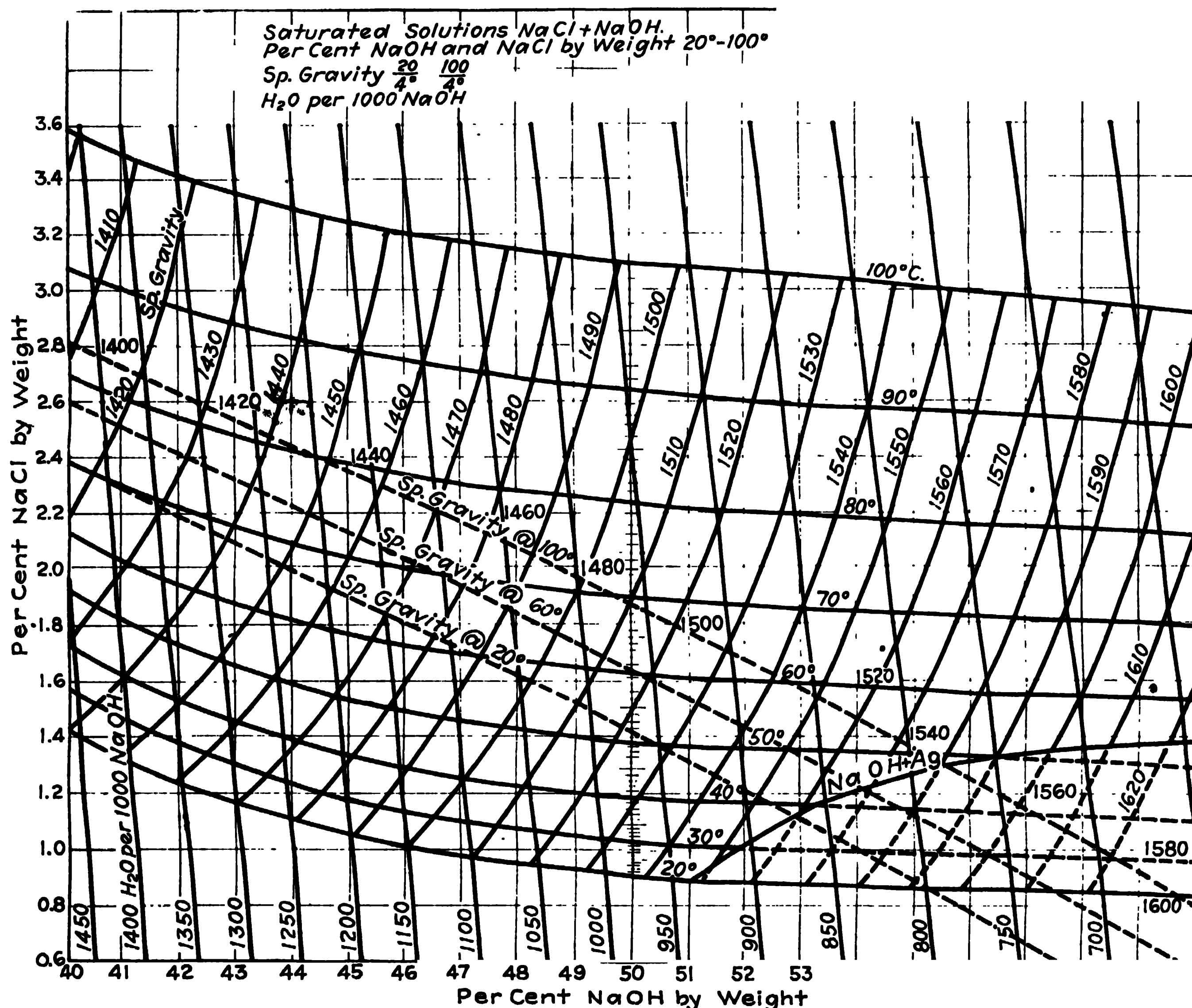


CHART 9. PERCENTAGE OF NaCl AND NaOH DURING CONCENTRATION

CATHODE LIQUOR TABLES—(*Continued*)

100 Deg. C.

Per Cent NaOH by Weight	Per Cent NaCl by Weight	Per Cent H_2O by Weight	Sp. G. 100°	G. NaOH per Liter	G. NaCl per Liter	G. H_2O per Liter	NaCl per 100 NaOH	H_2O per 100 NaOH
0	28.2	71.8	1170		329.94	840.16		
2	26.54	71.46	1177.5	23.55	312.50	841.45	1326.97	3572.82
4	24.88	71.12	1185	47.40	293.73	843.87	622.0	1778
6	23.20	70.80	1193	71.58	276.78	844.64	386.67	1180
8	21.52	70.48	1201.5	96.12	258.56	846.82	268.99	881.00
10	19.96	70.04	1210.5	121.05	241.62	847.83	199.59	700.39
12	18.4	69.6	1219.5	146.34	224.39	847.71	154.85	580.00
14	16.89	69.11	1229	172.06	207.68	849.25	120.70	493.50
16	15.38	68.62	1238.5	198.16	190.48	849.85	95.12	428.87
18	13.90	68.10	1248.5	224.73	173.54	850.23	77.22	378.33
20	12.42	67.58	1259	251.8	155.37	850.83	62.10	337.90
22	11.08	66.92	1269	279.18	140.60	849.22	50.36	304.18
24	9.75	66.25	1280.5	307.32	124.85	848.33	40.62	276.04
26	8.54	65.46	1292.5	335.05	110.38	846.07	32.84	251.76
28	7.33	64.64	1305	365.40	95.66	843.94	26.18	230.93
30	6.34	63.66	1318.5	395.55	83.59	839.36	21.13	212.20
32	5.35	62.65	1332	426.24	71.26	834.50	16.71	195.78
34	4.76	61.24	1347	457.98	64.11	824.91	14.00	180.11
36	4.17	59.83	1363	490.68	56.85	815.47	11.59	166.19
38	3.87	58.13	1380	524.40	53.41	802.19	10.18	152.09
40	3.57	56.43	1398	559.20	49.91	788.89	8.92	141.25
42	3.41	54.59	1417	595.14	48.32	733.54	8.12	129.97
44	3.26	52.74	1435.5	631.62	46.80	757.08	7.40	119.86
46	3.20	50.80	1454	668.84	46.53	738.63	6.95	110.43
48	3.14	48.86	1473	706.04	46.25	720.71	6.55	102.07
50	3.12	46.88	1493.5	746.75	46.60	700.15	6.24	93.76
52	3.07	44.93	1513.5	787.02	46.60	679.88	5.90	86.38
54	3.04	42.96	1534	828.36	46.60	659.04	5.62	79.50
56	2.99	41.11	1555	870.80	46.60	637.60	5.35	73.22
58	2.95	39.05	1576.5	914.37	46.60	615.53	5.09	67.31
60	2.91	37.09	1600	960.00	46.60	593.40	4.85	61.81

its arrangement, yet makes a most convenient form for arriving at the desired results in finishing caustic. If we start with a 51 per cent solution of caustic, this at 100 deg. will have a specific gravity of 1.503 and 1,000 lb. NaOH, 900 lb. H_2O, 62 lb. NaCl; cooling to 40 deg. C., we have practically 52 per cent caustic by weight, 1,000 lb. NaOH, 900 lb. H_2O, 22 lb. NaCl, specific gravity 1.550.

Our viscosity, which plays a very important part in the final time of settling of salt, is now practically 200 compared to water as 100. By still further cooling to 25 deg. C. we have a specific gravity of 1.560, a solution containing 1,000 NaOH, 900 H_2O, 18 NaCl, but our viscosity has reached nearly 400, making it practically impossible to settle out this last 4 lb. of salt. Also we are at the point of freezing or solidification for part of our solution, hence have passed the limits with this particular solution.

It is quite obvious that clear across this chart with 20 to 25 or 30 lb. of salt the same grade of finished caustic will result and could be plotted out. To this salt must be added the salt from decomposing chlorates, which varies with different plant operations. We have now passed from a cell liquor containing 1,000 lb. NaOH, 8,325 lb. H_2O, 1,462 lb. NaCl, to a solution containing 1,000 NaOH, 900 H_2O, 22 NaCl, and I think can safely leave the final finishing in the pots for another story.

Production of Leather From Rabbit Skins

Consul Norton writes from Sydney, Australia, that a secret process, said to be unknown hitherto to the tannery trade, has been discovered by an Australian for making leather from rabbit skins and recovering the fur as a byproduct for felt making. A company has been formed in Sydney to turn this discovery to practical use, having established works capable of handling about 100,000 skins a week. The leather has already been utilized in Sydney in the manufacture of boot and shoe uppers, hand bags, gloves and other articles.

Sugar Production in Mauritius

One of the unusual results of the recent situation in the American sugar market is the bringing of cane sugar to the United States from the small British island of Mauritius, off the east coast of Africa, says *Commerce Monthly*.

The share of Mauritius in the total sugar supply is not large, as the usual crop averages less than 2 per cent of the world's annual production. The output of about 240,000 metric tons annually represents the product of a highly concentrated industry carried on in one of the most densely populated regions of the world. With an area of 720 square miles, less than one-sixtieth of that of Cuba, the island devotes 176,000 acres to sugar plantations, or about one-eighth of the acreage in Cuba, recently reported as 1,385,000. The sugar crop of Mauritius for the past three years has averaged about 6 per cent of the Cuban crop. Production for the years from 1913 to date is shown in Table I.

TABLE I. PRODUCTION OF SUGAR IN MAURITIUS
(In thousands of metric tons)

Year		Year	
1912-13	213	1917-18 ...	226
1913-14	250	1918-19....	2[illegible]3
1914-15	277	1919-20 .	235
1915-16	215	1920-21	* 40
1916-17.	209		

* Estimat

Practically the entire crop is exported, as less than 10,000 tons a year is reserved for local consumption. As a rule the value of the sugar exported is more than sufficient to pay for the total imports received. Sugar accounts for 90 to 95 per cent of the exports, and molasses and rum are relatively large items in the balance.

During the war and the two following years the British Royal Commission on the Sugar Supply purchased the bulk of the Mauritius sugar and it is stated that the quantity contracted for in 1920 amounts to 200,000 tons.

TABLE II. SUGAR TRADE OF MAURITI
(In thousands of metric tons)

	Total Exports	Imports Into United Kingdom	Imports Into British India
1909-13 (average)	205	38	139
1914.......	289	71	145
1915	226	195	87
1916.	231	110	71
1917	191	52	26
1918	†197	100	33
1919	†260	181	78
1920	‡221	§104	24

*Total exports and imports into United Kingdom are for the calendar; while imports into British India are for the year ended March 31.
†Eleven months ended July 4.
‡Ten months ended May 14.
§First eight months.

Total exports of sugar from Mauritius and the amounts imported into the United Kingdom and British India from 1909 to date are shown in Table II.

The industry is carried on largely by French and Indian planters, the latter cultivating as much as 40 per cent of the total area in sugar cane. A syndicate represents the interests of the planters and it may later supervise purchases of machinery and other supplies. The development of the industry in the island has reached a flourishing state. Part of the cane area is irrigated and the fifty-nine sugar estates operate light railway systems to carry cane to the mills. Modern crystallizers and centrifugals are in use and there is an active interest in labor-saving machinery. It has been suggested that American manufacturers might find a market in Mauritius for sugar mill machinery, rails and tramway supplies.

Steel Rails From Sink-Head and Ordinary Rail Ingots—II

A Detailed Statement of the Disposition of the Metal From Ingots Used in This Test, as Demanded by Its Mechanical and Chemical Characteristics—Sink-Head Ingots Are Shown to Give Much More Uniform Metal Than Common American Types*

BY GEORGE K. BURGESS†

SINK-HEAD INGOTS

DUE to the uncertainty of the location of the sink-head junction, an arbitrary allowance has to be made in advance at hot saw or shears, or one risks having the A rails rejected. If the total top discard (bloom and rail) is adjusted to 13 per cent there will be no rails rejected on account of sink-head; if this is set at 8 per cent one would expect about one-half the A rails to contain surface imperfections caused by the sink-head and ingot junction. The sink-head alone entails on the average a discard of about 9.1 per cent of the Hadfield ingot, as is shown in Table VI.

The ingot usually enters the rolls with large end and sink-head first; there appears, however, to be no difference which end of ingot is first subjected to the "squaring up" pass. The presence of the sink-head appears to present no difficulties in either the blooming mill or rail mill. One ingot cracked at the bottom of the sink-head during rolling, but this was without effect on the passage of this bloom through the rolls.

Two of the thirty-five sink-head ingots (Nos. 18 and 4) examined as rails had pipes, detected in the mill, extending into the ingot 10 or 11 per cent, or to about 5 per cent below the sink-head in some cases (Table VI). All piping would appear to be eliminated with a discard of 11 per cent, which turns out to be very nearly that required to eliminate all sink-head imperfections and carbon segregation above 12 per cent (Table X).

COMPARISON INGOTS

As already noted, there were fifteen Maryland ingots in three groups of five each, of about 7,300 lb. each, top poured into ingot molds with small end up. They were rolled as portions of three heats on different dates, the total number of ingots in a heat being thirteen or twenty. The time of teeming into molds was about 35 sec. each and the temperatures are as shown in Table VII. The product from each heat thus forms a distinctive group and should be considered separately. The ingots were selected arbitrarily before being cast, it being agreed that five ingots would be taken and they were to be poured in succession after the second one of the heat. The heats were three of a series of rail steel from the ordinary output of the open hearth.

The first ten ingots, heats 2x4497 (ingots M1 to M5) and 1x3632 (ingots M6 to M10) were apparently made from rising steel, while ingots M1 to M15 of heat 2x4510 were from quiet or "killed" steel; ingots M6 to M15 were deoxidized with aluminum; ingots M1 to M10 were chilled on top, M1 to M5 with cast-iron caps, and M6 to M10 with water.

The effects of these differences in furnace and casting practice are very striking on the finished product. Thus the deoxidized flat-top ingots M11 to M15 show, as would be expected, pronounced piping; for this group, the average discard to physically sound steel is 26.5 per cent (Table VI) and ranging from 8.5 to 39.5 per cent. With this discard may be compared the discard of 5.2 per cent for the first Maryland group and 8.0 per cent for the second, and, except in two cases out of thirty-five, a negligible discard for piping below the sink-head of the Hadfield ingots (Table VI). The small discard (6.6 per cent) to sound steel for the average of the first two Maryland groups is, however, misleading, as there may exist internal or enclosed pipes—especially in the second or deoxidized group. In the first comparison group (ingots M1 to M5) one would ex-

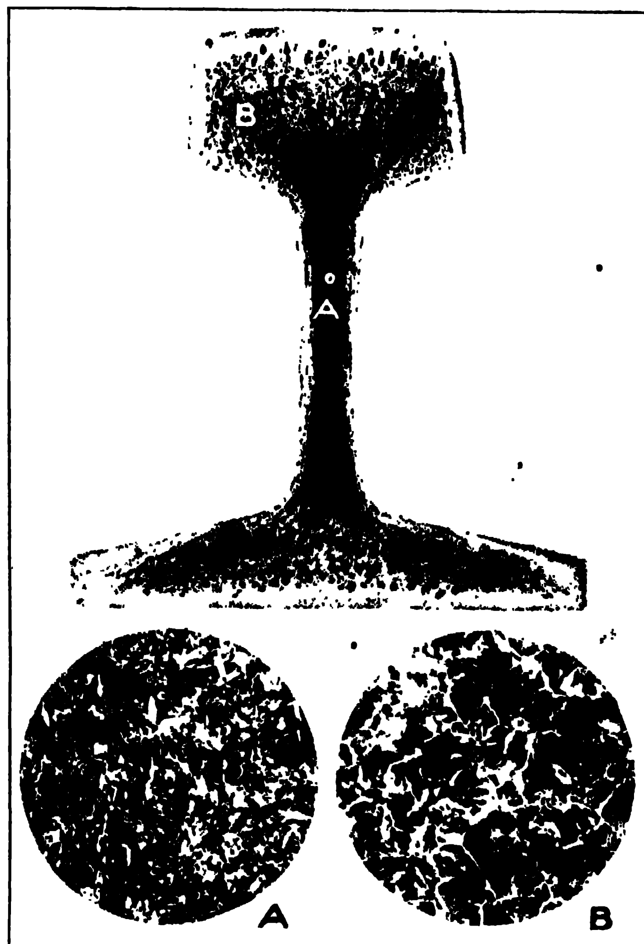


FIG. 3. RAIL M1-A
Sulphur print shows extreme segregation from top of ingot.
A—Moderately fine grained hyper-eutectoid segregation, pearlite with a trace of cementite and many small slag inclusions.
B—Moderately fine grained hypo-eutectoid structure, pearlite with a thick irregular ferrite network.

*For Part I see CHEM. & MET. ENG., vol. 23, No. 19, Nov. 10, 1920, p. 921.
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TABLE VI. DISPOSITION OF MATERIAL FROM INGOTS [1]

Ingot No [2]	Ingot Weight	—Bloom Crops— Top Weight	Bottom Weight	Weight of Test Pieces [3]	—Rail Crops— at Hot Saw [4] Middle No. 1	Middle No. 2	Bottom	X	—Weight of Rails [4]— A	B	C	D	E	Total Weight Rolled [5]	—Rolling Loss— Weight	Per Cent of Ingot	—Discard in Rail— Due to Sink-Head	Pipe	Total	—Discard to— Sound Steel [6] Wt.	Per Cent of Original Ingot	—Rail Material Available [7]— Wt.	Per Cent of Original Ingot	Per Cent of Net Ingot	Ingot No
Hadfield Ingots Rolled August 16, 1915																									
H24	5,300	185	297[10]	86	77	60	259	..	768	1,111	1,117	1,122	....	5,082	218	4.1	161	.	161	346	6.5	4,043[10]	76.3[10]	87.8	H24
H28	5,300	233	112	79	74	32	30	..	1,232	1,112	1,120	1,121	....	5,145	155	2.9	163	...	163	396	7.5	4,501	84.9	89.2	H28
H12	5,300	155	113	79	66	30	21	.	1,315	1,119	1,120	1,123	....	5,141	159	3.0	230	...	230	385	7.3	4,526	85.4	88.9	H12
H15	5,300	167	129	79	83	31	48	..	1,277	1,115	1,120	1,123	....	5,172	128	2.4	310	...	310	477	9.0	4,404	83.1	88.1	H15
H1	5,300	190	123	77	59	38	30	..	1,284	1,116	1,122	1,123	....	5,162	138	2.6	292	....	292	482	9.1	4,430	83.5	87.8	H1
H21	5,300	442	116	85	43	77	75	.	941	1,121	1,121	1,124	.....	5,145	155	2.9	162	....	162	604	11.1	4,230	79.8	84.8	H21
H9	5,300	294	131	79	46	75	89	.	1,096	1,121	1,117	1,119	.....	5,167	133	2.5	.....	....	.....	294	5.5	4,532	85.5	91.8	H9
H7	5,250	234	122	79	54	54	74	....	1,203	1,116	1,119	1,122	.....	5,177	73	1.4	235	....	235	469	8.9	4,404	83.9	88.2	H7
H35	5,300	280	161	77	46	48	50	....	1,172	1,113	1,115	1,118	.....	5,180	120	2.3	160	...	160	440	8.3	4,435	83.7	88.6	H35
H13	5,300	191	141	81	58	39	58	....	1,289	1,116	1,118	1,120	.....	5,211	89	1.7	80	..	80	271	5.1	4,644	87.6	92.7	H13
H22	5,250	437	123	81	47	45	54	....	1,032	1,116	1,117	1,122	.....	5,174	76	1.4	....	....	..	437	8.3	4,468	85.1	88.8	H22
H14	5,300	231	138	78	53	50	67	....	1,228	1,113	1,115	1,117	.....	5,190	110	2.1	284	....	284	515	9.7	4,368	82.4	97.5	H14
Hadfield Ingots Rolled August 17, 1915																									
H19	5,300	160	120	77	49	50	69	....	1,175	1,108	1,112	1,115	.....	5,035	265	5.0	326	....	326	486	9.2	4,261	80.4	85.0	H19
H26	5,300	160	130	75	47	53	70	.	1,226	1,108	1,110	1,112	.....	5,091	209	3.9	233	..	233	393	7.4	4,398	83.0	87.9	H26
H18	5,300	237	116	76	50	77	99	..	1,130	1,107	1,111	1,115	.....	5,118	182	3.4	.....	324	324	561	10.5	4,215	79.5	85.0	H18
H6	5,300	324	127	77	44	56	69	..	1,035	1,107	1,111	1,111	.....	5,061	239	4.5	158	....	158	482	9.1	4,283	80.8	85.5	H6
H23	5,350	134	131	78	49	79	100	..	1,183	1,102	1,105	1,109	.....	5,070	280	5.2	291	....	291	425	7.9	4,286	80.1	86.7	H23
H31	5,300	234	109	74	54	28	49	..	1,191	1,100	1,110	1,117	.....	5,066	234	4.4	237	....	237	471	8.9	4,355	82.2	86.0	H31
H29	5,350	566	123	77	44	63	78	..	867	1,107	1,111	1,111	.....	5,147	203	3.8	64	....	64	630	11.8	4,209	78.7	84.3	H29
H36	5,300	342	142	76	50	47	71	....	1,082	1,106	1,106	1,113	.....	5,135	165	3.1	73	..	73	415	7.8	4,410	83.2	88.4	H36
H4	5,350	270	123	71	50	46	56	....	1,228	1,106	1,107	1,111	.....	5,168	182	3.4	87	162	249	519	9.7	4,374	81.8	87.0	H4
H11	5,300	325	136	73	73	39	61	....	1,161	1,107	1,116	1,114	.....	5,205	95	1.8	254	....	254	579	10.9	4,317	81.5	86.4	H11
H12	5,350	204	124	74	54	60	97	....	1,194	1,101	1,107	1,114	.....	5,129	221	4.1	367	....	367	571	10.7	4,223	78.9	85.1	H12
H10	5,250	320	130	78	46	57	61	....	1,077	1,110	1,114	1,115	.....	5,108	142	2.7	148	....	148	468	8.9	4,346	82.8	86.8	H10
Hadfield Ingots Rolled August 18, 1915																									
H16	5,350	199	154	74	37	56	79	....	1,191	1,111	1,111	1,115	.....	5,127	223	4.2	305	....	305	504	9.4	4,297	80.4	86.4	H16
H20	5,300	276	122	73	43	66	72	....	1,175	1,107	1,111	1,113	.....	5,158	142	2.7	313	....	313	589	11.1	4,266	80.5	85.4	H20
H33	5,300	228	148	75	49	78	93	....	1,153	1,107	1,112	1,112	.....	5,155	145	2.7	281	....	281	509	9.6	4,278	80.7	86.7	H33
H17	5,300	145	117	74	53	73	93	...	1,269	1,107	1,113	1,115	.....	5,159	141	2.7	342	....	342	487	9.1	4,336	81.8	87.4	H17
H30	5,300	247	112	74	45	79	117	...	1,151	1,111	1,112	1,113	.....	5,161	139	2.6	270	....	270	517	9.8	4,291	80.9	86.8	H30
H27	5,300	245	97	78	57	63	71	....	1,229	1,119	1,120	1,121	.....	5,200	100	1.9	233	....	233	478	9.0	4,434	83.7	88.5	H27
H8	5,300	142	119	78	53	75	86	....	1,274	1,117	1,109	1,112	.....	5,165	135	2.5	346	....	346	488	9.1	4,344	82.0	87.5	H8
H3	5,300	205	115	71	81	55	65	...	1,204	1,103	1,106	1,109	.....	5,114	186	3.5	378	....	378	583	11.0	4,215	79.5	84.6	H3
H25	5,300	160	151	77	64	57	72	...	1,275	1,104	1,109	1,112	.....	5,181	119	2.2	340	....	340	500	9.4	4,337	81.8	87.5	H35
H34	5,300	195	166	83	58	43	57	...	1,157	1,105	1,115	1,113	.....	5,092	208	3.9	389	....	389	584	11.0	4,184	78.9	84.1	H34
Totals	179,700	8,357	4,519	2,623	1,856	1,879	2,540	....	39,464	37,749	37,859	37,946	......	174,791	5,519	3.0	7,512	486	7,998	16,355	9.1	147,643	81.9	87.9	..
Maryland Ingots Rolled August 16, 1915																									
M1	7,360	183	276	90	48	58	71	930	1,117	1,117	1,117	1,123	1,126	7,256	...	...	...	505	....	688	9.3	6,115	83.1	88.5	M1
M2	7,030	243	209	98	84	96	94	517	1,114	1,115	1,117	1,120	1,122	6,929	...	..	.....	....	.....	243	3.4	6,203	88.2	94.8	M2
M3	7,040	185	143	100	95	92	74	675	1,110	1,109	1,115	1,117	1,119	6,934	...		....	.	.....	185	2.6	6,345	90.1	95.8	M3
M4	7,130	189	226	95	147	81	37	660	1,108	1,108	1,115	1,116	1,120	7,002	...	.	..	336	.....	525	7.4	5,986	83.9	90.2	M4
M5	7,190	223	175	101	89	100	59	774	1,108	1,109	1,113	1,115	1,119	7,085	...	.	..	.	.	223	3.1	6,439	89.5	95.0	M5
Totals for heat 2 x 4,497	35,750																			1,864	5.2	31,088	86.9	92.8	
Maryland Ingot Rolled Aug. 18, 1915																									
M6	7,340	189	291	93	44	63	75	878	1,118	1,118	1,121	1,121	1,123	7,234	...	..	.	505		694	8.2	6,067	82.6	88.3	M6
M7	7,200	205	215	90	34	56	28	880	1,116	1,114	1,117	1,122	1,122	7,099	...	..	.	505	.	710	9.8	6,056	84.1	88.2	M7
M8	7,260	188	215	90	60	59	73	888	1,111	1,112	1,122	1,120	1,120	7,158	...	..		163		351	4.8	6,400	88.1	93.5	M8
M9	7,240	225	252	93	23	59	94	783	1,118	1,118	1,122	1,123	1,125	7,135	...			336		561	7.7	6,146	84.8	90.4	M9
M10[8]		3,315	230	79	.	68	140	....	...	...	1,115	1,116	1,117	7,180	...					.	.	.	.	..	M10
Total for heat 1 x 3,632	29,040																			2,316	8.0	24,669	85.0	90.2	
Maryland Ingot Rolled Aug. 19, 1915																									
M11	7,510	664	236	96	36	87	145	591	1,102	1,106	1,111	1,110	1,116	7,400			..	1,515	.	2,179	29.0	4,717	62.8	67.4	M11
M12	7,340	288	254	89	48	76	115	826	1,105	1,103	1,106	1,108	1,111	7,229				336	..	624	8.5	6,112	83.2	89.2	M12
M13	7,190	490	175	88	42	29	123	625	1,101	1,101	1,104	1,104	1,106	7,088	.	....		2,356	.	2,846	39.5	3,873	53.8	56.7	M13
M14	7,320	379	210	95	37	80	127	775	1,099	1,099	1,104	1,101	1,103	7,209		..	.	1,682	.	2,061	28.2	4,694	64.1	68.3	M14
M15	7,480	236	235	96	69	70	123	1,011	1,103	1,106	1,107	1,109	1,108	7,373		.		1,815	.	2,051	27.4	4,825	64.5	69.1	M15
Total for heat 2 x 4,510	36,840																			9,761	26.5	24,221	65.8	70.2	
Totals for all Maryland Ingots	101,630	3,887	3,112	1,314	856	1,006	1,238	10,813	15,530	15,535	15,591	15,609	15,640	100,131	...	....	.....	10,054	....	13,941	13.7	79,978	78.7	83.8	

1 Discard made only to physically sound steel. 2 H5 not included in this table, as the top bloom from this ingot was sent to the Bureau of Standards. 3 Test pieces 6-in. long were cut, according to Fig. 2. 4 See Fig. 2. 5 Weight of rails plus rail crops, plus test pieces, plus bloom crops. 6 Rail discard due to sinkhead and pipe plus top bloom crop. 7 Weight of rails plus test pieces, minus discard to sound steel. Thus it includes physically sound steel only, whether or not the chemical segration exceeded 12 per cent. 8 Top bloom of M10 split for examination. 9 For M6 to M9, inclusive. 10 An excess crop was accidentally made at the bloom shears.

TABLE VII. POURING TEMPERATURES OF COMPARISON INGOTS

Ingot No.	Heat 2x4510 Temp., Deg. C.	Ingot No.	Heat 2x4510 Temp., Deg. C.
M6	1,596	M11	1,545
M7	1,587	M12	1,538
M8	1,564	M13	1,540
M9		M14	1,528
M10	1,578	M15	1,531
Average	1,581	Average	1,536

pect to find a spongy segregated structure in the upper part of ingot. This is brought out in some of the sulphur prints of rail from the upper part of the ingots of this group, a typical one being shown in Fig. 3.

Of the first group, M5 contains a very pronounced pipe near the bottom of the ingot in the F position (Fig. 6). The question may be raised as to whether the practice of chilling the ingot top does not tend to produce internal pipes which may be distributed anywhere along the center line of the ingot.

The phenomenon of segregation, which is intimately allied to the furnace and casting practice for the Maryland ingots, is discussed separately. The mechanical properties, as brought out by the several tests, ultimate strength, yield point, elongation, reduction of area, hardness and drop test, show less dependence on the processes of manufacture, as will be brought out later.

TABLE IX. CARBON SEGREGATION IN RAILS FROM SINK-HEAD INGOTS

Ingot	Rail A Per Cent	Rail B Per Cent	Rail C Per Cent	Rail D Per Cent	Rail E Per Cent
H1	13.02	0.15	3.75	-4.59	1.23
H2	9.44	0.00	-2.67	-6.77	-1.60
H3	11.65	5.53	-3.89	7.42	0.79
H4	16.49	4.83	-3.82	3.41	0.62
H5			1.29	1.30	0.44
H6	9.25	4.86	-1.73	6.40	2.78
H7	19.79	0.30	-1.95	-0.15	0.60
H8	3.34	1.68	-0.15	-5.20	1.57
H9	23.77	4.87	-1.12	-6.20	0.34
H10	20.63	2.17	0.31	-4.54	3.09
H11	4.69	3.74	0.32	5.16	0.32
H12	2.16	1.44	2.41	6.52	0.57
H13	46.69	3.11	4.35	1.27	2.79
H14	2.48	1.49	0.00	4.32	0.30
H15	7.83	4.08	4.63	1.18	1.63
H16	13.93	4.52	2.33	9.74	1.41
H17	1.50	4.75	1.22	-5.33	3.29
H18	5.20	1.96	0.30	3.46	2.14
H19	9.66	2.85	0.00	7.28	0.81
H20	1.04	2.60	1.96	5.07	1.73
H21	11.91	1.66	0.75	0.45	2.61
H22	2.67	0.75	0.31	3.48	0.30
H23	24.35	0.77	-1.69	4.09	-1.42
H24	21.94	2.26	2.88	2.93	4.55
H25	5.17	2.68	1.52	2.56	2.73
H26	34.16	0.60	1.22	7.11	0.92
H27	4.76	1.38	0.00	4.48	3.09
H28	26.77	2.97	3.12	5.43	0.16
H29	10.50	3.58	-1.72	-7.55	0.49
H30	15.57	2.54	0.47	4.38	0.97
H31	12.89	2.95	0.31	3.70	0.62
H33	3.83	2.06	7.41	-2.68	0.60
H34	10.11	6.75	2.72	5.16	2.96
H35	10.33	3.32	5.11	6.16	1.46
H36	15.48	2.37	2.54	4.59	0.96
Average,	+12.73	+2.32	1.27	4.48	+0.40
Average deviation from mean	±7.48	±1.35	±1.68	±1.81	±1.42

TABLE VIII. MECHANICAL AND CHEMICAL CHARACTERISTICS OF RAILS

		Mechanical Tests					Chemical Tests: Carbon			Chemical Tests: Sulphur	
Rail No.		Yield Point	Ultimate	Elongation	Reduction	Brinell Hardness	"O"[2]	"M"[3]	Segregation[4]	"O"[2]	"M"[3]
H-A	Average = A_A	62,074	125,986	14.5	23.48	259	0.652	0.733	+12.73	0.047	0.050
	Δ[1]	1,585	2,342	0.7	1.25	6	0.018	0.044		0.003	0.005
H-B	Average = A_B	63,212	126,381	13.3	23.89	264	0.649	0.664	+2.32	0.047	0.048
	Δ	1,206	2,027	0.9	1.50	8	0.016	0.018		0.004	0.005
	$A_B - A_A$	+1,138	+395	-1.2	+0.41	+5	0.003	0.069		0.0	-0.002
H-C	Average = A_C	62,941	126,054	13.6	24.30	260	0.653	0.644	-1.27	0.047	0.046
	Δ	1,109	2,130	0.7	1.18	9	0.017	0.017		0.003	0.003
	$A_C - A_A$	+867	+68	-0.9	+0.82	1	+0.001	-0.089		0.0	-0.004
H-D	Average = A_D	63,029	126,158	13.6	24.47	260	0.650	0.621	-4.48	0.047	0.044
	Δ	1,310	2,381	0.7	1.14	7	0.017	0.022		0.004	0.004
	$A_D - A_A$	+955	+172	-0.9	+0.99	+1	-0.002	-0.112		0.0	0.006
H-E	Average = A_E	62,264	124,303	14.2	25.70	256	0.637	0.639	+0.40	0.046	0.046
	Δ	1,418	2,900	0.8	1.63	10	0.019	0.023		0.004	0.004
	$A_E - A_A$	+190	-1,683	-0.3	+2.22	-3	-0.015	0.094		0.001	0.004
All Hadfield rails	Average	62,704	125,771	13.8	24.38	260	0.648	0.660	1.94	0.047	0.047
	Δ	1,326	2,356	0.8	1.34	8	0.017	0.025		0.004	0.005
M-A	Average = A_A	62,063	124,834	13.2	22.76	255	0.644	0.735	+14.41	0.091	0.106
	Δ	2,091	3,472	0.6	2.14	11	0.064	0.048		0.005	0.020
M-B	Average = A_B	63,979	128,786	11.9	21.73	260	0.665	0.697	+5.00	0.099	0.110
	Δ	840	1,488	0.5	1.19	4	0.031	0.109		0.002	0.008
	$A_B - A_A$	+1,916	+3,952	1.3	-1.03	+5	+0.021	-0.038		+0.008	+0.004
M-C	Average = A_C	62,050	126,220	13.5	23.92	251	0.660	0.644	2.42	0.098	0.096
	Δ	631	1,606	0.6	0.61	6	0.029	0.034		0.001	0.002
	$A_C - A_A$	-13	+1,388	+0.3	+1.16	-4	+0.016	-0.091		+0.007	0.010
M-D	Average = A_D	61,567	125,248	13.1	25.80	248	0.660	0.612	-7.14	0.099	0.090
	Δ	999	1,495	0.6	0.72	4	0.031	0.032		0.002	0.006
	$A_D - A_A$	-496	+414	-0.1	+3.04	-7	+0.016	-0.123		+0.008	-0.013
M-E	Average = A_E	59,726	122,523	14.3	28.79	243	0.638	0.573	10.40	0.095	0.082
	Δ	1,068	1,535	0.5	1.09	5	0.043	0.044		0.002	0.002
	$A_E - A_A$	-2,337	-2,311	+1.1	+6.03	-12	0.006	-0.162		+0.004	0.024
M-F	Average = A_F	58,826	119,663	15.5	31.68	242	0.611	0.616	+0.27	0.088	0.091
	Δ	1,052	2,049	0.5	0.71	8	0.017	0.040		0.002	0.003
	$A_F - A_A$	3,237	-5,179	+2.3	+8.92	-13	-0.033	-0.119		0.003	0.015
All Maryland rails	Average	61,368	124,545	13.6	25.78	250	0.645	0.646	+0.16	0.095	0.096
	Δ	1,113	1,941	0.6	1.01	6	0.036	0.051		0.002	0.006
M-1 to M-5	Average	60,783	122,352	13.5	26.26	245	0.620	0.631	+1.80	0.071	0.076
	Δ	1,873	3,068	1.2	3.53	9	0.020	0.064		0.006	0.012
M-6 to M-10	Average	60,757	124,792	13.1	24.03	250	0.636	0.665	+0.98	0.098	0.103
	Δ	1,416	2,151	1.2	3.13	6	0.024	0.038		0.004	0.010
M-11 to M-15	Average	62,431	126,258	13.8	27.17	255	0.661	0.641	3.12	0.116	0.114
		1,604	4,681	0.7	2.62	3	0.038	0.045		0.005	0.002

[1] Δ denotes average deviation from mean.
[2] Near tread—i. e., in upper corner of head.
[3] Top of web.
[4] Percentage of carbon variation in O and M analysis—i. e., (M − O) / O.

TABLE X. CARBON SEGREGATION IN RAILS FROM COMPARISON INGOTS

Ingot	Rail A	Rail B	Rail C	Rail D	Rail E	Rail F
M1	30 88	7.17	- - 8 80	5 07	- -12 34	-13 45
M2	30 39	27 55	0 31	- 7 73	13 06	3 93
M3	13 30	9 63	0 96	5 79	-15 20	4 44
M4	20 17	5 28	- 8 23	4 41	15 89	2 96
M5	16 85	3 37	1 25	7 61	15 24	10 75
M6	16 51	9 20	- 4 98	- 5 93	3 71	0.62
M7	19 34	5 07	3 68	3 44	- 8 79	0 00
M8	2 51	5 05	0 91	- 5 76	- 6 65	0 64
M9	9 15	5 38	0 73	- 8 27	- 1 42	- 5 91
M10			0 31	- 3 73	- 4 41	..
M11	3 08	0 87	- 4 95	8 69	11 78	1 16
M12	32 52	1 61	3 61	11 00	11 68	- 2 08
M13		- 1 98	- 5 31	7 12	13 82	- - 1 47
M14	4 74	- - 6 26	2 48	11 92	8 62	0 16
M15	0 15	3 07	3 73	10 66	11 09	2 61
Average,	+14 41	+ 5 00	2 42	7 14	10 46	+ 0 27
Average deviation from mean,	7 53	2 67	2 35	1 39	1 57	3 18

TABLE XI. DISCARDS IN RAILS FROM SINK-HEAD INGOTS

Ingot	A-rail Crop, Ft.	Cut for Segregation, Ft	Top Discard, per Cent For Segregation	Top Discard, per Cent For Soundness	Middle Discard, per Cent	Bottom Discard, per Cent	Total Discard for Soundness
H1	5	15	16 2		1 8	3 0	4 8
H2	5	10	12 3		1 8	2 5	4 3
H3	11	5	13 9		2 6	3 4	6 0
H4	5	15	17 5		1 8	3 4	5 2
H6	5	5	12 4		1 9	3 7	5 6
H7	5	10	14 0		2 1	3 7	5 8
H8	10	5	12 1		2 4	3 9	6 3
H9	5	10	15 0		2 3	4 2	6 5
H10	5	10	15 6		2 0	3 6	5 6
H11	8	5	14 3		2 1	3 7	5 8
H12	10	0		10 7	2 1	4 1	16 9
H13	5	10	13 0		1 8	3 8	5 6
H14	5	10	13 8		1 9	3 8	5 7
H15	5	10	12 6		2 2	3 3	5 5
H16	9	5	12 4		1 7	4 4	6 1
H17	10	0		9 1	2 4	4 0	15 5
H18	5	10	13 9		2 4	3 9	6 3
H19	9	5	11 8		1 9	3 6	5 5
H20	9	5	14 0		2 1	3 7	5 8
H21	5	5	14 6		2 3	3 6	5 9
H22	5	0	11 5		1 8	3 4	5 2
H23	8	5	10 6		2 4	4 3	6 7
H25	10	0		9 4	2 3	4 2	15 9
H26	8	10	14 3		1 9	3 8	5 7
H27	8	0	9 7		2 5	3 2	5 7
H28	5	10	13 8		2 0	2 7	4 7
H29	5	5	16 8		2 0	3 8	5 8
H30	8	0		9 8	2 3	4 3	16 4
H31	7	0		8 8	1 6	3 0	13 5
H33	8	5	12 5		2 4	4 6	7 0
H34	12	5	14 4		1 9	4 2	6 1
H35	5	5	11 6		1 8	4 0	5 8
H36	5	10	15 9		1 9	3 9	5 8
Average			11 5				7 2

Chemical Segregation of Ingots of Both Types

Each Maryland ingot furnished six and each Hadfield ingot four rails, as shown in Fig. 2.* In studying segregation in the "A" test piece it should be remembered that for the sink-head ingots this position is that of the drop test piece at about 9 per cent below the top (including sink-head), while for the comparison ingots the "A" test piece is at the junction of the "X" and "A" rails, or at 10.6 per cent from the top of ingot. They are placed in sufficiently similar position therefore for the comparison, except that 10.6 per cent of a comparison ingot (7,260 lb.) includes 770 lb. or 23 ft. of rail, while 9.6 per cent of a sink-head ingot (5,300 lb.) contains 509 lb. or only 15 ft. of rail. The "A" position in the comparison thus has an average rail discard 8 ft. greater than the sink-head ingot.

The "E" position of the rails from sink-head ingots should be compared with the "F" position of the comparison ingots, the sink-head "D" with comparison "E," the sink-head "C" with comparison "C" and "D," and the sink-head "B" with comparison "B."

*See p. 924.

Chemical Tests. Determinations were made of the amounts of carbon, sulphur, phosphorus, manganese and silicon at the "O" and "M" positions (Fig. 4) for test pieces (B, C, D, etc., of Fig. 2) of all the rails. "X" and "A" rails of the comparison ingots and "A" rails of the Hadfield ingots were broken in 5-ft. pieces and analyzed with results, the more typical of which are included in Table XIII. Some specifications contain a clause which provides for the rejection of rails when the "M" position shows a carbon content more than 12 per cent greater (positive segregation) or more than 12 per cent less (negative segregation) than the "O" position. In the present investigation all material showing more than 12 per cent positive or negative carbon segregation was considered as unavailable for rails. The railroad using this specification has found from experience that 12 per cent is the maximum safe limit of segregation.

For both types of ingot, as shown in Table VIII, the longitudinal segregation of carbon is very slight along

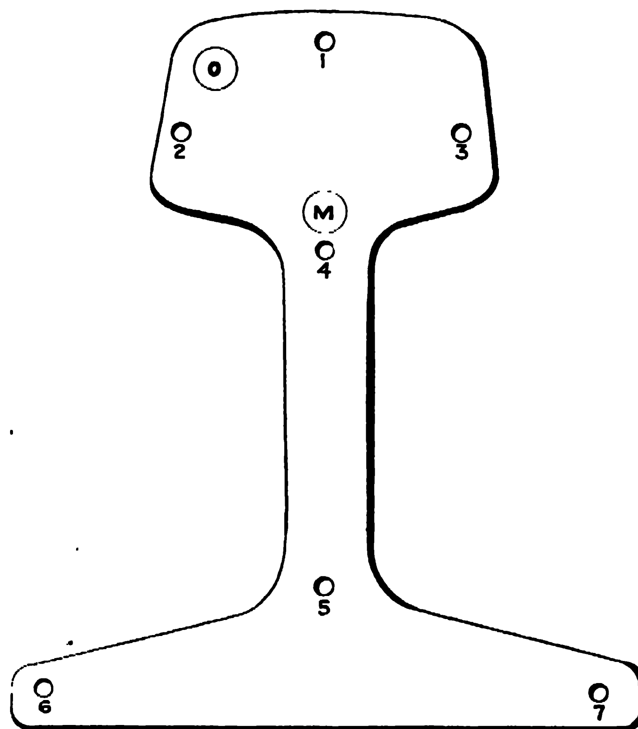


FIG. 4. 100-LB. PENNSYLVANIA RAIL SECTION SHOWING LOCATION OF VARIOUS TESTS

"O" is outer position for chemical analysis.

"M" is middle position of sample for chemical analysis and tensile test.

1 to 7 represent points where hardness was measured.

the "O" or tread positions, while for the "M" (top of web) positions, or along the center line of the ingot, it is quite marked, the carbon being greatest at "A" near the top of the ingot, decreasing to the "H-D" (or "M-E") position, and rising again as the bottom of the ingot is approached. The Maryland results are tabulated for the three types of ingot, but for this effect the type of ingot appears to play less of a role than for other factors.

The segregation of the sink-head ingots and of the three groups of ingots made with small end uppermost are discussed separately with reference to influence and method of manufacture.

TABLE XII. DISCARDS IN RAILS FROM COMPARISON INGOTS

Ingot	A-rail Crop. (Ft.)	Cut for Segregation (Ft.)	Top Discard, per Cent: For Segregation	Top Discard, per Cent: For Soundness	Middle Discard: For Segregation	Middle Discard: For Soundness	Bottom Discard for Soundness	Total Discard: Chemical	Total Discard: Physical
M1	5	60	31.9	..	32.0	..	4.7%	63.9	4 7
M2	5	40	24 8		34 5		4 3	59 3	4.3
M3	5	40	23.9		34 4		3 1	58.3	3 1
M4	5	40	23.7		34 5		3 7	58 2	3 7
M5	5	50	28 6		33 7		3 3	62 3	3 3
Average			26.6		33 8		3 8	60 4	3 8
M6	5	45	25.3	....		1 5	5 0	25 3	6 5
M7	5	30	23.7			1 3	3 9	23 7	5 2
M8	5	40	23 3			1 6	4 0	23 3	5 6
M9	5	40	23 8			1 1	4 8	23 8	5 9
Average,			24 0			1 4	4 4	24 0	5 8
M11	5		.	29.0		1 6	5 1	0 0	35 7
M12	5	30	19 8			1 7	5 0	19 8	6 7
M13	5		..	39.5	.	1 0*	4 1	0 0	44 6
M14	5	30	. .	28 2	.	1 6*	4 6	0 0	34 4
M15	5	35	.	27 4	.	1 9†	4 8	0 0	34 1
Average				26.8		1 6	4 7	4.0	31 1
Grand average								30.0	14.1

* M13 and M14 contain a trace of piping in B position.
† M15 has a small pipe at F.

SEGREGATION IN SINK-HEAD INGOTS

The sink-head ingots were of "piping" steel deoxidized with aluminum. Each is from a separate heat of converter steel.

These ingots are, in general, of remarkable uniformity as regards segregation (Table IX), thus showing the furnace and casting practice also to have been very uniform. At the "A" test piece 9.1 per cent below the top of the ingot on the average, the segregation, though variable, is always positive—i.e., the carbon content of the "M" position is greater than that of the "O" position. Fourteen of thirty-five ingots have a segregation greater than 12 per cent and three greater than 25 per cent; for one of these (H13), the "A" position is only 5.1 per cent below the top of the ingot (Table VI).

For these thirty-five sink-head ingots, the discard for segregation above 12 per cent is located 13.0 per cent plus or minus 1.86 below top of ingot, with a maximum of 17.5 per cent and a minimum of 5.1 per cent (Tables VI and XI).

SEGREGATION IN COMPARISON INGOTS

Group M1 to M5, Heat 2x4497. This heat has no aluminum addition in molds, and cast-iron caps were put on the tops of the ingots as soon as poured. It was found that the ingot tops were rounded after the steel had solidified; therefore they were made of rising steel not specially deoxidized in the mold. The ingots were stripped 20 min. after casting and remained in soaking pits from 2 hr. 10 min. to 2 hr. 23 min. This is about as rapid handling of ingots in the molds as it is possible to have, although the time in pits could have been lessened. The resulting composition and segregation is strikingly characteristic of the history.

The top of the ingot is characterized by high and variable segregation; thus the total top discard required to eliminate segregation above 12 per cent ranged from 23.7 to 31.9 per cent for the five ingots, as compared with a top discard of 2.6 to 9.3 per cent to the physically sound steel—i.e., free from pipe. Tables VI and XII.) Within this range of discard for segregation,

TABLE XIII. CARBON SEGREGATION ALONG TOP RAILS

Ingot		"O" Analysis	"M" Analysis	Segregation per Cent
Hadfield 1	Top	0.632	0.902	42.72
		0.649	0 789	21.57
		0.647	0 732	13 14
		0 650	0 683	5.08
		0.658	0 673	2.28
Hadfield 2	Top	0.610	0 967	58.52
		0.636	0 804	26.42
		0 635	0 705	11.02
		0 632	0 690	9.18
Hadfield 8	Top	0 649	0 758	16.80
		0 656	0.690	5.18
		0.657	0 673	2.44
		0.659	0.661	0.30
		0 654	0.662	1.22
		0.657	0 664	1.07
Hadfield 13	Top	0 627	0 786	25.36
		0 645	0.739	14.57
		0 649	0 664	2.31
		0 657	0.667	1.52
Hadfield 17	Top	0.667	0.699	4.80
		0.675	0.705	4.44
		0.669	0 686	2 54
		0.657	0.688	4.72
Hadfield 21	Top	0.676	0 809	19 67
		0.674	0 707	4.90
		0.680	0 708	4.12
Hadfield 29	Top	0 650	0 754	16.00
		0.646	0.682	5.57
		0.638	0.667	4.55
Hadfield 31	Top	0 646	0.717	10.99
		0.643	0.679	5.60
		0.647	0 657	1.55
		0.655	0.646	- 1.37
		0.658	0.668	1.52
		0.650	0.665	2.31
Maryland 1	Top "X" rail	0.489	0.619	26.84
		0 564	0.630	11.70
		0.554	0 731	31.95
		0.573	0 848	47.99
		0 579	0.808	39.55
		0 588	0.791	34.52
	Top "A" rail	0 816	0.750	21.75
		0 637	0.740	16.17
		0 629	0.707	12.40
		0 638	0.683	7.05
		0.631	0.717	13.63
		0.629	0.662	5.25
Maryland 2	Top "X" rail	0 511	0 886	73.39
		0 558	1.086	94.62
		0.602	0.915	51.99
		0 622	0.898	44.37
		0.630	0.894	41.90
		0.644	0 879	36.34
	Top "A" rail	0.619	0.849	37.16
		0.641	0 811	26.52
Maryland 5	Top "X" rail	0.589	0.672	14.09
		0 605	0 777	28.43
		0.621	0 927	49.28
		0.626	0 919	46.81
		0 652	0 844	29.45
		0.630	0 786	24.76
	Top "A" rail	0.647	0 761	17.62
		0 652	0 700	7.36
		0 658	0 734	11.55
		0 641	0.721	12.48
	Top "X" rail	0.618	0 685	10.84
		0 648	0.701	8.18
		0 662	0.754	13 90
		0.666	0 703	17.57
		0 677	0 807	19.20
		0.674	0.769	14.09
	Top "A" rail	0.684	0.766	11.99
		0.683	0.769	12.59
		0.690	0.727	5.36
Maryland 9	Top "X" rail	0.626	0 545	--12.94
		0 654	0 685	4.74
		0.671	0 746	11.18
		0.656	0.839	27.90
		0 700	0 841	20.14
		0 688	0.818	18.90
	Top "A" rail	0 699	0 800	14.45
		0 705	0 786	11 49
		0.706	0 764	8 22
		0 706	0.743	5 24
		0 703	0 735	4.55
Maryland 12	Top "X" rail	0 620	0 816	31.61
		0 671	0 830	23.70
		0.670	0 871	30.00
		0 701	0 887	26.53
		0.710	0.806	13.52
		0.699	0.778	11.30
	Top "A" rail	0 698	0.745	6.73
		0.692	0 713	3.03
		0.696	0 672	—3 45
		0.680	0.686	0.88
Maryland 14	Top "X" rail	0.714	0.684	—4.20
		0.711	0.742	4.36
		0.694	0.756	8.93
		0.700	0 781	11 57
		0.692	0.783	13 15
		0.705	0.776	10 07
	Top "A" rail	0 705	0.746	5 82
		0 706	0.736	4 25
		0.708	0.705	- 0.42
		0.682	0 679	- 0.44
		0.701	0 637	—9.13

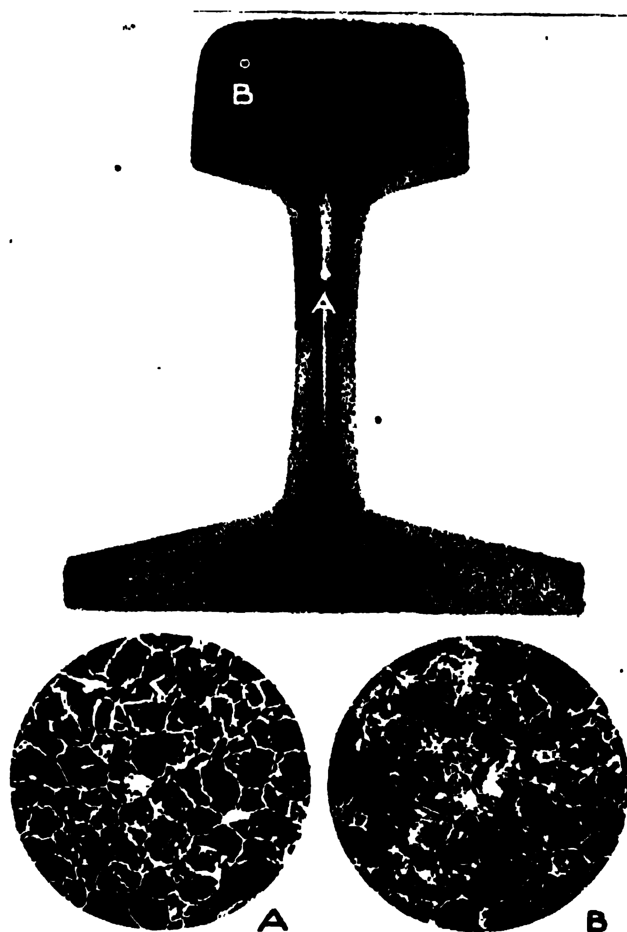


FIG. 5. RAIL M4-F

Sulphur print shows soft streak in web from bottom of ingot.

A—Moderately fine grained structure, pearlite with a thick irregular ferrite network, and ferrite clusters. Soft streak in web of rail.

B—Average moderately fine grained structure, pearlite with a trace of ferrite.

however, the segregation in a single ingot varied by enormous amounts, such as 26.52 to 94.62 per cent for ingot M2 and —7.36 to 49.28 per cent for ingot M5 (Table XIII). This type of ingot is also characterized in all cases by high negative segregation in the lower portion of the ingot, particularly marked at the "E" position, where it ranges from —12.34 per cent to —15.89 per cent (Table X). Except for M1, at the bottom of the ingot "F" position (—13.45 per cent, Table X), there is a reversal to relatively small positive segregation. All but M2 contain a well-marked soft streak at F, the bottom of the ingot, and in the case of M5 this streak encloses a very bad pipe (Figs. 5 and 6). The total material that should be discarded from this type of ingot for segregation ranges from 58.2 to 63.9 per cent (Table XII). Provision should be made for a larger bottom bloom crop than is customary, to eliminate both segregation and piping in the bottom of the ingot. The bottom rail and the one next the bottom of every ingot of this group (M1 to M5) should be discarded for segregation, and the bottom rail has in addition elements of physical weakness shown by the soft steel streaks which may enclose pipes.

Group M6 to M10, Heat 1x3632. The ingots of this heat had rounded tops on which water was put a few moments after casting; they were also treated, while being cast, with 2 oz. of aluminum per ton of steel. They were, therefore, of rising steel deoxidized in the molds, and should show somewhat greater tendency to piping than the first group; this is borne out by the results. The ingots of the second group required a discard averaging 8.0 per cent on account of pipe, while only one of the first group required a discard in excess of this amount (Table VI).

With respect to the "B," "C," "D," "E" and "F" positions for this group, the segregation is relatively low (max. 9.20 per cent, Table X) and uniform from one ingot to another as well within any particular ingot downward from the "B" position. The top discard for carbon segregation greater than 12 per cent (in "O" and "M" positions) is 23.3 to 25.3 per cent (Table XII) and within this discard the segregation is less extreme than in ingots of the first group, the maximum being about 25 per cent, which is attained in only two positions out of twenty-nine (Table XIII).

Group M11 to M15, Heat 2x4510. Two ounces of aluminum per ton was added to the ingots M11 to M15 for the purpose of deoxidation. The ingot tops, which were flat after pouring into molds, were not chilled with caps or water. These ingots were, therefore, of quiet, piping steel and apparently more nearly approach the type of steel represented by the Hadfield ingots than do the other two groups of Maryland ingots. They remained somewhat longer in the molds, 30 min. as compared with 20 and 23 min., before stripping and slightly longer in the soaking pits than the other comparison ingots.

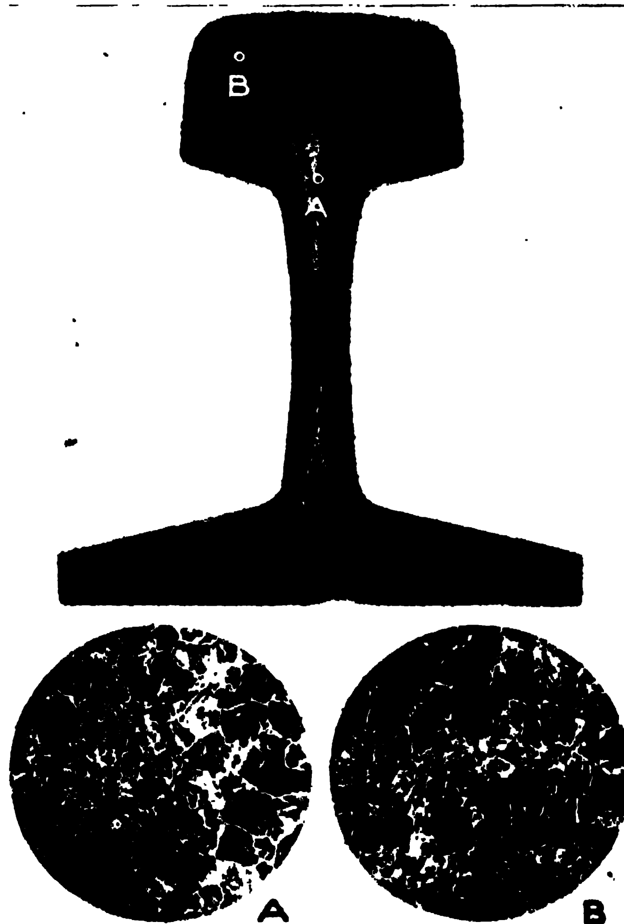


FIG. 6. RAIL M5-F

Sulphur print shows pipe in rail from bottom portion of ingot.

A—Structure along edge of bad pipe, eutectoid streak with large amount of slag bordered by hypo-eutectoid streak.

B—Average moderately fine grained structure, pearlite with a trace of ferrite network and slag.

The considerable piping at the top of the ingots of this group is very strikingly characteristic of the above open-hearth and casting practice. The carbon segregation in the upper half and at the bottom of this type of ingot is slight, but there is developed negative segregation, ranging about 11 per cent at the "D" and "E" positions (Table X). In contrast to the other two types of Maryland ingot, except for M12, which shows other anomalies, the extent of the top discard is determined by piping (average discard 26.8 per cent) rather than by segregation (average discard 16.4 per cent; Table XII). The metallographic examination shows a small pipe in rail M15 at the bottom of the ingot in the "F" position, and incipient piping in M13 and M14 at the "B" position.

A striking characteristic of this group (M11 to M15) is the freedom from segregation in the "A" position; excluding M12A for which the segregation at "A" is 32.52 per cent, the average for the others is about 2 per cent segregation at the "A" position (Table X). M12 also possesses the following irregular segregation characteristics; at "A" there is segregation to such an extent that the microstructure is that of a hyper-eutectoid steel; at "B," a narrow hypo-eutectoid streak; at "C" there is the same structure as at "A"; and again at "D" a heavy hypo-eutectoid streak.

Segregation of Elements Other Than Carbon. In general it might be expected that the elements sulphur and phosphorus would follow carbon in segregation characteristics, and that manganese, silicon, chromium and nickel would show little or no segregation. These expectations are borne out in both the sink-head and comparison ingots.

Detailed studies showed longitudinal segregation of phosphorus to be absent for the "O" (tread) position and slight for the "M" (web) position. There is practically no longitudinal or transverse sulphur segregation in the sink-head ingots, while for the comparison ingots, the results on sulphur segregation are erratic (Table VIII), but on the whole follow the carbon segregation.

For the elements manganese, nickel, chromium and silicon there is no well-defined segregation within the ingot.

Part III will be published in a subsequent issue.

Analysis of Samples of Ancient Armor

The analysis and microscopical examination of about one dozen samples of ancient armor from the Metropolitan Museum of Arts, New York, have been practically completed by the Bureau of Standards. The analysis indicates that all the samples were made from very pure wrought iron converted into steel by the old cementation process, as would be expected.

The carbon determination was made on the entire cross-section, as the material of all the pieces was too thin and corroded to obtain samples from different layers.

The microstructure indicates that the process used in the production of the original iron was very similar to our wrought-iron process. The metal was then carbonized, probably by a supplementary process, hammered into sheets, differing in hardness—i.e., in the amount of carburization—and these sheets were welded together.

The whole was then hammered into shape and quenched, thus producing the final hardening effect.

New Hydro-Electric Project in Scotland

A project is on foot—and is, in fact, already taking concrete form—for the utilization of the water power now running to waste in the watershed of the Tay, with a view to generating an increased supply of electric energy for the counties of Forfar, Perth and Fife in Scotland, reports Consul H. A. Johnson of Dundee. Two schemes having the same object in view have already been before the public. In the first instance the government, through its water-power resources committee, investigated the possibilities of the Highland lochs and received reports upon nine distinct undertakings, the most productive of which, from the standpoint of power, was that in central Scotland for the utilization of the energy of Lochs Ericht, Laidon, Rannoch and Tummel. These, it was stated, would be capable of developing a continuous supply of 42,000 electrical horsepower at a cost on a pre-war basis plus 50 per cent of £1,580,000 ($7,689,000).

The second was a project of the Dundee Corporation, which called for an expenditure of £4,000,000 to £5,000,000 (roughly $20,000,000 to $25,000,000), and under which it was proposed to utilize Lochs Ericht, Rannoch and Tummel. It was generally believed, however, that the task was too formidable for a city of the size of Dundee to undertake.

Features of the New Plan

The scheme now proposed is said to differ materially from those heretofore discussed. It appears that the matter now is in the hands of a group of business men and financiers, who have been investigating the possibilities of Lochs Ericht and Garry. It is claimed that from these two lochs alone 100,000 hp. can be developed with little difficulty, and this would be sufficient to furnish power and light to the three counties before mentioned. Italian engineers have been making extensive surveys through the Atholl Forest along Lochs Garry, Rannoch and Ericht. One of the noteworthy features of this new scheme is that there will be little damage to either sporting or agricultural interests, while under the Dundee Corporation scheme local opposition arose because of the destruction that plan involved. At this stage figures as to probable cost are not available.

Ultimate Results Expected

As to the ultimate results it is believed that there will be light, heat and power available for the three counties (which embrace the cities of Dundee, Perth, Forfar, Arbroath and Montrose) not only for the requirements of today but allowing for future expansion. It is understood that the company will not sell the power to the consumer but will bring it down to the various local authorities, who will buy it and distribute it themselves.

Manufacture of Fertilizers in South Africa

An explosives works near Cape Town is now erecting a large plant for the manufacture of fertilizers, which are very essential where agricultural industries are carried on in South Africa. Superphosphates, basic phosphates and nitrogenous fertilizers will be made. Small quantities will be available for the coming season. When the plant is running at full capacity—which will not be until next year—it will be capable of meeting the entire demand of South Africa.

Report of the Activities of the German Board of Trade During the War*

A Summary of the Official Board of Trade Report on the Conditions in Chemical and Allied War Industries, With Tabulated Data on the Wage Conditions and Accidents for the Period 1913-1918

THE extraordinary circumstances created by the war in the trades and industries have necessarily influenced the activities of the German Board of Trade. The reports of the Prussian Administration and Trade Authorities for the years 1914-1918 (official edition published by the Secretary of Commerce and Trade, Berlin, 1919) consist of a portly volume of 1,700 pages, giving an almost exhaustive account of the field of activity of the various officials of the Board of Trade and at the same time containing important documents on the German war industry.

The numerous articles in the German and foreign literature about the industrial production during the war have somewhat exhausted the subject; the official reports, however, treat matters from an entirely different standpoint. Much has been written about the important extension of the industries essential to war and of how astonishingly quickly the non-essential works had adapted themselves to the necessities of the day; but the influence of these changes and transformations on the general conditions of the working people is generally treated as a matter of secondary consideration. The official reports dwell at length on this influence. Page by page we are shown what efforts of all the interested parties were necessary, especially in view of the reduced personnel and the insufficiently trained substitutes to keep pace with the steadily increasing demands of the army and the war economy.

The fact that under such exceptional circumstances, aggravated by the steadily and increasingly depressing effects of the blockade, the accident-preventing measures and those for the hygienic protection of the workers did not suffer any noticeable impairment must be considered as a great feat for the German industry.

Special Activities of the Trade-Control Officials During the War

The normal activity of the Trade-Control officials during the period referred to was greatly burdened by the drafting of many of them into army service, and above all by the enlarged scope of their task, such as the examinations of the applications for leave of absence from the army and reinstatement in industrial work, the probing of applications for the release of confiscated materials and other such occupations benefiting the war departments to the detriment of the war industries. In addition these officials were called upon to give opinions and suggestions for the classification of the workers in very essential, essential and less essential occupations, to the co-operation in the care of war invalids, to help in the distribution of food, clothing and shoes, to handle the prisoners of war and even to handle the distribution of medals and certificates of distinction—activities which, as can be easily surmised, are largely foreign to the Trade-Control Service when functioning under normal conditions.

Interference of the Military Authorities in the Work of Trade Inspectors

The suddenness of the technical adaptation of many works for the production of ammunition brought the trade inspectors up against an accomplished fact before even they could take measures for the better security of the workers and of the population.

Complaints came in from the Government Trades Department of Potsdam that the military authorities had deliberately omitted to consult the trade inspectors about the advisability of changing certain works and that they encouraged many firms in their resistance against the trade officials. Similarly, reports came from the Department of Erfurt that most of the employers, encouraged by a circular from the Quartermaster General, considered that all the usual works safety measures were abolished. One may understand this procedure of the military authorities when the pressing demands from the "front" are recalled.

Accidents in the Explosives Industry

In the course of the war, improvements were gradually introduced in practically all the industrial branches, particularly in the explosives industry. Factory experiences were exchanged. This was largely brought about by the important services rendered by a central war control office and a committee for the superintendence of munition and explosives factories.

The reports published by the unions in the chemical industries of all the accidents which occurred in the empire were of great help in improving working conditions. If, for instance, in seventy works in the Department of Potsdam, where explosives were manufactured, manipulated and stored, seventy death cases occurred through fires and explosions, such a death rate could not be considered as high, particularly in view of the circumstance that among the thousands of drafted workers many were physically and professionally poorly qualified for this line of work.

The Köln-Rottweiler powder factories in Premnitz for the manufacture of nitro compounds, erected in the course of the war, are given as an example for the average accident occurrences in this industry. Thus, with an average working force of 3,000 employees, the following accidents occurred during the years 1917 and 1918:

	Kind of Accident		
	Slight	Serious	Fatal
Burns by spilling of acid	33	17	..
Burns through fires in the centrifuges	18	8	..
Burns through ignition of guncotton and powder	6	4	12
Burns through ignition of cannon charges	..		2
	57	29	14

*Abstracted and translated from *Chemiker-Zeitung*, July 11 and 17, 1920.

TABLE I. YEARLY WAGES IN MARKS IN INDUSTRIAL TRADES IN THE POTSDAM DISTRICT (TRADES GROUP VII)

		Workers Under 16 Yrs. Old			Female Workers Over 16 Yrs. — Time Work			Female Workers Over 16 Yrs. — Piece Work			Male Workers Over 16 Yrs. — Unskilled — Time Work			Male Workers Over 16 Yrs. — Unskilled — Piece Work			Male Workers Over 16 Yrs. — Skilled — Time Work			Male Workers Over 16 Yrs. — Skilled — Piece Work		
		1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917	1913	1915	1917
Greater Berlin District	State Institutions in Spandau	a500	900	1,100	700	1,200	1,800	900	1,600	2,300	1,200	1,500	2,200	1,700	2,400	3,700	2,000	3,100	3,700	2,200	3,900	4,700
		b600	1,100	1,200	900	1,500	1,900	1,000	2,300	3,000	1,500	2,200	3,000	3,300	3,300	3,900	2,100	3,400	4,500	2,400	4,700	6,900
	Other Greater Berlin Works	a400	700	1,200	600	1,000	1,500	900	1,600	1,700	1,000	1,800	3,500	1,600	2,400	4,000	1,900	3,200	3,800	2,000	3,400	4,100
		b600	800	1,500	800	1,500	1,800	1,200	2,100	3,200	1,500	2,400	3,700	1,900	2,900	4,200	2,300	3,700	4,400	3,000	4,100	5,200
Rural District		a400	500	800	500	700	1,000				800	900	1,200	1,500	2 300	2,300	1,300	1,600	2,400			
		b500	1,000	1,200	900	1,100	1,500				1,600	2,000	2,800	2,500	3,000	3,600	1,600	2,400	4,700			

a Average minimum wage. b Average maximum wage.

The reports of the Trade-Control Service bring out the details of these and similar accidents in many other works.

Development of the War-Time Wage Conditions

Special tabulated references are devoted to the development of the war-time wage conditions.

The increases in wages during the years of war appear relatively small when compared with the present scale of wages, which shows such an abrupt rise since the outbreak of the November, 1918, revolution. However, there was generally an increase of 100 to 150 per cent above the peace-time wages.

TABLE II. AVERAGE WAGES PER HOUR IN PFENNIGS IN BITTERFELD DISTRICT (TRADES GROUP VII)*

Trade	July 1914	July 1915	July 1916	July 1917	July 1918	Dec. 1918	Remarks
Locksmith	47	48	57	68	85	155	Add to this a bonus for children in some factories. During 1915 and 1916 the weekly bonus was 0.35 to 1.20 marks. During 1917 and 1918 the hourly bonus was 3 to 7 pfennigs.
Building	45	45	55	64	77	130	
Engineer helpers	42	42	49	56	69	127	
Factory workers	42	42	47	54	67	124	
Laboratory workers	38	38	45	56	69	118	
All round workers	34	34	41	48	67	113	
Youths			42	42	52½	65	
Female workers	..			37½	45½	80	

* Note the great increase in wages from July, 1918, to shortly after the signing of the armistice.

The developments in the wage conditions of today have their inception in the years of war—a fact which cannot be emphasized enough.

Tables I, II and III show examples of the average yearly, hourly and daily wages for workmen before and during the war.

Social War Work in the Industrial Districts

Great efforts were made by the War Industries Department to supply the workers with food and clothing in order to better their living conditions. For example, 10,000 persons were fed daily in two shifts by the Rheinische Metallwaren und Maschienfabrik. The Farbenfabriken vorm. Friedr. Bayer & Co. in Leverkusen spent during the war for such purposes the round sum of 4,500,000 marks for distributing daily 8,000 dinners and about 9,000 war soups. A big cloth factory in the district of Dusseldorf supplied its employees with large quantities of potatoes, cereals, milk, meats, etc., by leasing a 90-acre farm and also by cultivating the land around the factory. The Bergische Stahlindustrie in Remscheid established shoe-repair works and clothing depots for their workingmen and their families.

Many other similar examples are described.

The reports also contain a series of interesting details about the development of the social aspects in industrial works during the war.

Women as Industrial Workers

As a result of the increasing demands for men, a great proportion of the workmen was drafted for military service and practically all factories were forced to take in women as substitutes. This generally had good results. As a general rule the women were not required to do too hard physical work. Naturally they were primarily considered for work at which unskilled labor had been previously employed. In the course of the war, however, many of them acquired knowledge of trades and became skilled workers. Occasionally women (in automobile factories) succeeded in getting the necessary training for machining shafts and spindles from working drawings.

Many employers, to reduce the physical effort of their women employees, introduced mechanical devices for lifting and other similar devices which proved to give greatly satisfactory results, especially in the ammunition industry.

Special Lines of Work Performed by Women Industrial Workers

Among the many special lines of work performed by women may be mentioned the following: Adjusting small motors, blacksmithing and mechanical work, making dies for punching machines, making, assembling and adjusting turbines; in the wood industry, veneering; in the chemical industry, filling grenades, gas mines and bombs, manufacturing powder, rockets; in the sugar factories, beet weighing and at the apparatus for diffusion, saturation, evaporation and vacuum. In the iron industry women were sometimes employed for handling the steam hammers. In the powder fac-

TABLE III. AVERAGE DAILY WAGES IN MARKS IN THE COLOGNE DISTRICT

Month of July	Youths 1914	Youths 1917	Youths 1918	Unskilled Workers 1914	Unskilled Workers 1917	Unskilled Workers 1918	Trained Workers 1914	Trained Workers 1917	Trained Workers 1918	Skilled Workers 1914	Skilled Workers 1917	Skilled Workers 1918
EXPLOSIVE WORKS (AMMUNITION PLANTS)												
Men	1.75	9.00	11.00	....	15.50	17 00	4 68	17 00	19 00	5 00	10 50	12 00
Women	.	8 50	10.40	.. .	12.10	13.00		14.00	15 00			
OTHER CHEMICAL WORKS (ACID AND ALKALI PLANTS)												
Men	2.50	4.50	6.50	4.00	8.00	9.50	4.80	11 00	13 00	5 50	13 00	16 00
Women	....	3.00	4.00	....	5.00	6.50	....	. ...	....			.

tories they worked in the drying and mixing rooms, at powdering, screening, cutting and grinding machines; some women were employed to handle even the presses and in some instances they were called upon to handle the very dangerous kneading work.

The Control officials often made special mention of the courage women showed in performing very dangerous work.

TABLE IV. INFLUENCE OF THE WAR ON THE NUMBER OF ACCIDENTS

	Average Accidents Reported in 1912 and 1913 per 1,000 Workers					Average Accidents Reported in 1914 and 1915 per 1,000 Workers *			
	Slight	Serious	Fatal	Total	Percentage for 1913	Slight	Serious	Fatal	Total
Quarrying and excavating	320	24	7	351	1 866	198	18	3	21[illegible]
Group IV. Metallurgical industry, machines and apparatus	7,118	89	19	7,226	7.13	7,920	123	18	8,06[illegible]
Groups V and VI. Chemical industry	727	16	5	748	12 06	522	9	4	53[illegible]
Group VII. Textile industry	316	9	2	327	2.95	233	10	2	245
Group IX. Food industry	985	22	4	1,011	4.29	1,030	32	4	1,06[illegible]
Group XIII. All the industries and trades	11,791	248	50	12,089	5.62	11.798	240	42	12,080

* The percentage could not be figured out, as there are no reliable data on the number of employees during 1914

The law of Aug. 4, 1914, gave the legal permission necessary for women to be allowed to do overtime and night work. During the war all the factories worked on the two and three shifts plan, with the result that night work steadily increased.

Complaints came from time to time about the moral deportment of the women workers; the increase in earnings resulted in the very detrimental policy of spending excessively for luxuries and amusements. In spite of this, the help of the women workers will be remembered with a feeling of deep gratitude. The male substitutes brought into the factories by the law regulating the auxiliary service did not prove as efficient by far as the women substitutes.

War-Time Abrogation of the Child Labor Law

The occupation of youthful persons also was extended largely. Very often the strict execution of the legal child labor protection measures had to be overlooked. The conduct of the youths in the factories was the subject of many complaints. The apprentice institution was badly neglected. Numerous young people did not enter in a factory as apprentices, but entered directly in the war industries as helpers. Due to the prevailing need for workers, apprentices were kept doing regularly one and the same kind of helper's work and consequently they could not learn anything else of the trade.

The lack of raw materials in many branches caused the discarding of many trades altogether. In many cases the employers had to be reminded not to lose sight of the interests of the trade when normal times should arrive and afford to their apprentices a regular trade instruction.

Statistics of Industrial Accidents for the Period 1912-1918

As stated before, the hygienic condition of the various factories was very satisfactory when the exceptional conditions created by the war are considered. It is surprising to find that in those groups of industries which employed the largest number of workers and where the absolute number of accidents had naturally increased there was a lower relative percentage in the frequency of accidents. (See Table IV.)

This is explained by the fact that even in the branches of ammunition production, to which the trade-groups listed as V, VI and VII owe their powerful development, the number of persons employed in non-dangerous and easier kinds of work was the larger. Another cause of the low percentage of accidents in this line of work was the introduction of the method of working by shifts, which did not permit the workers to get overtired.

The relative number of accidents in factories with reduced personnel was much greater, due to the fact that the best and most reliable employees were lost either by drafting to the war service or by migration into ammunition industries, in consequence of which difficult work was often performed by unskilled substitutes.

Accidents Due to the Toxicity of the Materials Used

The fatal cases from poisoning by nitrous gases were relatively numerous, due to the increased number of plants for the production of explosives. The poisoning effect of the finished explosive materials in plants taking up the filling was generally not so apparent. Only dinitrophenol makes an exception, causing occasionally serious poisonings with quick fatal issue.

Nitroglycol should be treated more cautiously than nitroglycerine on account of its higher volatility. In manipulating it the workmen experienced at first a feeling of dizziness and blood congestion; later they became used to it.

Trinitroanisol produced dermatitis and eczema by the action of its dust particles on the unprotected skin. In a plant where the hygienically harmless trinitrotoluol was employed several persons died one after the other, all from acute atrophy of the liver. This was probably due to the use of a trinitrotoluol which was admixed with poisonous impurities.

Unpleasant skin eruptions occurred, particularly in summer time, at the plants using silver fulminate, but no serious poisonings ensued from this cause.

The toxicity of benzene is as a rule underestimated; it was employed on a large scale as a substitute for benzine and was not treated cautiously enough. Quite a number of death cases occurred in benzene depots and in laundries from this cause. Painters and varnishers suffered much through the vapors of benzene, which was an ingredient of their paints, particularly when confined to the narrow space of a ship. Similar hardships resulted at the manufacturing and manipulation of cellon varnish, which was extensively used for various purposes; the solvents for it (ketones, methanol, chloroform, ethyl formate) caused dizziness and fainting spells, also irritation of the eyes.

Accidents Due to the Use of Substitute Materials

The use of Ersatzmaterialien—substitute materials—led to unexpected accidents. The serious explosion which destroyed the trinitrotoluol factory of the chemical works Griesheim-Elektron, in November, 1917, was due to the overheating and burning of a nitrator. This accident, it is explained, was caused by the fact that the asbestos rope used for tightening the manhole cover contained a large admixture of cotton which had undergone a nitrification and ignited spontaneously.

. SOME IMPORTANT TRADES GROUPS IN THE POTSDAM DISTRICT

erage Accidents Reported in 1916 and 1917 per 1,000 Workers					Accidents reported in 1918 per 1,000 Workers					Number of Employees		
Slight	Serious	Fatal	Total	Percentage for 1917	Slight	Serious	Fatal	Total	Percentage	1913	1917	1918
145	14	2	161	2.59	183	14	1	198	2.96	18,830	6,216	6,678
,163	266	43	11,472	5.51	10,797	259	36	11,092	5.35	101,282	208,188	207,181
693	29	5	727	4.70	815	48	13	876	4.08	6,200	15,453	21,457
210	15	2	227	3.79	186	6	.	192	3.63	11,106	5,977	5,284
679	37	3	719	4.65	499	22	6	527	3.40	23,533	15,465	15,500
,570	452	63	15,085	5.29	14,004	436	68	14,058	4.95	215,195	285,199	292,947

d 1915.

In a compressed air plant a rather serious explosion occurred when instead of the war lubricating oil, which gave up considerable pitch, a cylinder oil of a 200 deg. C. flash point admixed with petroleum was used for the compressor; the petroleum probably formed an air mixture, igniting at 140 deg. C., the temperature of the exit air in the compressor.

The bad material for belting caused many accidents. Skin eruptions produced by oils assumed proportions unknown heretofore. They occurred on persons who had to work with substitute lubricating and drilling oils. The use of unfit substitutes and the lack of cleansing and washing articles were the main causes for it. Women particularly had to suffer from these annoying skin diseases, which appeared usually on the hands and forearms, but spread also to other parts of the body and very often caused fever and general impairment of health. In many works petrolatum was distributed as a protective ointment; linoxyl soap was recommended as a cleanser.

Other Accident Causes

A woman working at the turning bench of a cartridge factory had her celluloid comb take fire by a glowing steel chip and suffered in consequence serious burns.

At a plant manufacturing aceto-acetic ester two workingmen died from burns. The cause is explained by the fact that during the chemical reaction combustible vapors were given off and were ignited by the sparks of a passing locomotive.

In filling bottles with fluid hydrocyanic acid from steel containers an explosion occurred, killing two men; later on several more containers exploded—this time in the yard.

The report adds: "After thorough investigation, fluid hydrocyanic acid is to be classed as an explosive material and its use for the destruction of moths in mills appears doubtful." This remark goes too far and is misleading. Fluid hydrocyanic acid is under certain conditions sufficiently stable, but requires careful handling.

In some instances hydrogen was pumped, by mistake, into oxygen containers and this resulted in many accidents. The cause of the mistake was that the oxygen and hydrogen containers could not be clearly distinguished. This was remedied by making the containers and the caps of different diameters for the two kinds of gases.

Very little white lead was manufactured during the war, and on account of this few cases of lead poisoning were reported. There was an increase in lead poisoning cases in the printing trades due to the lack of washing materials. The Farbenwerke A.-G. in Dusseldorf took advantage of the standstill of their white-lead plant to introduce improvements not requiring manual labor in their oxidation chambers.

Liquid Air as a Blasting Material

Of special interest are the reports of the superintendents of the mining districts covering statements about the introduction of the air-blasting process and the accidents caused by it. As there was a big shortage of safe blasting materials from the beginning of the war, the use of liquid air as a blasting material started as early as 1915. According to the opinion of the inspecting officials, few of the accidents which occurred were due to the use of the new blasting method. The poor quality of the accessories—ignition cord, blasting capsules, spark plug—was the direct cause of many accidents in blasting with liquid air.

Use of Compressed Gas in Foreign Countries

A number of consular officers have made special reports on the use of compressed gas. These reports may be examined at the Bureau of Foreign and Domestic Commerce or its district offices.

Consul General Roberston, at Buenos Aires, Argentina, reports that it is used for various purposes. The gas is manufactured locally and the output of the factories is used by the entire republic. The machinery for its manufacture was originally imported from France and Germany. The consul general says that there should be a fair market for equipment for utilizing gases for industrial, hospital and laboratory uses. The most feasible method of marketing machines for gas manufacture or for its application industrially is by giving the representation to one of the large American commission houses which has the advantage of technical experts and knows the machinery market thoroughly.

Compressed gases are used in Ottawa, Canada, according to Consul General John G. Foster, in connection with industrial establishments and hospitals. The hospitals and the dentists obtain their supply from the dental-supply houses, the largest being in Montreal and Toronto. It is stated that these firms, which have branches in the principal Canadian cities, import all the gas and oxygen used from the United States. Importation is made in large cylinders, the gas being repumped into smaller ones for distribution.

Vice-Consul John C. Moomaw, at Bombay, India, writes that compressed gases are generally used by the principal engineering, shipping, dock and railway concerns in his district for welding and cutting metal; also in many of the hospitals. The gases are of local make, being supplied by a branch of a large British house, which also furnishes machinery and equipment for gas application.

In Sweden compressed gases are being used extensively for welding, according to a report by Consul Walter Sholes, at Goteborg. Shipyards and larger shops produce the gas in their own plants instead of buying cylinders with compressed gas. Machinery for the production of compressed gas was formerly obtained in Germany and France, but Sweden now supplies its own markets.

The Present Status of the Electric Furnace in the American Metal Industries*

Present Technology and Future Possibilities of the Electric Furnace as Applied in the Manufacture of Synthetic Cast Iron, Steel, Steel Castings, Ferro-Alloys, and in Heat Treating, Brass Melting and the Smelting of Non-Ferrous Ores

BY ROBERT M. KEENEY

THE development of the electric furnace to a position of great industrial importance during the last decade was one of the most noteworthy steps in the progress of metallurgy. In 1910 there were electrometallurgical power loads in about twenty-five cities in the United States and Canada. Today such a load is found in over 200 cities. Ten years ago so little was known of the characteristics of an electric-furnace load that few companies cared to have an electric furnace on their lines. Today, with an electric steel furnace in practically every manufacturing city in the country, the load is considered desirable and is much sought. The wide extension to so many communities is, of course, due mainly to the war. Although the number of steel furnaces installed during the past few years is far greater than could have been foreseen ten years ago, and although many were installed mainly for war purposes, it does not appear that there has been an overdevelopment in this respect. The quality of electric steel has become so well established that the electric process is here to stay, and it will probably eventually supersede other processes for the production of castings, and super-refining will be practiced on a large scale for treatment of molten bessemer and molten open-hearth steel. The electric furnace load of the United States and Canada for the production of steel, ferro-alloys, brass, zinc and silver amounts to approximately 800,000 kva.

PIG IRON

Although the electric smelting of iron ore was developed simultaneously in the United States and Sweden, and although in 1908 D. A. Lyon erected here in California, at Heroult, the first electric furnace to produce pig iron commercially, the process is no longer in operation in this country. Pig iron is being produced in the United States by electric melting of scrap, not by smelting iron ore. On the other hand, development in Sweden and some other countries has been steady. The furnace used is similar to the shaft furnace installed by Lyon in 1908, which is especially adapted for production of low-carbon and low-silicon iron, but not foundry iron. It operates best with charcoal as a reducing agent, and has proved a failure when operated with coke. The pit type furnace, with no shaft except charging spouts, operates satisfactorily with coke, and also produces foundry iron. The last two furnaces operated at Heroult were of the low pit type, and could be operated with coke and charcoal mixed for production of high-grade foundry iron. In 1910 there were in operation two electric iron-smelting furnaces of a total input of 3,500 kw. At the present time there are installed thirty-three electric iron-smelting furnaces of from 2,000 to 7,000 kva. capacity, with a total load of 100,000 kva. and a production capacity of 250,000 tons of pig iron per year. During the war production costs have favored electric smelting, so that electric pig iron is now being produced in Sweden for $5 per ton less than blast-furnace charcoal iron. This is in spite of an increase in power cost of 50 per cent which has raised the average cost of power from $8 to $12 per horsepower-year.

Electric-furnace production of pig iron will probably never develop to any great extent in the United States along the line of development in Sweden, because of the high cost of power, but I believe that the time is coming, particularly in the Western States, when pig iron, more specifically cast iron, will be made by melting of scrap iron, scrap steel, iron ore, coke and lime in the electric furnace to produce iron for direct castings or for pigs. During the war a considerable quantity of low-phosphorus pig iron was made in the United States and Canada by electric melting of steel scrap. The Canadian production in 1918 amounted to 32,200 tons. Toward the end of the year it was at the rate of 4,000 tons per month. Six plants were in operation in Canada and two in the United States. There seems to be a future for the process, especially in foundries where the cost of foundry pig iron is high, due to freight. I know of one mountain city where the foundries pay $55 per ton for pig iron laid down at their plants. Iron in the ladle could there be made by the electric process for $35 per ton.

The metallurgy of synthetic electric-furnace cast iron, as it is called, was worked out on a large scale in France during the war. Three plants were erected with a total power input of 40,000 kva. During 1916, 1917 and 1918 220,000 tons were made with metal cast direct from these electric furnaces, of which there were sixteen of from 1,000 to 2,200 kva. capacity. Power consumption is from 675 to 800 kw.-hr. per ton of cast iron. Any grade of iron desired can be produced. The process is conducted as a continuous operation, with the furnace kept full of charge. With a large unit the load is very steady, but it is probable that in the operation of small units there might be a tendency to momentary overloads. These would be no worse than in a steel-melting furnace. The power factor of the furnaces is about 80 per cent on sixty-cycle current. A phase voltage of 50 to 70 volts is used.

REFINING GRAY IRON

Another use of the electric furnace is in refining gray iron from the cupola. Cupola iron, after treatment in the basic electric furnace, shows a marked

*Read before the National Electric Light Association meeting at Pasadena, Cal., May 20, 1920.

decrease in sulphur and an increase in transverse strength. At present, because of costs, the process appears adaptable only for the very highest grade of castings. The electric furnace is also being used for the production of malleable iron castings. It has furthermore been considered as a mixer for keeping molten blast-furnace pig iron hot for casting it into pipes in ingots.

Steel

The most marked increase in the use of central station power electric furnaces during the past ten years has been in the electric-furnace manufacture of steel. In 1904 there were four small furnaces in operation in Europe. In 1907 there were sixty-seven furnaces in operation throughout the world. Of this total, seven were installed in the United States and Canada, with a total power input of 5,600 kva. and a charge capacity of forty tons per heat. On Jan. 1, 1920, there were installed or under construction in the United States and Canada 363 furnaces with a total charge capacity per heat of about 1,600 tons and a total power input of about 600,000 kva. Of the 363 furnaces, 323 were installed in the United States and 40 in Canada. The number of electric steel furnaces in the world is estimated at 875.

The production of electric-furnace steel in the United States in 1918 was 511,364 gross tons. Almost 50 per cent of the production was alloy steel. Of the 323 furnaces in this country 54.5 per cent are being used for castings. The percentage of the tonnage of 1918 produced as castings was 21.1 per cent of the total.

There has been a great development in the use of the electric-steel funrace for the production of ingot alloy steels for automobile construction and high-speed steel. The electric furnace operating with a basic lining produces tons of high-grade alloy steels per heat as compared with the crucible furnace producing pounds. Lower grade raw materials can be used because of the possibility of refining to remove phosphorus and sulphur. The furnace has proved particularly successful in the production of alloy ingots such as chrome : vanadium steel, turning out a product better in quality than similar open-hearth steel with a much lower loss of alloys by oxidation.

For the production of high-speed steel in large heats the electric furnace proved well adapted during the war, it being common practice to pour 5-ton heats of steel valued at $3 to $5 per lb. However, the substitution of the electric furnace for the crucible furnace will be gradual, because it is not yet demonstrated that average electric high-speed steel is quite equal in quality to the highest grades of crucible high-speed steel. To meet the grade of highest quality crucible steels, the electric-furnace product must be made from the purest raw material available, and even then, considering electric steel versus crucible steel from the conditions existing in each case, it does not seem possible that melting conditions can be as closely controlled in the electric furnace as in the crucible. This statement applies only where the operation is the simple melting of pure material.

A future probable large development in electric steel is the use of the furnace for finishing molten converter and open-hearth steel. The Illinois Steel Co. has installed ten 30-ton electric furnaces to treat steel which has been first blown in the bessemer converter, then held in the open hearth, and eventually transferred to the electric furnace. This process was used to a small extent in the early days of electric furnace steel production in this country, and a few years will probably see its general adoption.

Electric Steel Castings

In 1910 of the total production of electric steel in this country 2.53 per cent was as castings. In 1918 there was manufactured 108,296 tons of electric steel castings, representing 21.1 per cent of the total production of electric steel. Except for the manufacturers of high-speed steel, most companies producing alloy steels, such as chrome : vanadium steel, generate their own power, and do not buy from a central station, because the electric-furnace plant is usually a part of a large steel plant. This is especially true in plants using the duplex process for refining molten steel. On the other hand, practically all foundries buy their power. Electric-steel castings can now be made more cheaply than converter castings, and at as low a cost as open-hearth castings. The grade of the casting is better than the product of either of the other methods.

A great advantage of the electric furnace over the open hearth is the rapidity with which heats are made, so that it does not require handling of large quantities of metal as in the case of the open hearth. Within a few years the electric furnace will probably replace all other processes for making steel castings, and most castings will be produced without refining, by melting scrap on an acid bottom.

Aside from the fact that the skill shown in furnace operation may cause a low load factor, most foundries operate on a 10-hr. day instead of a 24-hr. day, so that with 10-hr. operation a load factor of 18 to 30 per cent is obtained. On a 24-hr. day the load factor will vary from 40 to 55 per cent when making castings. This low load factor, as compared with other electrometallurgical industries, is caused by time lost in charging and pouring when the power is off. Due to greater length of time between pourings, a furnace producing ingots on a basic bottom with refining should have a higher load factor than those mentioned, but this is offset by the present common practice of running with about half or one-third load during the refining period at the end of a heat. A furnace refining molten steel instead of melting cold scrap should attain a load factor of 75 per cent on 24-hr. operation.

The power consumption varies from 550 kw.-hr. per ton when melting scrap on an acid bottom for castings to 1,000 kw.-hr. per ton when making high-speed steel ingots requiring refining. The voltage on the only type of single-phase furnace now used is about 140 volts on the arc, 220 volts open circuit. On two- and three-phase furnaces the voltage is from 90 to 110 volts. The power factor of the single-phase furnace mentioned varies from 50 to 70 per cent due to heavy reactance in the circuit. The two- and three-phase furnaces have power factors of from 85 to 95 per cent. The electrode consumption is 15 to 25 lb. per ton of steel.

New Types of Furnaces Based on the Original Heroult Furnace

During recent years the tendency in electric-steel furnace construction has been to increase the power input per ton; to use three-phase current and automatic regulators; not to have large reactances in the primary circuit; and not to build furnaces with a bottom electrical

connection, at least a connection carrying all of the load. In fact, now that the basic Heroult patents have expired, most new types of furnaces appear to be the original Heroult furnace embellished and camouflaged, which is probably a good thing. The power input per ton of charge has been increased from 170 kw. in the early furnaces to 500 kw. in the most recent steel-casting furnaces. One furnace has been built with electrical connection permitting cutting the secondary voltage in half during refining. The use of three-phase current has become almost standard either as three-phase current in the furnace or three-phase converted to two-phase. Few single-phase furnaces are being built. The single-phase furnace with the bottom contact, however, blazed the way for rapid melting of scrap for steel castings on an acid bottom and the use of heavy power input per ton of charge.

The use of heavy reactance in the circuit is being discarded with few exceptions, and furnaces are generally operated with a moderate reactance and automatic regulators. Common reactances are 7 per cent to 15 per cent in the transformer. The bottom contact, as used for carrying all of the current, has apparently gone out of use with the gradual abandonment of single-phase furnaces, although it is still used for putting a small part of the current through the bottoms of some two-phase and three-phase furnaces.

The furnace with a moderately high power factor, 80 to 85 per cent, has proved to be a better load for the central station than the furnace with a very high power factor, 95 per cent, because it is not so sensitive to short circuits in the furnace, and at the same time there is enough reactance present to render electrode regulation easy with regulators. The use of furnaces with heavy reactances and hand regulation of electrodes should be discouraged, as the heavy reactance is not necessary if regulators are installed.

Electrical Heat Treating

Electric furnaces of the carbon resistance type have been installed in considerable number for the heat treatment of forgings and castings. The furnaces are ingeniously designed with a very complete automatic control of temperature, and control movement through the furnace of the piece being treated. The heating is by a resistor of granular carbon confined in carborundum fire sand troughs, which results in a uniform load without surges and a power factor of 98 per cent or better. The load on the furnace is controlled by variation of secondary voltage with taps on the secondary of a special type of transformer. The electric heat treatment of steel is certain to become common practice even at a higher cost because of the ease of control and uniformity of the results obtained. Single-phase furnaces of 900 kw. power input have been installed alone or with two or three connected in balance on a three-phase circuit and operated successfully. A further advance is the adaptation of this type of electric furnace to the soaking pit for large steel ingots and billet reheating furnaces.

Another type of electric heat-treating furnace was developed during the war, in which the heating unit consists of a nickel: chromium alloy ribbon mounted on a cast-iron supporting plate and insulated therefrom by suitable refractory material. The furnaces are of the cylindrical, vertical type and take three-phase 440-volt current. Units of 400-kw. capacity have been built. The current is automatically thrown off and on as the temperature rises above or falls below the desired point. These furnaces were designed for the heat treating of gun barrels, but can readily be adapted for the industrial uses of the future.

Ferro-Alloys

The war demand brought the electric-furnace ferro-alloy capacity to a point which, with the arrival of a more normal peace demand for ferro-alloys, puts the industry in much the same condition as existed in the European calcium carbide industry in 1899, when overproduction and patent litigation compelled most plants to look for new products, which strangely proved to be ferro-alloys. The increase of installed furnace transformer capacity for ferro-alloy production was enormous from 1915 to 1918. In 1910 there were only two plants in the United States which produced ferro-alloys in the electric furnace. They had a total transformer capacity of possibly 20,000 kva. On Jan. 1, 1920, there were forty plants with a combined transformer capacity of 200,000 kva. At the date of discussion, probably 75 per cent of these plants are not operating.

With the enormous increase in plant capacity the United States easily led the world in production of ferro-alloys when the armistice was signed. The plant capacity of ferrosilicon has increased from 10,000 or 15,000 tons per year to 100,000 tons per year. Instead of importing ferrotungsten and ferrochrome, large quantities were exported. Ferrovanadium, which had always been exported, was shipped abroad in larger quantities than ever. But the two most important developments have been the electric smelting of manganese ores and the increased use of molybdenum in steel.

In 1914 there were no electric smelting plants built for production of ferromanganese. On Armistice Day there were ten plants of total transformer capacity of 55,000 kva. and production capacity of about 80,000 tons per year. At the close of 1918 about 15 per cent of the ferromanganese production of the United States was being made in electric furnaces. With two exceptions these plants are now out of operation, the two largest having resumed work when the price of ferromanganese advanced several months ago.

Through the interest of one of the largest smelting companies in the world in a Colorado molybdenite deposit, which is probably the most extensive known deposit of molybdenite, containing at least 100,000,000 tons of 1 per cent ore, large-scale investigation of the use of molybdenum in steel has resulted. This work shows that the addition of small quantities of molybdenum to chrome, nickel, chrome: nickel or chrome: vanadium steel results in a steel of greater strength and toughness, which is easily forged, easily heat treated and easily machined. Probably 300 tons of ferromolybdenum were produced in 1918 as compared with less than twenty-five tons in previous years. There was a very small production in 1919.

Practically all ferrosilicon furnaces are now installed in three-phase units. If it is desirable to install units of less than 1,500 kva. capacity, a single-phase furnace with two vertical electrodes in series is usually built. There is at least one plant in this country equipped with single-phase furnaces of this type. All of the large ferromanganese furnaces erected in this country are of the three-phase type. The ferromanganese furnace gives about the smoothest and most easily controlled load of any of the ferro-alloy furnaces.

Ferrochrome is made in both single-phase furnaces

and three-phase furnaces. Before the war an engineer from the largest point of ferro-alloy production, Niagara Falls, claimed that ferrochrome could not be made in a furnace of over 1,000-kw. capacity. This was proved to be a fallacy by the recent installation of a 1,500-kw. furnace in Denver which operates more satisfactorily than a smaller furnace at the same plant.

Ferrotungsten is almost universally made in the single-phase furnace of the Siemens type with the bottom forming one electrode. The metal is allowed to build up in the furnace and the furnace torn down to remove it. This results in considerably more irregular load curve than with the larger tapping furnaces. One plant, now dismantled, successfully made ferrotungsten in a three-phase furnace.

The characteristics of ferromolybdenum operation are much the same as for ferrotungsten, except that when the 55 per cent molybdenum alloy is being made, it can be produced in a tapping furnace instead of a knockdown furnace.

Electric furnace ferrovanadium is usually produced in a single-phase furnace, either of the Siemens type or series type.

Ferro-uranium is made in small furnaces of the Siemens type. Due to absence of slag in the operation, the load is very irregular, and considerable reactance is usually used in the circuit, especially if automatic regulators are not used. The load characteristics of a ferrotitanium furnace are somewhat similar to those of ferro-uranium.

In commercial production of these ferro-alloys, ferrosilicon, ferromanganese and ferrochromium can be made in three-phase furnaces as readily as in single-phase furnaces, and there is no reason for permitting installation of single-phase furnaces for their production. Ferrotungsten, ferromolybdenum, ferrovanadium, ferro-uranium and ferrotitanium must be made in single-phase furnaces. At least the operation is much more apt to succeed in a business way. It may be noted that the line of division in these alloys is between metals of a low melting point and metals of a high melting point. Silicon, manganese and chromium have comparatively low melting points when electric-furnace temperatures are considered, while the melting point of tungsten, molybdenum, vanadium, uranium and titanium is high.

Some power companies seem to have an idea that electric ferro-alloy furnaces can run on any old voltage. If possible an endeavor should be made to deliver power at a constant voltage throughout the twenty-four hours of a day. Recently I put in operation a ferro-alloy plant with the understanding that the primary circuit was 4,500 volts. Furnace transformers were installed with a ratio of 4,500/75. During the twenty-four hours the secondary furnace voltage varied from 72 to 85 volts, depending on whether the industrial load of the town was on or off. This results in two things—it ran up the demand charge, because the furnace would run at the same amperage with higher voltage unless watched continuously, and means the production of a poorer grade of metal when running a knockdown furnace, as the button will not be so compact with high voltage. The difficulty was not caused by anything in the furnace transformer, which had a reactance of 7 per cent, as the same ratio of variation was shown on the 110-volt lighting circuit. In another case a large furnace was installed on a power line which the power company claimed was more than heavy enough. It resulted in a line drop of 25 per cent, which made the furnace voltage so low that enough power could not be got into the furnace to keep it hot. Ferro-alloy furnaces are run on certain voltages because practice has proved these voltages to be the best. Of course, in 3,000 to 4,000-kw. furnaces it is necessary sometimes to raise the voltage above the desired limit for good metallurgical practice in order to get power into the furnace.

The electric-smelting load, at the present time exemplified by ferro-alloy furnaces, is probably one of the best loads a power company can get, and in the future may prove a much larger load with application of electricity to smelting of non-ferrous ores, which is not such a dream as it may seem at present.

Brass

There has been a remarkable growth of the use of the electric furnace for melting brass and non-ferrous metals. From one silver-melting furnace of the carbon resistor type in 1914 the number has grown to 261 on March 1, 1920. Of these furnaces 61 are carbon resistor furnaces, 118 are induction furnaces and 82 are arc furnaces of various types. Furnaces are being used to melt brass castings, wrought brass, bronze, copper and nickel. The total estimated installed transformer capacity is 23,000 kva., of which one-third is on carbon resistor furnaces, one-half on arc furnaces, and the remainder on induction furnaces. The carbon resistor furnaces operate at 98 per cent power factor, giving a very steady load. The most common size has 105 kva. transformer capacity. The induction furnaces are built in the smallest units of any of these furnaces, taking 30 to 60 kw. load with a power factor of 70 to 85 per cent. The indirect rotating arc furnace operates at 80 to 90 per cent power factor, and is built in sizes up to 300 kva. Depending on the kind of brass being melted, the power consumption varies from 250 to 400 kw.-hr. per ton. All of the brass furnaces are single phase except one type of three-phase furnace which has not been widely installed for this purpose.

Zinc

Although there has been considerable experimenting in the United States and Canada during the past ten years on electric smelting of zinc ores, nothing has been done in commercial production. Electric smelting of zinc ore and dross has been practiced commercially in Sweden since 1901. Two plants are in operation in that country, with a total transformer capacity of 15,000 kva. A large part of this capacity has been used for smelting dross. When smelting ore the main difficulty has been in production of blue powder instead of zinc. Single-phase furnaces of 350 to 750 kva. size are used. Although the blue powder difficulty appeared practically solved by experimenters in the United States several years ago, nothing commercial has resulted. Electric smelting of zinc ore in the United States will possibly at some time be accomplished in a commercial plant. It is much better adapted to operation in small units for isolated mines than the electrolytic process.

A large 1,000-kw. melting furnace of the carbon resistor type was put in operation in 1919 for melting the zinc cathode in an electrolytic zinc plant. In the first weeks of operation it is reported that the furnace melted zinc with a power consumption of 70 to 80 kw.-hr. per ton of metal, and a metal loss in dross of 0.024 per cent.

In addition to the cheapness of the power, the character of the power contact negotiated and the basis of figuring rates will have some effect on the efficiency of operation of the electric furnace. I believe that electric furnaces, particularly smelting furnaces, are operated at their highest efficiency under contracts which provide for a flat charge per kilowatt-month, based on the maximum demand, rather than a charge which includes a maximum demand charge and a kw.-hr. charge. Under such a contract the furnace operator is compelled to install small units for a continuous operation of twenty-four hours per day rather than a large unit to be operated only ten hours per day. In the end it means a better load for the power company, and will probably mean money saved for the furnace plant. Under such a contract the power company is protected to the extent of its overhead charges by the minimum guarantee payments if the plant should not be operated continuously. Under such a contract I have operated plants in which the process was intermittent at a load factor of 70 per cent, and in plants where a continuous process was being used have run at an average load factor of 85 per cent.

In the contract under which I have operated, the power factor must be over 75 per cent, and the maximum instantaneous demand cannot exceed 300 per cent of the normal rate. The power company also requires that the load on any one phase shall not exceed the load upon any other phase by more than 15 per cent. There has been no difficulty in meeting these requirements.

Future Development

In melting steel and non-ferrous metals and electrolytic refining of metals a power cost of 1c. per kw.-hr. is reasonable, but a smelting process or electrolytic reduction process, except when producing the high priced ferro-alloys, such as ferrovanadium, cannot stand this price. The smelting-furnace operator does not expect the two-mill power of Sweden, but in most cases he must have five-mill power. The present cost of power limits the following electrometallurgical processes to hydro-electric power: the smelting of iron ore, ferro-alloy production, aluminum, electrolytic zinc precipitation and the electric smelting of non-ferrous ores.

The price of coal and oil has reached such a point in many Western smelting centers, where hydro-electric power is available, that if electric furnaces were developed to a point where they could be substituted for combustion furnaces, substitution of electric furnaces would undoubtedly result. This development is certain to come before many years if fuel prices remain high, particularly oil.

Modern industry demands high-grade products. Even if electric-furnace steel costs slightly more than open-hearth steel, the requirement of the best steel possible for present-day industrial purposes is certain to result in a large increase of the production of electric-furnace steels and non-ferrous alloys. This will eventually increase the consumption of electrically produced ferro-alloys.

In summary, a considerable increase of the uses of electricity is to be eventually expected in the following processes: (1) iron castings from scrap or a duplex process of cupola melting with electric-furnace refining; (2) steel castings and alloy steels; (3) ferro-alloys; (4) aluminum; (5) brass melting; (6) electrolytic zinc; and (7) electric smelting of non-ferrous ores.

The National Bureau of Standards

The National Bureau of Standards was created on March 3, 1901, by an act of Congress. It is charged with the development, construction, custody and maintenance of reference and working standards and their intercomparison, improvement and application in science, engineering, industry and commerce. Besides the standards of measurement, such as standards of length, volume, heat, light, electricity, etc., there are standard constants, an example of which is the mechanical equivalent of heat; the standards of quality, as exemplified by specifications; standards of performance, such as the ratings of engines, boilers, dynamos and other machines, and standards of practice, which include the various building and safety codes, etc.



U. S. BUREAU OF STANDARDS BUILDINGS

Divisions of the Bureau

For purposes of organization, the bureau is divided into nine scientific divisions, as follows: Division of Weights and Measures; Electrical Division; Division of Heat and Thermometry; Optical Division; Chemistry Division; Division of Engineering Physics; Division of Structural, Engineering and Miscellaneous Materials; Division of Metallurgy, and the Ceramics Division.

Its War-Time Activities

While the application of science to the industries was recognized by a few of the more advanced manufacturers in this country, its importance to our national life was not generally realized until the war had been in progress for some time. It was then found that science was a very practical proposition without which it was impossible to make any headway. The detection of airships and submarines, the location of hidden guns, the manufacture of substances the supply of which was cut off, were a few of the problems put up to the scientist by the military departments. The Bureau of Standards suddenly found itself the center of a vast number of activities which required a great increase in its personnel and equipment.

Supremacy in peace is no less dependent upon science and standardization, and this should not be lost sight of at this time when the tendency to revert to old times is so great—what we have gained we should hold.

Legal Notes

BY WELLINGTON GUSTIN

Seller Must Prove Product Possessed Quality Desired Where Such Is Known to Him

In the case of the James K. Thompson Co. against the International Compositions Co. judgment for the former was reversed and new trial granted by the New York Supreme Court, Appellate Division.

The plaintiff Thompson company sued on contract for the price of a quantity of copper oxide. The oxide was sold for the specific purpose of making a high-grade anti-fouling marine paint. The seller knew that there was required for the work a very fine grade of copper oxide, and the first two deliveries were fully up to the standard required by the buyer. However, the third delivery was claimed to have been much coarser. There were foreign substances in it and it would not pass through the fine sieve that the other oxide delivered would pass through. The buyer claimed this violated the requirements of the contract of sale. But before discovering the defect in this article it had used about one-third of this defective third shipment, and in making paints therefrom it made paint utterly useless and which was returned by its patrons, and the buyer claimed damages by reason of the loss of other materials that it put into the paints which were thus rendered unsalable by reason of the defective copper oxide, such damages amounting to double the seller's claim.

The rule of law is laid down that the seller, having knowledge of the fine quality of oxide required by the buyer for the making of marine paint, has the burden of showing that he furnished the required quality. And the defendant, urging a counterclaim, has the burden of proving same.

Indorsement on Check Insufficient to Discharge Whole Claim in Dispute

The Supreme Court of Errors of Connecticut has reversed the judgment obtained by the defendant Premier Manufacturing Co. in the suit brought against it by the Crucible Steel Co. of America, and ordered judgment for the latter.

Crucible Steel brought its action to recover for goods sold and delivered under five separate invoices. There was no dispute concerning the first three. The two others were in dispute because it was claimed the products had been shipped from Pittsburgh instead of New Haven, Conn., as ordered, and that the goods were not received. Defendant sent its check for the undisputed items. Subsequently this action was brought to recover for the two items remaining unpaid together with some incidental charges. The Premier company defended on grounds of accord and satisfaction and that it had never received the merchandise. The trial court found the Premier company had received the merchandise, that it had paid for the incidental and other charges against it, but gave it judgment on the issue of accord and satisfaction, as shown by payment of its check. On back of the check were the words "In full settlement of invoices to date," etc.

In tendering the check the Premier company intended to pay its entire indebtedness to the Crucible company according to the former's understanding of it, and to settle thereby all matters in dispute with the Crucible company up to the date of the check. The latter accepted the check, gave credit on its books for the invoices listed on the back of the check, and continued to bill the Premier company for the other invoices and items charged against it.

Commenting on the defense that acceptance of the check was an accord and satisfaction of the disputed account, the Supreme Court said the defense of accord and satisfaction requires the defendant to allege and prove a new contract based upon a new consideration, and there must be a meeting of the minds of the parties, and the new consideration must be offered by the debtor and accepted by the creditor with intent to satisfy the whole claim, and the fact that such sum is offered in discharge of the whole claim must be made known to the creditor in some unmistakable manner.

Further, the court held that the memorandum on the back of the check was insufficient to express clearly the condition that, if accepted, it must be accepted in satisfaction of the entire amount claimed by the creditor on five separate invoices, thereby precluding the Crucible company from suing for the balance.

Fraudulent Representations Do Not Make Fertilizer Fraudulent Under Statute

The Supreme Court of Louisiana has reversed the judgment of the lower court in the action by the Planters' Fertilizer & Chemical Co. against Barton & Barton, ordering judgment be entered in favor of the chemical company for $5,719.15 with 6 per cent per annum from June 22, 1913, and that costs of the suit also be paid by Barton & Barton.

The company sued for the price of fertilizer sold Barton & Barton as per contract. The defense was that the agent who negotiated the sale for the chemical company represented that the fertilizer would contain 8 per cent ammonia in the form of either cottonseed meal or tankage, whereas it contained ammonia in neither of these forms, and proved to be valueless for the purposes sold, and that it was fraudulent within the statute.

Now, this Act 126 absolves the purchaser of fraudulent fertilizer from having to pay for same; but the fertilizer was not in itself fraudulent, said the court, being an honest article of commerce and duly inspected by the official fertilizer inspector and found to conform to all the requirements of law. It did not accord with the representations which defendant said the sales agent made, but which the agent denied having made; but this did not render it fraudulent. The representations, if made, might have been fraudulent, without the fertilizer itself being so, said the court.

The contract called for "planters' cane fertilizer No. 8, 8 per cent ammonia," with nothing said as to the kind of ammonia. Moreover, it contained the clauses that the fertilizer "is purchased without any guaranty from the chemical company or its agents as to results from its use," and that "no agreement not expressed in this contract shall be binding" upon the company.

The company showed that "planters' cane fertilizer No. 8, 8 per cent ammonia" was manufactured according to advertised formula, was on the market as such, and that the article sold to Barton & Barton conformed to the formula.

Synopsis of Recent Chemical & Metallurgical Literature

Distribution of Phosphorus Between Ac_1 and Ac_3.—J. H. Whiteley, of Stockton, England, read a very interesting and important paper upon this subject before the British Iron and Steel Institute May 6, 1920. Experimenting on steels listed in Table I, he found that after normalizing any of these at 1,300 deg. C. a uniform distribution of all elements which are affected by the copper reagent was had. If, now, one of these normalized samples, such as E, be heated for one hour at 810 deg. C. and then quenched, it would appear as Fig. 1 after etching with picric acid. The striated areas evidently represent the patches of martensite, and the light areas represent the patches of ferrite existing in equilibrium with austenite at 810 deg. C., which is within the transformation range for that steel. Etching with a copper reagent merely accentuates the contrast between light and darker areas.

The author recommends that a polished specimen, etched with picric acid, be repeatedly dipped in a reagent (containing 0.04 g. of copper oxide dissolved in 6.0 c.c. of strong nitric acid and made up to 200 c.c. with methylated spirit) until a bluish coating appears. Then remove the copper by rubbing the surface lightly with the finger under running water and repolish the surface on a wet cloth free of polishing powders. Repeated etchings bring out very delicate contrasts. Sharp contrasts can also easily be had by following one such etching with the usual Stead's reagent.

If Fig. 1 be heated *in vacuo* at 680 deg. C. for fifteen minutes, and etched with the copper reagent noted above, the structure shown in Fig. 2 is revealed at the same spot. Evidently, light areas represent location of alpha iron existing at 810 deg. C. poor in carbon and rich in some other element "X." If only carbon were responsible the dark areas in Fig. 2 would be smaller than in Fig. 1, rather than larger.

Similarly, quenching from various temperatures between Ac_1 and Ac_3 showed that a redistribution of "X" and carbon occurs at any temperature within the transformation range. The white areas naturally diminish relatively as the temperature rises, since the volume of austenite holding carbon in solution increases in volume with increasing temperature.

Figs. 3, 4 and 6 show the appearance of sample G, after various temperings at 740 deg. C. Since carbon has been shown to diffuse very rapidly, "X" appears to require four hours to reach equilibrium at 740 deg. C. The same effect occurs quicker at higher temperatures, but in this case the white areas are smaller, due to a larger relative volume of austenite. Diffusion below Ac_1 is very slow, since twenty hours at 660 deg. C. is required to give fuzzy edges on the white spots of Fig. 6.

By etching carefully to bring out relief in the dark areas, such as in Fig. 4, it was found that the diffusion of "X" is quite rapid in gamma iron. Uniform distribution of "X" in gamma iron requires only fifteen minutes at 840 deg. C., but even so is not as rapid in diffusion as carbon (Fig. 5).

When annealing above Ac_3, "X" diffuses very much slower, requiring 1,000 deg. C. before it reaches the rate attained at 860 deg. C. The author cites this as evidence that the martensites produced by quenching from temperatures a little below and a little above Ac_3 are not physically identical.

Evidence that the white spots in Fig. 6 are really due to phosphorus was had by studying compositions of various steels. For instance, in sample A, after having been heated several hours at 820 deg. C. and etched, only the pearlitic areas and grain boundaries could be seen. Samples B and C, after one hour at 820 deg. C., gave the same appearances as steels D and E, but less pronounced, the gamma iron areas being etched less deeply.

If the white spots represent high P concentration in

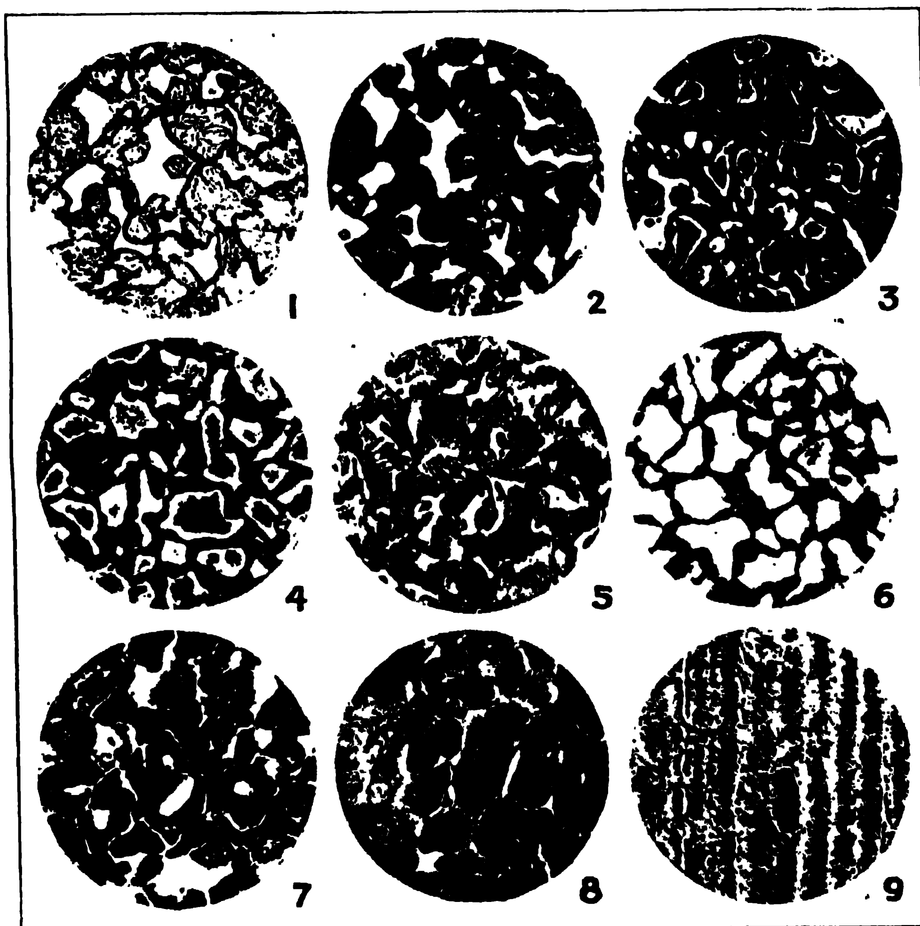


Fig. 1. Sample E. 1 hr. at 810 deg. C. and quenched. × 420.
Fig. 4. Sample G, after 1 hr. at 740 deg. C. × 400.
Fig. 7. Sample G, after 1 hr. at 810 deg. C. and 15 min. at 740 deg. C. × 440.

Fig. 2. Same as Fig. 1, tempered at 680 deg. C. for 15 min. × 420.
Fig. 5. Sample G, after 1 hr. at 760 deg. C. and 5 min. at 830 deg. C. × 440.
Fig. 8. Sample G, slowly heated to 830 deg. C. and held there 1 hr. × 400.

Fig. 3. Sample G, after 15 min. at 740 deg. C. × 400.
Fig. 6. Sample G, after 4 hr. at 740 deg. C. × 400.
Fig. 9. Sample G, as rolled and 2½ hr. at 855 deg. C. × 135.

TABLE I. ANALYSES OF SAMPLES USED IN THE EXPERIMENTS

No.	Description	C Per Cent	Si Per Cent	P Per Cent	S Per Cent	Mn Per Cent	Cu Per Cent	A Per Cent	Temperature of Reversal, Deg. C.	Carbon Content of Gamma Iron at This Temperature Per Cent
A	Basic open-hearth steel plate	0 11	0 04	0.006	0 023	0 29	0 012	0 004		
B	Basic open-hearth steel plate	0 155	0.025	0 01	0.027	0 48	0.083	0 10	810	0 35
C	Basic open-hearth steel plate	0 16	0 03	0 014	0 038	0 57	0 06	0 044	810	0 35
D	Basic open-hearth steel plate	0.18	0 04	0 027	0 039	0.45	0 054	0 065	780	0 45
E	Acid open-hearth steel plate	0 185	0 015	0 061	0 075	0 52	0 086	0 054	770	0 50
F	Basic bessemer steel billet, 2-in. square section	0 06	tr.	0 104	0 112	0 56	0 026	0 072	.	....
G	Basic open-hearth steel plate	0.18	0.04	0 12	0 055	0 51	0.067	0 026	740	0.75
H	Case-hardened electrolytic iron	0.20	. .	0 002	.	none	.....	.. .	....	....
I	Steel			0 06		tr.			..	

alpha iron, then the percentage of phosphorus must be higher in low-carbon steel to show the same etching differences because they could contain a larger volume of ferrite—a consideration checked by experiment. Time, temperature and concentration affect the size and appearance of the white areas exactly as they should if they were due to some diffusable substance contained therein.

Analyses given in Table I make it clear that whereas the contrasts developed by the copper reagent vary directly with the phosphorus contents, none of the other elements show parallel differences. For instance, silicon is very low in all samples. Copper in samples B and G is about the same, yet there is a marked difference in etching effects. Manganese was absent in sample H and was present in quite considerable amount in sample A, yet the action of the cupric reagent is very similar. Samples B and G are about equal in manganese, yet the reagent brings out extreme differences. Copper in B is seven times as much as in A, yet the cupric reagent acts about the same in these cases. B, again, is higher than sample G in copper, whereas the latter shows pronounced contrasts under the reagent. As for arsenic, G contains one-quarter as much as B and A contains one-twenty-fifth as much as B, proportions which may not be harmonized with the experiments.

It is possible that "X" is some element not usually analyzed for. Mr. Whiteley notes that a ½-g. piece of G was heated four hours at 1,000 deg. C. in dry hydrogen, cooled in the furnace, then heated one hour at 840 deg. C. in dry hydrogen, a procedure thought to remove oxygen effectively, yet the resulting structure after etching was entirely similar to Fig. 6.

If samples are quenched after a long time near Ac_1, ferrite is likely to etch more quickly than the martensite, since the latter contains such high carbon that its solution pressure is less than the low-phosphorus ferrite. If this same sample is air-cooled, etching reverses, since then there is no cementite in solution. There is a temperature where the etching figures reverse, as tabulated under "Temperature of Reversal." This is evidently the temperature where the solution pressure of alpha iron containing P equals that of austenitic material. Phosphorus has been previously equalized by high-temperature normalizing; therefore it would require a diffusion and divorce of carbon and phosphorus to reverse these etching figures, since martensite otherwise would always etch less than iron containing no carbon in solid solution.

Fig. 7 shows small white spots locating high-phosphorus areas at 840 deg. C and white markings outlining the volume of ferrite existing at 740 deg. C. Phosphorus appearing in the lower temperature ferrite is coming from the surrounding black portion—that is, from gamma iron—more rapidly than from the enclosed white portion. Phosphorus, as well as carbon, is more soluble in gamma iron at higher temperatures, but the solubility of phosphorus is less if the austenite is saturated with carbon at the high temperatures. Therefore phosphorus is not completely insoluble in gamma iron.

In all the experiments, small samples were heated very rapidly, requiring only two or three minutes. When heating at 4 deg. per min. above 700 deg C., followed by air cooling, all the structures developed were the same up to 815 deg. C. Fig. 8 shows the cellular structure developed by slow heating and soaking at temperatures higher than 815 deg. C., then quenching or air-cooling. Time required to develop this structure varies inversely as the temperature above 820 deg. C. If the phosphorus has not previously been entirely equalized, cellular structure is found after a rapid heating. Soaking at high temperature and slow heating seems to be essential for cellular structure in previously normalized samples. Phosphorus is responsible for this phenomenon, because it could not be developed in sample A and increased in contrast and ease in formation as phosphorus increased. The temperature required to form the structure increases with the amount of carbon in the steel, consequently it can be developed only in steels of very low carbon contents. Much further work is required before these and other points in connection with the subject can be elucidated.

Micro-ghostlines shown in rolled plate by copper reagents have ordinarily been ascribed to phosphorus. That they remain after heat treatment has been explained by the slow diffusion of phosphorus, but it has herein been shown that phosphorus migrates rapidly within the transformation range. Samples A to E in their rolled condition were heated for two and one-half hours at temperatures slightly below Ac_1, which would certainly have equalized phosphorus in the gamma iron. Fig. 9 shows sample G after such heat treatment; ghostlines are still present. If rolled plate is heated slowly to 900 deg. C., a cellular structure is developed, but the cells are ranged parallel to the direction of rolling. It is therefore evident that the micro-ghostlines are not entirely due to the heterogeneous distribution of phosphorus. To account for these ghostlines it seems necessary to infer the presence of some other substance which diffuses with extreme slowness at temperatures below 950 deg. C., but with greater rapidity at 1,000 deg. C.

Reconstruction Status of the French Industries.—The official report of the French Industrial Reconstruction Bureau states that the activities in the devastated area are progressing quite satisfactorily. This, of all the plants in operation in 1914, employing 729,185 workmen, about 77 per cent were already in working condition July 1, 1920, employing 307,185 workmen. (*La Technique Moderne*, September, 1920.)

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Chlorides of Zinc From Zinc Ores.—A method of preparing zinc chloride and the double chlorides of zinc with the alkali metals from zinc sulphate is described by F. K. CAMERON, J. A. CULLEN and R. W. HYDE. The object of the invention is to obtain this salt by a simple and economical process from zinc ores. Zinc sulphate is prepared by roasting oxide ores of zinc with sulphuric acid and subsequently leaching the product. The resulting solution is treated for the removal of impurities. Sodium chloride is added in excess and the solution is evaporated to a density of about 55 deg. Bé. Upon cooling the concentrated solution sodium sulphate will crystallize out and can be separated from the mother liquid. The solution is concentrated to a density of about 60 deg. Bé. and upon cooling a double salt of the composition $ZnCl_2.2NaCl.3H_2O$ will separate as pure crystals. In case insufficient sodium chloride was added the salt $ZnCl_2.NaCl.3H_2O$ will separate upon cooling. If to the double salt a solution containing 30 per cent or more hydrochloric acid be added and the mixture be agitated, sodium chloride will separate. The filtrate can be freed from hydrochloric acid by heating and upon evaporation pure zinc chloride can be obtained. (1,352,399; assigned to the American Smelting & Refining Co.; Sept. 7, 1920.)

Aluminum Casting Alloy.—THERON D. STAY, of Cleveland, Ohio, has found that an aluminum alloy containing 10 to 12 per cent copper and 0.1 per cent or less titanium is especially adapted for the production of castings in which the metal is irregularly distributed as to bulk, but which must possess good machining and bearing qualities. The process of making the alloy is divided into four stages: (1) The production of an alloy containing about 82 per cent copper, 12 per cent aluminum and 6 per cent titanium in an electric furnace, titanium oxide being reduced by an excess of aluminum; (2) the production of an alloy containing about 52.1 per cent aluminum, 46.5 per cent copper and 1.4 per cent titanium by melting 100 parts of the alloy made as in (1) and 100 parts of copper in a graphite crucible and adding to the molten metal 50 parts of an aluminum alloy containing 3 per cent copper; (3) production of an alloy containing equal parts of copper and aluminum in a crucible furnace, and (4) production of the desired alloy containing 88 to 90 per cent aluminum, 12 to 10 per cent copper and 0.1 per cent titanium or under, from proportional amounts of the alloys obtained in (2) and (3), aluminum and scrap alloy, melted in a crucible. By producing the final alloy in this way only a relatively small amount of alloy has to be produced in an electric furnace at a high temperature and a minimum amount of metal has to be heated to the high temperature necessary to melt copper. (1,352,322; assigned to the Aluminum Castings Co.; Sept. 7, 1920.)

Use of Sulphur Dioxide as a Reducing Agent in the Electrolysis of Copper Solutions.—In the electrolysis of solutions obtained by leaching copper ores with sulphuric acid the current efficiency is decreased by the presence of ferric iron, ferrous iron being without appreciable effect, and the low current efficiency is one reason why hydrometallurgical processes are not extensively applied to copper ores. It is necessary, at plants in operation, to remove the copper from a portion of the solution by some other method than electrolysis, usually by precipitation on scrap iron, otherwise the accumulation of iron salts through the cyclic use of solution would make continued operation impossible. The copper-free solution is discarded and the resulting waste of acid adds to the cost of production. WILLIAM E. GREENAWALT, of Denver, Col., has designed an apparatus whereby sulphur dioxide is used as a depolarizer and reducing agent for ferric salts in the electrolysis of impure copper solutions containing iron. The application of sulphur dioxide to an electrolyte so that it will function effectively in reducing ferric salts produced by electrolysis and act as a depolarizer presents some difficulties. These are slight solubility of sulphur dioxide in water or copper solutions, particularly in hot solutions; its reducing action in cold solutions is slow but is effective in hot solutions. The slight solubility renders the effect transient. In the apparatus designed by Greenawalt a large volume of electrolyte contained in a closed tank is treated with sulphur dioxide by spraying the solution into sulphur dioxide gas by means of rapidly rotating disks, which also agitate the solution. A portion of the reduced solution is sprayed into a trough on the side of the closed tank from which it flows to the electrolytic cell. The rate of flow is such that the tailing solution from the cell contains less than 0.25 per cent ferric iron. The concentration of sulphur dioxide gas in the closed tank is maintained by a pyrites, sulphide concentrate or other burner. The gas passes in series through several reducing tanks and finally to a scrubbing tower which is fed with fresh solution from the leaching tanks. The solution from the tower flows to the first reducing tank. In the arrangement described there are two electrolytic cells for each reducing tank, a portion of the oxidized solution from the first pair of electrolytic cells is bypassed to the second reducing tank and so on. (1,353,995; Sept. 28, 1920.)

Alloys.—The following special alloys are described by FOSTER MILLIKEN of Lawrence, N. Y.:

An alloy to resist high temperatures and the action of acids, alkalis and chemical mixtures at high temperatures:

	Per Cent
Copper	50 to 60
Nickel	28 to 36
Zinc	4 to 8
Iron	4 to 8

An alloy designed for the manufacture of valves and fittings, particularly those used in handling gasoline and light petroleum distillates:

	Per Cent
Lead	10 to 14
Copper	55 to 65
Nickel	6 to 11
Zinc	14 to 18

Acid-resistant and high-temperature-resistant alloy:

	Per Cent
Iron	16 to 20
Chromium	5 to 7
Copper	31 to 38
Nickel	38 to 46
Manganese	½ to 2

(1,354,988; 1,354,989; 1,354,990; assigned to Foster Milliken, S. Fullerton Weaver and James M. Reppljer, as trustees; Oct. 5, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Preparation of Phthalic Anhydride. — Phthalic anhydride is prepared by passing naphthalene vapor mixed with oxygen-containing gas—e.g., air—over an appropriate catalyst at a temperature below red heat, say 380 to 400 deg. C.; suitable catalysts are vanadium or molybdenum oxides. The catalyst may be prepared, for example, by impregnating pumice with a colloidal solution of vanadic acid mixed with starch or finely-divided blood charcoal, drying, and heating in air to burn off the carbonaceous matter; or by soaking pumice in gum solution, and then shaking it with ammonium vanadate; or powdered pumice is mixed with ammonium vanadate and suitably formed; or ammonium molybdate is precipitated on pumice by means of blood charcoal, and the charcoal then burnt off by heating in air. (Br. Pat. 145,071—1919. A. WOHL, Langfuhr, Danzig, Aug. 18, 1920.)

Hardening Metals.—The hardness and tenacity of metals, particularly aluminum and its alloys, and their ease of working with cutting tools are increased by heating for a considerable length of time to a temperature below the usual annealing temperature. An aluminum-zinc alloy with 15 per cent of zinc after being cast or annealed at 530 to 550 deg. C. is kept at 70 deg. C. for four or five days; an aluminum-copper alloy with 2 per cent of copper is kept at 160 deg. C. for ten days. Bronze with 6 per cent of tin is kept at 500 deg. C. for five days, and brass with 28 per cent of zinc is kept at 300 deg. for three days, or 210 deg. C. for ten days. Soft iron is kept at 300 deg. C. for fifty days. The heating may be interrupted during the process to enable the metal to be shaped, whereupon the heating is continued until the final hardness is attained. (Br. Pat. 145,129—1919. SOC. ANON. DES USINES GIULINI, Basel, Switzerland, Aug. 25, 1920.)

Printing Fabrics and Yarns.—Discharge effects are obtained by first mordanting cotton fabrics or yarns with tannate of aluminum, iron or chromium, then printing on a thickened solution of caustic alkali, to which may be added vat or sulphur dyes and a reducing agent, or an alkaline mordant such as sodium aluminate or an alkaline lead solution, or both, then aging or steaming, washing or otherwise preparing for dyeing, and finally dyeing with colors appropriate to the mordants used. The initial mordanting may be effected by first applying aluminum, iron or chromium mordants and then dyeing, padding or printing with tannin, or vice versa, or the metal salt and tannin may be applied simultaneously. Other colors—e.g., aniline black, vat or sulphur dyes—or diazo compounds (on fabric prepared with β-naphthol), or other discharges may be applied at the same time. Glucose, glycerine or tannin may be added to the alkaline discharges. According to examples—fabric is chrome-mordanted, tanned, printed with the alkaline discharge, aged, washed and dyed; fabric is padded with a solution of tannin and potassium chlorate, padded with iron acetate, printed with the alkaline discharge, aged, washed and dyed; fabric is printed with a mixture containing iron acetate, tannin, acetic acid, hydrosulphite N F conc. and starch-dragon thickening, aged, washed and soaped, printed with the alkaline discharge, aged, washed and dyed; fabric is padded with a solution of tannin and potassium chlorate, printed with iron acetate and aluminum acetate simultaneously, aged, washed and soaped, printed with the alkaline discharge, aged, washed and dyed. (Br. Pat. 145,240—1919. CALICO PRINTERS' ASSOCIATION, Manchester; W. ROUSE, Renfrew and G. NELSON, Hyde, Cheshire, Aug. 25, 1920.)

Scouring Wool.—Raw wool, woollen yarns and cloth, and mixed goods are scoured, etc., by treatment with the alkaline salts of acids of the type of lysalbinic and protalbinic acid, to which cleaning material such as ammonia salts, sodium carbonate, potassium carbonate and soap may be added. The wool, etc., may be scoured at a temperature of 70 deg. C. The first-mentioned alkaline salts are prepared by heating albuminoid matter in alkaline solution—for example by heating glue in a solution of caustic alkali to 80 or 85 deg. C. for from two to three hours—neutralizing the solution with weak formic acid, and then concentrating the solution. Impurities may be removed by treating with dry calcium or magnesium hydroxide, or both, filtering, and then adding sodium carbonate. (Br. Pat. 145,448—1919. C. BENNERS, Grunau, near Berlin, Aug. 25, 1920.)

Sulphuretted Dyes.—Sulphuretted dyes are obtained by heating with sulphurizing agents mixtures of aminoazo, diaminoazo, nitroaminoazo, nitrooxyazo, or aminooxyazo compounds with C-alkylated diamines of the benzene or naphthalene series, for example *m*- or *p*-toluylenediamine or xylylenediamine, or N-aryl-derivatives of such diamines, for example naphthyl-*m*-toluylenediamine, or the corresponding nitroamines. According to examples products are obtained by heating with sulphur mixtures of *m*-toluylenediamine with aminoazobenzene, benzene-azo-β-naphthlyamine, benzene-azo-α-naphthylamine, *p*-nitrobenzene-azo-α-naphthylamine, or *p*-nitrobenzene-azo-β-naphthylamine, and a mixture of 4-α-naphthylamino-2-aminotoluene with benzene-azo-α-naphthylamine. The products are solubilized by treatment with sodium sulphide and dye cotton olive, reddish-brown, brown, yellow-olive, yellowish-brown, and brown to black brown shades. Products are also specified from mixtures of *m*-toluylenediamine with *p*-nitrobenzene-azo-*m*-toluylenediamine (brownish orange), benzene-azo-*m*-phenylenediamine (black brown), *p*-nitrobenzene-azo-cresol (crude cresol mixture), a benzene-azo-phenol, or a benzene-azo-naphthol. (Br. Pat. 145,523—1920. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Cellulose Acetate. — Cellulose acetate soluble in acetone is dissolved in a fully hydrogenized monocyclic ketone such as cyclohexanone or methylcyclohexanone, to form solutions suitable for lacquering and for the production of artificial silk and films. A solvent or diluent, as for example, alcohol, acetone, ethyl acetate or benzene, may be added to the ketone. (Br. Pat. 145,511—1919. BADISCHE ANILIN UND SODA-FABRIK, Ludwigshafen-on-Rhine, Sept. 1, 1920.)

Sulphuretted Dyes.—Sulphuretted dyes are obtained by heating with a sulphurizing agent the azo compounds prepared by coupling diazo compounds with N-ethylarylamines; aromatic amines or substances yielding them such as nitroamino or azo compounds may be added to the melt. According to examples products are obtained by heating with sulphur *p*-nitrobenzene-azo-ethyl-α naphthylamine, *p*-aminobenzene-azo-ethyl-β-naphthylamine, *p*-aminobenzene-azo-ethyl-β-naphthylamine, a mixture of benzene-azo-ethyl-α-naphthylamine and ben-

zidine, a mixture of benzene-azo-ethyl-α-naphthylamine, and benzene-azo-α-naphthylamine, or a mixture of *p*-nitrobenzene-azo-ethyl-α-naphthylamine and *m*-toluylenediamine. The products are solubilized by treatment with sodium sulphide, and dye cotton yellow-brown and brown-yellow shades. (Br. Pat. 145,522—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Edible Gelatine.—Edible gelatine is prepared in sheet form by applying a coating of liquid gelatine to a flexible foundation from which when dry the coating is stripped as a sheet, and finally, in order to simulate the crinkled appearance of ordinary edible gelatine, placing the sheets in a frame of wire netting, softening by momentary immersion in hot water, and redrying while in the frame, for example, in the current of air from a blower. (Br. Pat. 145,486—1919. R. A. MCQUITTY, London, Sept. 1, 1920.)

Treating Cellulose and Its Products.—Pure cellulose such as cotton, cellular tissue and papers and cardboards made therefrom are hardened and rendered water-resisting by treatment with thionyl chloride. Indifferent solvents for the thionyl chloride, such as chloroform, carbon tetrachloride, benzene, etc., may be used. A better parchmenting effect on paper is produced by exposing the paper, after treatment if necessary in vacuum, to the vapors of thionyl chloride. Continued treatment renders paper absolutely impermeable. It is desirable, after treatment, to wash with water or dilute alkali, or to treat with dry ammonia gas. (Br. Pat. 145,610—1919. F. MOELLER, Cassel, Germany, Sept. 1, 1920.)

Treating Cellulose and Its Products.—The process described in Br. Pat. 145,610—1919 may be applied to the treatment of vegetable materials containing cellulose, such as wood, cork, straw, jute, hemp, linen, flax, artificial silk, yarns and fabrics obtained therefrom, cellulose derivatives such as cellulose hydrate, hydro-cellulose, oxy-cellulose, kindred substances such as starch, dextrine, or fabrics and substances treated or impregnated therewith. These materials may also be hardened and rendered less sensitive to water by treatment with sulphur chloride, the deposited sulphur being subsequently removed by a suitable sulphur solvent. The products of this treatment may be parchmented and the fat-resisting material so obtained rendered water-repellant by further treatment with thionyl chloride. (Br. Pat. 145,611—1919. F. MOELLER, Cassel, Germany, Sept. 1, 1920.)

Coated Fabrics.—In the production of coated fabric for balloons, etc., the elasticity and softness of the fabric are retained by impregnating with a pliable medium, such as castor oil or a solution comprising softening agents, previous to the application of the coating of nitrocellulose, etc., thereby limiting the penetration of the coating material into the fiber of the fabric. (Br. Pat. 145,546—1919. GES. FÜR VERWELTUNG CHEMISCHER PRODUKTE, Berlin, Sept. 1, 1920.)

Cellulose Acetates.—The acetylization of cellulose or its derivatives is carried out in two stages: In the first stage a catalyst other than sulphuric acid is employed, or several of such catalysts either simultaneously or in succession, and in the final stage sulphuric acid is used as the catalyst. Working in this way, complete solution of the cellulose is obtained, and the acetates can be separated from the solutions by dilution with or in the presence of acetone; the solubility of the acetates may be varied by subjecting them in the known way to a process of hydrolysis. In examples, bromine and fused zinc chloride are used as catalysts in the first stage, and acetylization is completed after the addition of sulphuric acid diluted or not with glacial acetic acid and with or without a further addition of acetic anhydride. (Br. Pat. 145,525—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Compound Sheet Materials.—A method of uniting two or more layers of dissimilar materials, particularly plastic materials, which are difficult to stick together—for example, uniting rubber with other plastic materials—consists in providing a suitable intermediate layer to which the layers to be connected firmly adhere. Materials suitable for the intermediate layer are pulverulent materials such as straw meal, wood meal, barium sulphate, talc, china clay, vegetable powders, etc., or fibrous materials such as textile fibers, cellulose fibers, wadding, fiber fleece, etc., or a layer of paper or wide-meshed fabric. For example, a gas-proof and liquid-tight fabric may be prepared by coating a fabric foundation with acetyl-cellulose as a gas-proof layer, then applying the intermediate layer before acetyl-cellulose is completely dry; and finally applying a liquid-tight layer of nitrocellulose. (Br. Pat. 145,544 1919. GES. FÜR VERWELTUNG CHEMISCHER PRODUKTE, Berlin, Sept. 1, 1920.)

Degumming Textile Materials.—In an amylolytic process for degumming textile materials, such as fabrics, a bath which may be prepared from ordinary hard water is employed containing animal amylase, neutral salts of alkali or alkaline-earth metals such as sodium or calcium chloride, and biliary salts, whereby the amylase is protected, and the bath may be used at a temperature of 58 deg. C. (Br. Pat. 145,583—1919. SOC. SUISSE DE FERMENTS, Basel, Switzerland, Sept. 1, 1920.)

Oxyaldehydes.—Oxyaldehydes are prepared by the reaction of phenols or their derivatives with formaldehyde, or a compound yielding it, in the presence of a nitroso compound and an acid condensing-agent. Examples are given of the preparation of salicylic aldehyde and *p*-oxybenzaldehyde, 2-oxy-5-methylbenzaldehyde, anisic aldehyde, vanilin, protocatechuic aldehyde, and the aldehyde from 2-naphthol-3:4-disulphonic acid; the nitroso compounds specified are nitrosodimethylaniline, nitrosodiethylaniline, and nitrosophenol, hydrochloric acid being employed as condensing-agent. (Br. Pat. 145,581—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Damp-Proof Matches.—A process for making damp-proof matches consists in using in the paste from which the heads are formed an agglutinating substance formed by the condensation product of a mixture of substances having the properties of phenol and of an aldehyde. These substances react when heated and produce, in the presence of suitable catalyzers, insoluble bodies. For example, a paste is prepared by placing the powdered constituents in a bath containing water, phenol aldehyde and soda, the stalks are dipped into this bath and after removal the tips are allowed to harden. The aldehyde and the catalyzer, which may be hydrochloric acid, may be used in the form of vapor. (Br. Pat. 145,798—1919. R. DUBRISAY, Paris, Sept. 1, 1920.)

Current Events
in the Chemical and Metallurgical Industries

The Perfume Industry of France

On Friday evening, Nov. 12, Burton T. Bush, president of Antoine Chiris Co., addressed the American Section of La Société de Chimie Industrielle on the natural perfume industry of France. Excellent views of the flower fields near Grasse and interiors of the attar extraction factories were exhibited on the screen. Three processes of extraction were illustrated:

Enfleurage, or the cold fat process, is the oldest. The blossoms are packed in layers with soft tallowed cloths between, the attar vapors being adsorbed, giving the odorous pomas from which the cologne spirit perfumes are prepared.

Maceration, or the hot fat process, is used where heat does not injure the essential oils. The blossoms are ground up and cooked in molten fats heated by hot water and pomas made much more rapidly than in the cold process.

Countercurrent extraction with pure petroleum ether is the latest method, giving a high rate of production and low-temperature extraction. Concretes, a solution of the attars in the natural blossom waxes, are produced.

Only about 11 oz. of substance is obtained from 100 lb. of such a flower as lavender. Last year 121,000 lb. of violets, 1,200,000 lb. of roses and 500,000 lb. of bitter orange blossoms were extracted. The demand for cosmetic odors cannot be supplied by the natural industry, with the result that synthetic products are now being produced in great quantities. In the United States, 36,000 lb. of ionone (synthetic irone or extract of violet) was manufactured last year. Mr. Bush expressed the opinion that if this industry is given tariff protection, it will grow greatly.

Annual Meeting of American Ceramic Society

The 1921 annual meeting of the American Ceramic Society will be held Feb. 21 to 24, at Columbus, Ohio, where the Hotel Deshler has been engaged as headquarters. The management of this new and commodious hotel has promised to reserve the ball-room and four other rooms on the same floor, so that the general meetings of the society and the divisional meetings will be taken care of adequately.

Details of the entertainment are in the hands of the local committee, of which Prof. A. S. Watts is chairman, and it is expected that the usual Section Q, or smoker, will take place on Monday night, with the banquet on Tuesday. Those who recall these delightful events at the Philadelphia meeting will not fail to be present this year.

The trips to be taken on the last day of the meeting will be replete with interest, as Columbus is situated at the very heart of the clay-working industry.

The literary program, if it may be judged by past experience, will be filled with papers of a high degree of excellence. The arrangement of the program is in charge of R. H. Minton, chairman of the Committee on Papers, and contributors should communicate with him.

New Jersey Chemical Society Holds Third Annual Meeting

The third annual meeting of the New Jersey Chemical Society was held at Newark Monday evening, Nov. 8. Thirty-three new members were elected at this meeting, thereby making a total membership for the society of 516.

Richard K. Meade[1] gave an illustrated talk on the manufacture of lime and hydrated lime, emphasizing the different types of furnaces used, the various methods of firing, and the products produced.

James A. Donan, a representative of the Standard Oil Co. of New Jersey, accompanied the moving pictures depicting "The Story of Petroleum Oil," by an address in which he explained and elaborated on the pictures, describing the production of oil and its byproducts from the oil well to the consumer.

E. E. Klipstein, who was to talk on "Prospective Competition Between European and American Chemical Industries," was unable to be present, and his place was taken by Dr. R. S. Lee, who gave an extremely interesting illustrated lecture on the yeast industry.[2]

National Council of State Boards of Engineering Examiners Formed

Representatives from seven state boards of engineering examiners Colorado, Michigan, Iowa, Florida, South Dakota, Louisiana and Illinois - met in Chicago Nov. 8 and 9 and organized the National Council of State Boards of Engineering Examiners.

The purpose stated in the constitution as "to examine the state laws providing for registration of engineers and the custom and rule of procedure of the different boards in the examination of applicants, with suggestions and recommendations for uniformity of practice so far as the same can legally be done by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

The officers elected were: President, Marcel Garaad, New Orleans; vice-president, C. S. Hammatt, Jacksonville, Fla., and secretary-treasurer, Alvin Le Van, Des Moines, Iowa. The next meeting will be in St. Louis, Oct. 3, 1921.

Bureau of Mines Station at Rolla, Mo.

Bureau of Mines representatives are touring the Wisconsin zinc district and the Missouri lead and zinc districts investigating various conditions connected with the location of the new Mississippi Valley zinc and lead station at Rolla, Mo. Among other members of the party were Frederick G. Cottrell, director of the Bureau; Charles Fulton, president Missouri School of Mines, and H. A. Buehler, State Geologist of Missouri.

[1] See CHEM. & MET. ENG., "The Manufacturing of Lime for Chemical and Metallurgical Purposes," vol. 28, Nos. 17, 18, 19, pp. 841, 873 and 929.

[2] See CHEM. & MET. ENG., vol. 23, No. 17, pp. 835-837.

American Coke & Chemical Co. Begins Operating the St. Louis Plant

The St. Louis Coke & Chemical Co., subsidiary of the American Coke & Chemical Co., has heated the first forty ovens and blast furnace and will start the second bank of forty ovens within the next six weeks. By Dec. 1 the plant will produce from 100 per cent Illinois coal metallurgical coke for the blast furnaces, tar, gas for the steel mills of the National Enamelling & Stamping Co., ammonium sulphate, light oils and pig iron. The conversion of Illinois coal is made possible by the Roberts coke oven, invented by Arthur Roberts, an American.

The American Coke & Chemical Co., of 208 South La Salle St., Chicago, controls subsidiary companies in several states, all licensed under the Roberts patents. Work will be started in Chicago this winter on the first unit of 320 ovens, the plant to be laid out for the eventual construction of 1,500 ovens. Plants of 80 ovens will be started in several other places in the early spring.

The Roberts process is said to be the first successful method for the coking of coals such as are mined in Illinois. The original test was run in the 24-oven plant at Dover, Ohio, where 16,000 tons was put through. The coke was used to produce pig iron at the plant of M. A. Hanna & Co. and the pig was reduced to steel plates at the Niedringhaus plant, Granite City, Ill. These plates after passing all Government tests were shipped to the Pacific Coast, where they were used in the construction of Hull No. 18 of the United States fleet.

The inventor states that the reasons for the excellent performance of this oven, as compared with other processes attempting to coke soft coals, is due to the absolute control of the heat. The heat is generated uniformly on all surfaces and not at concentrated points. The distribution of heat is even and in large volume as distinguished from high temperatures existing in other ovens. Short coking time and low temperature are accomplished by special construction which permits the large volume of heat in contrast to high temperatures now obtaining in narrow coking chambers. For these reasons superiority is also claimed in converting the regular coking coals.

Representatives of foreign business concerns are interested in this new American process. Japan can now coke only about one-half of 1 per cent of the coal mined; the Saar Basin and Lorraine coals have never been coked; only 10 per cent of the British coals are convertible and only 5 per cent of the United States coals are at present cokable. South America, Russia and other countries may be likewise benefited by the new process.

A.C.S. Intersectional Meeting

The Milwaukee and Chicago sections of the American Chemical Society will meet in joint session at Milwaukee on Nov. 20. Among the features of the occasion will be an indoor baseball game between teams of the two sections. The meeting originated on invitation from the Milwaukee Section. The social interchange between Western groups in the American Chemical Society promises to become contagious, causing a closer welding of all the parts into a better national organization.

St. Lawrence Waterway Hearings Under Way

The series of hearings before the International Joint Commission, which will be held in all the principal cities affected by the Great Lakes-St. Lawrence waterway project, was initiated in Chicago recently. Evidence was presented to show that:

1. The interior of the country—richest in productivity—is to a large extent the present and will be the future origin of America's export shipments.

2. This same section, by reason of its growing population, is to a large extent today and will be to a greater extent tomorrow the market for America's imports.

3. The need of more adequate means of ingress and egress from the central section of the United States and Canada to the markets of the world is America's greatest economic problem.

4. Increasing cost and difficulties of rail transportation from Atlantic seaports are placing a burden on commerce that is becoming prohibitive.

5. This waterway improvement comprising the completion of a route up the St. Lawrence from Quebec through Lake Ontario, the Welland Canal, Lake Erie and via Detroit to the whole system of the Great Lakes, costing about $110,000,000, will provide the necessary facilities.

The Canadian section of the work will cost about $60,000,000 and the international section about $50,000,000. It is estimated that about 4,000,000 electrical horsepower would be developed in the system.

Compression and Hardness of White Metal Bearing Alloys

Experimental work on determining the compression and hardness value of white metal bearing alloys at temperatures up to 100 deg. C. has been completed by the United States Bureau of Standards. A paper has been prepared entitled, "Some Properties of White Metal Bearing Alloys at Elevated Temperatures," a summary of which is as follows:

An apparatus is described for determining the yield point and ultimate strength of white metal bearing alloys at temperatures up to 100 deg. C. A new design of heating apparatus is described for determining the Brinell hardness of such metals in the range of temperature indicated above. The results of compression tests and Brinell hardness tests at temperatures up to 100 deg. C. are given for five typical white metal bearing alloys, including three tin base alloys, one lead base alloy and one intermediate alloy. These tests showed that the tin base alloys maintain their properties better at elevated temperatures than those containing lead. Results of tests are given which indicate that up to 3 per cent the lead in a high-grade babbitt does not affect the yield point or ultimate strength at 25 deg. C. or 75 deg. C. Tests are described which show that the yield point of tin base alloy is not affected by heating for six weeks at about 100 deg. C., but that the yield point is lowered in the lead base alloy by heating for only two weeks at this temperature.

Strong Paper Co. Changes Name

The Strong Paper Co. of Middletown, Conn., has changed its name to the Elam Strong Paper Co., and has increased its capital stock from $100,000 to $160,000.

New Forestry Policy Sought by the A.P.P.A.

A new forestry policy was recommended in the reports read at the American Pulp and Paper Association, which recently met in Chicago. It is said that the Federal Government is preparing to spend $50,000,000 on forestry in the next five years in addition to large amounts to be expended by individual states.

The reports urge acquisition by State and Federal Governments of forest land and land for reforesting. Extension of federal supervision of state and private forests and a unified system of reforesting under federal control are also advocated.

To stop the cutting of young timber to pay taxes it was proposed that no state or federal taxes be collected on forest land until cutting of the timber started and that the tax then be placed on the lumber.

President George W. Sisson of the association said the paper industry is "in a better situation than many others because it had not been through a period of overproduction which piled up excessive stocks."

"On the contrary," he continued, "the mills have been barely able to keep up with the flood of orders. Our great problem is now and will continue to be the securing of a sufficient supply of raw material to meet the needs of the mill."

Fermogas Promoter Held for Grand Jury

Legal action has been brought against P. J. Chasler of 1259 51st St., Brooklyn, N. Y., for the alleged misappropriation of funds given him for investment in the Fermogas Co. This company has a small demonstration plant in which the Chasler process of fermenting cellulose to alcohol by means of a mold is shown to prospective stock purchasers. The claim is made that gasoline substitute can be produced and sold at a profit at 5c. a gal. The process has been examined by many investors and about $70,000 worth of stock has been sold. However, there does not appear to be any technical proofs or recognized alcohol engineers' reports available to verify the claims of the inventor. The complaint was filed by Emmerick Bares, who bought $5,000 worth of stock. Mr. Chasler was held under $10,000 bail to await action of the Grand Jury.

E. A. Cappelen Smith Recipient of Gold Medal

At the meeting of the Mining and Metallurgical Society held at the Hotel Commodore, New York City, E. A. Cappelen Smith was awarded the society's gold medal for his excellent work in hydrometallurgy. Mr. Smith, who originally came to this country from Norway as a metallurgist, followed his profession here with the Anaconda Copper Co. and later with the Chile Copper Co. It was while connected with the latter company that he carried successfully to solution the problem of reclaiming copper from the great Chiquicamata orebody in Chile by leaching and subsequent electrolytic deposition of copper.

The medal was presented by Waldeman Lindgren, president of the society, and speeches were made by Dr. Arthur L. Walker and Harry F. Guggenheim.

Shortage of Crude Oil Closes Plant

The Imperial Oil Co. has had to close its refinery at Ioco, near Vancouver, because it is unable to obtain crude oil, and consequently cannot renew contracts for fuel oil. The refinery will be reopened in June.

No Quarters for Civilian Chemists at Edgewood Arsenal

The War Department has ruled definitely that no quarters for civilian chemists may be erected at Edgewood Arsenal with War Department funds. The decision was based on the ground that the War Department could not depart from its policy of furnishing quarters to officers only. It is feared that this decision will have the effect of decreasing efficiency at Edgewood Arsenal, since its isolated location makes it necessary for the technical employees to live in Baltimore, which is forty minutes away. The train schedule is such that men who would be inclined to work overtime cannot do so.

Enlarging Iron Articles

In CHEMICAL & METALLURGICAL ENGINEERING for Sept. 1, 1920, a brief abstract of a paper read before the British Institution of Automobile Engineers was printed. It noted that it was commercially possible to deposit electrolytic iron on worn parts of machinery, to build them up to approximate size so that they can be carburized and machined to a piece practically as good as new. It should have been pointed out that the process was originated in Sherard Cowper-Coles' laboratory at Sunbury-on-Thames, and was largely used for the repair of worn parts of motor cars during the war.

Book Reviews

ADVERTISING THE TECHNICAL PRODUCT. By *Clifford Alexander Sloan*, vice-president Campbell-Ewald Co., and *James David Mooney*, vice-president's staff General Motors Corporation. 365 pp., with illustrations and charts. New York: McGraw-Hill Book Co., Inc. Price $5.

Prepared jointly by an engineer and advertising man collaborating with several authorities in both fields, this work is valuable for study and reference to the buyer and seller of advertising space alike, as well as to those who have technical products for sale and must plan selling campaigns. It is a clear analysis of the important factors peculiar to advertising the technical product. Many an advertiser can save considerable money now being wasted through lack of attention to the forces governing his selling plan. The salesman of space, on the other hand, will see in reading the text and between the lines that he must study to present the facts bearing on the economic returns to the advertiser and should not rely on the too common form of "good fellow" salesmanship. The principles laid down in this book may well be applied to general advertising procedure.

The authors have done well in dealing with cold facts and principles in contrast to the "pep" talk so commonly found in volumes on advertising and selling. The style and text matter in the first chapters make for interesting reading, the final chapters and appendix being largely a collection of data evidently gathered from reliable sources. It is a book for continued reference. Even those who feel they have graduated from the school of study may crystallize ideas and derive inspiration for fresh thought in its use.

Some parts of the text drag slightly, but the amount of superfluous matter is surprisingly small. The authors strike a false note once or twice in apologizing for reference to certain publishers of trade papers and journals. The open-minded reader would not take issue over these references or feel any stigma attached to sources of data, and the opinion of the superficial, suspicious reader doesn't matter.

CHESTER H. JONES.

Personal

Dr. WILDER D. BANCROFT, professor of chemistry at Cornell University, delivered an address before the Chicago Section of the American Chemical Society on "Contact Catalysis" on Nov. 6. The Chicago Chemists' Club gave a special luncheon for Dr. Bancroft at noon the same day. Dr. Bancroft also spoke before the students at Chicago University and Northwestern University the following week on "Colloids" and "Drops, Bubbles and Grains."

Captain D. B. BRADNER, acting director of research at Edgewood Arsenal, has resigned his commission and will continue his duties as a civilian.

ARTHUR HOWE CARPENTER has accepted the position of assistant professor of metallurgy at the Armour Institute of Technology, Chicago, Ill.

RICHARD H. CATLETT has resigned as production manager of the Taylor Chemical Co., Penn Yan, N. Y., to be chemical engineer with the Lewis Recovery Corp., Boston, Mass.

SIDNEY CORNELL will be engaged in professional work in Philadelphia for some time to come and can be addressed at 28 Cliveden Ave., Glenside, Pa. Mr. Cornell still retains his New York office at 80 Maiden Lane.

W. A. DEAN has resigned from the technical staff of the Dorr Co., New York, and has accepted a position as manager of the Gulf Reduction Co. His post office address will be Camp Walton, Fla.

SHERMAN EATON, who was formerly with the Wharton Steel Co., Wharton, N. J., is now with the Continental Clay Co., Langley, S. C.

Colonel C. W. EXTON has been transferred from the Infantry to head the training section of the Chemical Warfare Service. Colonel Exton, in addition to having been graduated from West Point, has been through the service schools of Fort Leavenworth and recently was graduated from the General Staff College. During the war he was Commandant at the service schools in France, in which emergency Chemical Warfare officers were among those trained.

ALBERT H. FAY is now valuation engineer, Oil and Gas Section, Internal Revenue Bureau, Washington, D. C.

LOUIS J. GUREVICH, research metallurgist, research department, Hydraulic Steel Co., Cleveland, Ohio, has been transferred in like capacity to the Canton Sheet Steel plant of the same company at Canton, Ohio.

A. L. HEILBRUNN of the Fleischmann Yeast Co., Chicago, spoke before the Chicago Chemists' Club recently on "Industrial Fermentation."

RAYMOND M. HOWE, of the Mellon Institute, spoke at the regular monthly meeting of the Pittsburgh Foundrymen's Association at the Hotel Chatham, Pittsburgh, Nov. 15. Mr. Howe spoke on refractories, with special reference to their application in foundry practice.

WALTER LAIB, who has been with the Ohio Salt Co., Rittman, Ohio, for nine and a half years as chief chemist and general superintendent, has resigned to assume the position of treasurer and sales manager of the Cleveland Match Co.

ROBERT J. MCKAY, superintendent of the research department of the International Nickel Co., of Bayonne, N. J., is now industrial fellow at the Mellon Institute, Pittsburgh, Pa.

Miss JESSIE E. MINOR, who has been for several years the chief chemist for the Hamersley Manufacturing Co. of Garfield, N. J., has recently moved to Springfield, Mass., to take charge of the pulp and paper department of the Emerson Laboratory at 145 Chestnut St. Miss Minor was for several years a graduate student at the University of Pennsylvania and later studied at Bryn Mawr, where she received the degree of Doctor of Philosophy in chemistry. She also spent several years studying industrial conditions in the Union of South Africa.

HARRY S. MULLIKEN has been engaged by the Bureau of Mines to act as special technical assistant to Director F. G. Cottrell. Mr. Mulliken's appointment puts into effect a plan which has long been considered of having a technical engineer attached directly to the office of the director. Mr. Mulliken is a graduate of the Worcester Polytechnic Institute. He began industrial metallurgical work with the Chicago and Aurora Smelting & Refining Co. He has since served as superintendent of the Pilot Bay, B. C., lead smelter; assistant superintendent of Gregg Refineries at Perth Amboy, N. J.; superintendent of the Aguascalientes Smelter of the American Smelting & Refining Co.; general superintendent of the Peñoles Co., at Mapami; superintendent of the American Metals Co., in Mexico. During recent years Mr. Mulliken has been practicing as a consulting engineer, with offices in New York.

BERT RUSSELL, who left the Patent Office a little over a year ago after extended service in its various chemical divisions, will, on Dec. 1, 1920, leave the service of Prindle, Wright & Small, New York City, to accept employment in the office of Roy F. Steward, chemist and patent attorney, McLachlan Bldg., Washington, D. C.

H. A. SCHWARTZ has become manager of research for the National Malleable Castings Co., Cleveland, Ohio.

LEWIS B. SKINNER, chemical and metallurgical engineer, of Denver, Col., is now connected with the Midwest Refining Co.

E. A. CAPPELEN SMITH has been awarded the gold medal of the Mining and Metallurgical Society of America for distinguished contributions to hydrometallurgy.

ARTHUR H. SPURLOCK, formerly of the American Refractories Co., has become treasurer, in charge of finances, accounting, credit, collections, etc., of the H. H. Robertson Co., Pittsburgh, Pa.

Dr. WILLIAM H. WALKER, after twenty-five years of active service in teaching and research in applied chemistry and chemical engineering at the Massachusetts Institute of Technology, has tendered his resignation as director of the division of industrial co-operation and research, to take effect on Jan. 1, 1921. He will resume his consulting practice which was interrupted in 1917 by his entering the service, and although no longer officially connected with the institute, will maintain his interest in the development of the division and will closely co-operate with it in the fulfillment of the contracts under the Technology Plan already existing. This division acts for the Institute of Technology in the administration of its obligation incurred under the Technology Plan by which over 200 of the most prominent industries of the country have made contracts involving annual retainer fees of over a quarter million dollars. Dr. Walker will be succeeded by Prof. Charles L. Norton, professor of industrial physics at the institute and director of the Research Laboratory of Industrial Physics.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Nov. 15, 1920.

Consumers have not lent active support to the chemical market during the week. Some trace of an irregular buying movement was inaugurated, but the punch has been lacking and operations were not impressive. There are many different opinions as to when a resumption of live trading will be noticed and even the best informed find it quite impossible to make any definite prediction, since no parallel situation has ever been witnessed before in the chemical market. Export orders reached the market in moderate quantities, principally for heavy chemicals to Europe. *Formaldehyde* prices were greatly depressed by large resale offerings and the market drifted into new low territory. Final quotations ranged from 24c. to 25c. per

lb. Small lots of *borax* are being moved at 9½@10c. per lb., according to time of delivery and quantity. Sales of brown, broken *acetate of lead* are reported by producers at 15⅝c. per lb., while white crystals are moving at 15@15½c. per lb. The inquiry is reported fairly active and supplies show no signs of accumulation in any direction. dealers offer carlots of powdered *sodium bisulphite* at 6⅜c. per lb. and 7c. in smaller quantities. This chemical has been in rather limited supply of late, but seems to be getting in better shape for prompt delivery. *Nickel salts* has been a surprise to local consumers, who expected a decline. Leading producers have not altered former quotations and are holding the single variety at 16c. per lb., and the double at 14c. per lb. *Barium chloride* has been reduced by leading holders, owing to the large supplies that were recently imported from Europe. Ton lots have changed hands as low as $85 per ton. This seemed to be an inside figure and the general quotations heard range from $90 to $95 per ton.

Coal-Tar Products

Buying of a very conservative order is still in evidence in practically all branches of the coal-tar market, with orders directed entirely to the present consumption. In producing quarters most factors realize the quiet conditions, but find sufficient business to keep plants in fair operation. Bituminous coal supplies and prices are reported quite favorable and tend to a steady production of crude by-products. *Aniline oil* retains its easy tendency, with the demand very light and supplies available in first hands at 27@30c. per lb. depending upon quantity. Leading factors in *benzaldehyde* report sales limited to small lots, with prices ranging for the technical grade at 65@70c. per lb. and U.S.P. at $1@$1.50 per lb. *Paratoluidine* remains quite firm in the hands of producers. The demand is sufficient enough to keep prices steady at $1.85 per lb. *Xylene* is heard only in light routine demand and prices range from 45c. to 50c. per gal. *Napthalene* is meriting more interest among intermediate manufacturers and contract prices over next year are heard at 14c. per lb. Very little business is being turned at this figure and consumers are keenly looking forward to more normal prices.

Sodium Salts Over 1920

The beginning of 1920 was the signal for a sharp impetus to all *sodium salts*. Reports from leading producers of an acute coal shortage brought *bichromate of soda* to the front with smashing advances ranging from 18c. per lb. in January to 45c. per lb. quoted in April, its brightest month. *Caustic soda* began its gradual climb during January and reached its peak in April. The incessant demand from all parts of the world, together with the abnormal railroad conditions, brought about a severe shortage on spot markets and domestic consumers were forced to pay a premium from second hands. *Soda ash* followed in sympathy with *caustic soda*. A novel feature of the market was the sensational rise of *nitrite of soda* from 14c. per lb. to 50c. per lb. Domestic manufacturers were hampered by a shortage of soda ash, one of the main constituents in its production, and importations were almost at a standstill. During March, 1920, a shipload of *nitrite* was ruined by an explosion and within forty-eight hours the price advanced from 15c per lb. to 50c. per lb. All other *sodium salts* listed here have followed suit with the leaders due to the vast accumulation of export orders on the American market. Prices since June, however, have gradually been declining to a normal basis. Depreciation in foreign exchange, ample supply of coal, more stable conditions in railroad transportation and keener competition have brought prices back to a pre-war situation. Manufacturers are once more striving to place business directly with the domestic consumers at prices which are satisfactory to both parties. The past few months have seen a radical change in general business principles. Contracts on leading chemicals have been placed with consumers through first hands only. This step practically does away with the dealer who, through his unscrupulous speculation, has proved so disastrous to the chemical industry.

SODIUM SALTS

Article	Jan.—March	April July	Aug.-Oct.
Acetate soda	7@8½c.	9@12½@11½c.	11½@8½c.
Soda ash, 100 lb.	$2.25@$3.50	$3 75@$3 10	$3@$2 25
Bichromate soda	18@40c.	45@24c.	22@12c.
Caustic soda, 100 lb.	$4 50@$6 50	$7@$6	$5 50@$4@$4 35
Cyanide soda	25@30c.	30@40c.	60@40@28c.
Nitrite soda	14@50c.	50@17c.	15@8½c
Prussiate soda	22@32c.	32@26c.	25@22c.
Sulphide soda	5@6½c	7@10c.	10@7c.

Naval Stores

Turpentine during the week has been very quiet and prices are still falling, with $1.20 per gal. the prevailing midweek quotation. It is generally assumed that owing to the recent dullness throughout the naval stores list supplies of *rosins* and *turpentine* have been accumulating and that a large surplus now exists in the Southern market. However, the present levels are so close to production cost as to make a curtailment of output necessary and an estimate places the material on hand equivalent to five months' consumption. *Rosins* are nominally in the same position, with offerings of $12.75 for B-N and $13@$13.25 for W.G-W.W. grades being turned down by consumers.

Miscellaneous Materials

There is a comparatively firm undertone in the *shellac* market and routine business has not suffered any great depression. Demand has been sufficient to sustain the A.C. garnet grade around 90c. and orange superfine at $1.05@$1.10 per lb. *Blanc fixe* has fallen off under pressure of accumulating supplies and the pulp grade is available at 3@3½c., while the dry grade in considerable quantities can be purchased at 5@5½c. per lb. Buyers continue to pay 14@18c. per lb. for *casein*, depending upon source and quantity, and it is not expected that this price will be lowered.

The Chicago Market

Chicago, Ill., Nov. 11, 1920.

The outstanding feature of the trade is the fact that, while demand continues light and supply plentiful, there are practically no distressed lots in sight, indicating that the speculative element has largely been eradicated. Suplies of all lines are in the hands of producers or legitimate dealers, this indicating that any future price movements will be toward a stable base and not the result of manipulation.

In no line does there seem to be any buying beyond immediate requirements, and the prevailing slowness in all other lines is directly affecting many chemicals. This is particularly true of coal-tar products. The anilines not only are contending with a fall season of unprecedented slowness in the textile industry but are also facing imports from abroad of sufficient volume to affect stocks materially. Low grain quotations and livestock markets are keeping oils at a low level and naval stores, owing to the lack of construction work, have failed to show their customary November strength. Flaxseed receipts continue heavy at primary points, with linseed oil prices correspondingly weak.

Heavy Chemicals

Alcohol leads in interest by reason of sharp reductions in *methyl* grade and in *denatured*, the former being priced now at $1.90@$1.95 per gal. for 95 per cent and the latter at 85c. for 96 per cent. *Ethyl* grade is held firm at $5.60 per gal. for 190 proof. The reductions mentioned have not brought any noticeable stimulation about. *Formaldehyde* is heard of as offered at prices all the way from 22c. to 28c. per lb., with transactions few and of small volume. *Mercury* is another weak spot, being quoted at $60 per flask and some being sold at a dollar or two less. A topheavy market points to a further drop.

Reports from the East of heavy receipts of *bleaching powder* have depressed an already weak market and none can be sold above 5½c. per lb. Holders of stock are reluctant to let go at this figure and a negligible amount of business is the result. *Soda ash* is also very weak, spot offers of $2.05@$2.15 per 100 lb. attracting few buyers. *Caustic*

soda is quoted at \$2.25@\$2.40 for immediate delivery and is in fair demand with the higher figure most closely reflecting present worth. *Soda cyanide*, off in demand and plentiful in supply, is offered at 28c., but 27c. could buy it. *Glycerine*, in spite of curtailed production, continues to encumber the market, with dynamite grade offered at 20c., including drums, and very little sold. It is freely stated that further reduction is looked for.

With the sole exception of *nitric*, acids show weakness in price and poor demand. *Nitric* is being taken up about as fast as offered, prevailing price being about 7c. per lb. for 36 deg. *Acetic acid*, 28 per cent, is nominally 3c. per lb. and 60 deg. *sulphuric* \$16 a ton, with trading so dull that quotations mean very little.

Coal-Tar Products

A small amount of business is reported in crudes, principally in benzene, naphtha and toluene. Intermediates are so dull that quotations are purely nominal. *Aniline oil* is quoted at 30c. a lb., *aniline salt* at 38c. and all related products are similarly weak. *Toluene* has witnessed some real demand and has changed hands at 38c. per gal. *Benzene*, at 36c. per gal. is quite firm and *naphtha*, with plentiful supply, is held firm at 35c. The long continued lack of demand in this class of goods seems to point to some additional price reductions before long.

Vegetable Oils

A great deal of complaint is heard by consumers of vegetable oils that while their prices of finished products have been materially reduced the public is still being forced by the retailer to pay high prices, thereby keeping consumption at a low figure and accentuating the stagnation of the trade. Trading in this line is inactive, prices being largely nominal. On the local market *linseed oil* is off to 91c. per gal. in sellers' tanks f.o.b. the city and to \$1.17 in single barrels from jobbers' stocks. Even these prices induce but little buying. Reports of frost in Argentina and fluctuating prices on flaxseed in Minneapolis and Duluth have failed to give any color to the market. *Cottonseed oil* continues to drop, planters' "strikes" to the contrary not supporting prices. Most recent offers are for crude in cars at the works, 7½c. per lb., and for prime summer yellow in sellers' tanks Chicago, 9½c. Crude *corn oil* is offered at 9c. in tanks here, and *red oil* is nominally 10¾c. in car lots, with no buyers.

Naval Stores

Naval stores are as quiet as other lines, but prices remain fairly steady. In barrels, out of stock in small lots, *turpentine* brings \$1.29 per gal. The end of the season is approaching in the South and industrial demand is keeping up, so that the future trend should be either firm or upward. *Rosin* is quoted at \$13.20 for W.W. and W.G., and only 15c. less for inferior grades. Current fluctuations in foreign exchange cause the export demand of the future to be questionable and this, in turn, is inducing caution on the part of domestic purchasers.

The St. Louis Market

St. Louis, Mo., Nov. 12, 1920.

Compared with the enormous activity of the war years present demand may be considered at a low ebb, but heavy chemical producers do not express themselves pessimistically. They state that the volume of business is satisfactory, considering general business conditions, and that a large part of their production for the coming year is on contract, with many other contracts not yet up for renewal. Shipments on contracts have fallen off very little, but spot business is rather dull. Contract prices remain higher than those of last year, but are below the market prevailing several months ago.

Demand for *66 deg. sulphuric acid* remains fairly steady, but prices have declined for bulk lots, going down to \$22 per ton from \$24. The price in carboys remains at 1¾c. per lb., carload lots. The demand from the oil refineries is becoming stronger and producers believe it will continue that way as long as the reserve oil stocks of the country continue to decline. The *98 per cent* sulphuric acid market is quiet, and is quoted at \$25 per ton f.o.b. works. The *60 deg.* acid is holding firmly at \$16.50 per ton, or 1¼c. per lb. in carboys. *Oleum* is firm at \$28.50 per ton.

Stocks of *muriatic acid* are smaller, although demand remains slow. Present price is 1¾@2c. per lb. in carboys, against 2@2¼c. two weeks ago. In bulk it remains at \$25 per ton.

There is a steady demand for *sodium bisulphate* (niter cake) and on this item prices have advanced. It is quoted now at \$7@\$8 per ton, as against \$5@\$6 two weeks ago.

Nitric acid demand is fairly strong and prices are steady. Deliveries are normal. Quotations are \$7 per 100 lb. for the 36 deg. test and \$10 per 100 lb. for the 42 deg. test. Standard mixed acid is held nominally at 1½c. per lb. for the sulphuric content and 11½c. per lb. for unit of nitric, with fairly good inquiry.

Zinc chloride shows activity, the contract price having advanced to \$4.50 per 100 lb., against \$4 two weeks ago. Demand for U. S. Government supplies of *phenol* is quiet with prices at 12c. per lb. in lots of 15 tons or more.

The Iron and Steel Market

Pittsburgh, Nov. 12, 1920.

Production of steel ingots in October was at the rate of about 42,950,000 gross tons per annum, the highest rate shown for any month since December, 1918, with the exception of February and March of this year. The increase over the rate in both September and August, however, was only one-half of 1 per cent. During the month there was a more or less steady decrease in the rate of production, and this decrease has continued, so that the rate today is much below the average of October. Furthermore, production was aligned differently, in October, among producers. Some independent producers curtailed output very materially, while some may have increased their output, and the Steel Corporation, plentifully supplied with orders, certainly did so. The October rate of production is not likely to be equaled until the iron and steel industry has completed its readjustment.

The Steel Corporation's unfilled obligations decreased by 537,952 tons in October, this comparing with decreases of 430,234 tons in September and 313,430 tons in August, while in the fourteen preceding months there had been increases of various amounts.

The October decrease in unfilled obligations was equal to 39 per cent of rated capacity, while shipments may be estimated at about 87 per cent of capacity, which would indicate 48 per cent of capacity for the net bookings, the total bookings minus the cancellations, for even the Steel Corporation, with prices much below those of the independents has had some cancellations. Net bookings at 48 per cent of capacity in October compare with bookings of 53 per cent in September, 57 per cent in August and 85 per cent in July, similarly computed. This decrease in bookings is plainly much less than the decrease in market demand for steel products, and the divergence is readily explained. Ever since the independent prices soared above those of the Steel Corporation the corporation has been offered much more business than it accepted. Of late, in changed circumstances, the corporation has been in position to accept a larger proportion of the business offered, and thus its bookings have not decreased as rapidly as the sum total of market demand has decreased. The independents have been getting the overflow, and the overflow has decreased in correspondingly exaggerated ratio.

Steel Prices

In one sense the finished steel market is yielding rather rapidly, for there are price declines when the volume of tonnage that can be secured by cutting prices is quite limited. In another sense it is yielding quite slowly, for when everyone is convinced that independent prices are going to settle at least as far as down to the Steel Corporation level one might expect prices to decline at once and be done with the operation. The explanation, of course, is that steel mills with a considerable volume of contract

business on books are indisposed to cut prices when to do so would be to encourage cancellation of the business they already have.

The Steel Corporation prices are of course unaltered. In the independent market black sheets are down a quarter cent in the week to 6c., galvanized being correspondingly 7.50@7.75c. Bars, shapes and plates remain generally at 3c., with more likelihood of the price being cut for a desirable order. All effort to obtain $8.50 for tin plate has been abandoned, and odd lots arising in stock are offered at $7.50.

Pig Iron

A week ago foundry pig iron was quotable nominally at $45 valley. Quotations have since been made by furnaces at $40, without any important sales being made, and the market is quotable at $40. Bessemer remains quotable at $42 and basic at $38.50 valley. Declines from the top points reached in August now amount to $10 in foundry and basic and $6.50 in bessemer. Part of the declines may be described as practically voluntary reductions on the part of furnaces. Now there is a new attitude. The furnaces see no occasion to make further reductions except when offered suitable inducements by way of actual orders. They point out that the reductions are really large, yet almost no orders have resulted and it is time for consumers to offer inducements. No effort is made to deny that further reductions must come, but there is evidently plenty of time left. Where the market will eventually turn no one ventures to predict. A price of $28.50 for basic iron would probably be considered quite low in most quarters, but if $28.50 were to be the eventual turning point, then in declining from $48.50 to $38.50 half the total decline has already occurred, and the furnaces consider that quite a concession, particularly for a period of less than two months.

Future of Steel Prices

It is curious that it is commonly if not universally predicted that the independent steel market will decline to the Steel Corporation level, the market then being stabilized, and practically no thought is given to the important point that if the independents are forced to go down to the corporation level it will only be in such circumstances that they will be forced to compete for business, in which case it is a fair presumption that they will cut the Steel Corporation prices. No independent shows a disposition voluntarily to drop to the corporation level. Any decline will be forced by lean order books. Hence while the common prediction is that the independents will get down to the corporation level a more precise prediction would be that the Steel Corporation prices are the only prices at which the independents are unlikely to sell.

In some circles the possibility is now being referred to of the Steel Corporation itself reducing its prices somewhat. The corporation's policy is that of seeking moderate profits only, and the profits have no doubt been eminently satisfactory, particularly in view of the very conservative accounting methods the corporation unquestionably follows. Costs may come down somewhat, although only so recently as Aug. 26 the freight advances effected a large increase in costs. Possibly the corporation may readjust prices on the basis of relative costs, reducing some prices and leaving others alone.

There is a large latent demand on the part of the railroads which are now operated under legislation that seems to insure a fair return, making railroad investment safe if not especially profitable, while there is such control that makes it certain large railroad purchases will not be made unless it is clear the prices are right. If a resumption of buying of steel products is to be led by the railroads the price readjustment may have to be more drastic than would otherwise be the case. It is possible also that there is considerable latent buying by way of investment construction, in cases in which the prospective investors have definite ideas as to the prices they will be charged, and their attitude may have to be taken into account when the steel market finds its eventual turning point in the matter of prices.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.65 - $0.75
Acetone	lb.	$0.15¾ - $0.16½	.16¾ - .17
Acid, acetic, 28 per cent	100 lbs.	3.50 - 3.75	4.00 4.50
Acetic, 56 per cent	100 lbs.	7.50 - 8.00	8.50 9.50
Acetic, glacial, 99½ per cent, carboy	100 lbs.	11.50 12.00	12.50
Boric, crystals	lb.	15½ 16	16½ - 19
Boric, powder	lb.	15½ 16½	.17 .20
Citric	lb.		54 55
Hydrochloric (nominal)	100 lb.	1.85 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	16½ 18
Lactic, 44 per cent tech.	lb.	10 - .11½	12 16
Lactic, 22 per cent tech.	lb.	04½ - .05½	.06 - 07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 5.00
Muriatic, 20 deg. (see hydrochloric).			
Nitric, 40 deg	lb.	.07 07½	.08 08½
Nitric, 42 deg	lb.	07½ 08	08½ 09½
Oxalic, crystals	lb.	23 24	24½ 25
Phosphoric, Ortho, 50 per cent solution	lb.	.19 - 20	21 - 22
Picric	lb.	28 - .35	.40 - 50
Pyrogallic, resublimed	lb.	2.30 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	11.00 12.00	.....
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	18.00 19.00	
Sulphuric, 66 deg., drums	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 30.00	37.00 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 30.00	38.00 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	2.00 35.00	40.00 - ..
Tannic, U. S. P.	lb.	1.45 1.50	1.55 1.65
Tannic (tech.)	lb.	.60 70	.80 .90
Tartaric, crystals	lb.		49 52
Tungstic, per lb. of WO	lb.	.. -	1.20 1.40
Alcohol, Ethyl (nominal)	gal	5.75 - 6.25	.. ..
Alcohol, Methyl (see methanol)		-	
Alcohol, denatured, 188 proof (nominal)	gal.	.. -	1.12 - 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	-	1.05 - 1.10
Alum, ammonia lump	lb.	.04½ - .04¾	.05 - .05½
Alum, potash lump	lb.	05½ - .06	.06½ - .07
Alum, chrome lump	lb.	14½ - .15	.16 - .17
Aluminum sulphate, commercial	lb.	.03½ - .03¾	.04 - .04½
Aluminum sulphate, iron free	lb.	.04½ - 05	05½ - .06
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ - .09½	.09½ .10½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 - .35	.36 - .38
Ammonium carbonate, powder	lb.	14½ - .15½	16 - .16½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.13½ - 13¾	14 .14½
Ammonium chloride, granular (gray salammoniac)	lb.	.12 13	.13½ .14½
Ammonium nitrate	lb.	- 10	11 .14
Ammonium sulphate f.o.b. New Orleans	lb.	.05 - .05½	.06 - .06½
Amylacetate	gal	. -....	4.50 - 5.00
Amylacetate tech	gal	..-..	4.00 - 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	13½ - .13½	.14 - .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	18 - .19	.19½ - .20
Barium chloride	ton	90.00 - 95.00	100.00 - 105.00
Barium dioxide (peroxide)	lb.	.24 - .25	.26 - .27
Barium nitrate	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - 05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		.. - ...	... -......
Blue vitriol (see copper sulphate)		......-......	......-......
Borax (see sodium borate)		......-......	......-......
Brimstone (see sulphur, roll)		...-.....	......-......
Bromine	lb.	.70 80	.85 - .90
Calcium acetate	100 lbs.	3.50 - 3.55	.. - ...
Calcium carbide	lb.	.05½ - 06	.06½ - .06¾
Calcium chloride, fused, lump	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated	lb.	02 - 02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	lb.	05½ - 05¾	.06½ .06¾
Calcium peroxide	lb.	. . . .	1.50 - 1.70
Calcium phosphate, monobasic	lb.	. - .	.75 - .80
Calcium sulphate, pure	lb.	. . - .	.25 - .30
Camphor	lb.	.	1.10 1.15
Carbon bisulphide	lb.	.08 - 09	.10 - .11
Carbon tetrachloride, drums	lb.	13 - .14	.16 - .17
Carbonyl chloride (phosgene)	lb.	. -. .	1.25 - 1.50
Caustic potash (see potassium hydroxide)		.. - .. .	. . -. ...
Caustic soda (see sodium hydroxide)		. -	.... -. ....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - 09½	.10 - .10½
Chloroform	lb.	.40 - 43	.44 - .47
Cobalt oxide	lb.	. . -. .	3.75 - 4.00
Copperas (see iron sulphate)		. -	.... - .....
Copper carbonate, green precipitate	lb.	.27 - 28	.29 - .31
Copper cyanide	lb.	. . -.	.65 .70
Copper sulphate, crystals	lb.	.07½ - .08	.08½ - .09
Cream of tartar (see potassium bitartrate)		. -	. ...
Epsom salt (see magnesium sulphate)		... - .. .	.. . -......
Ethyl Acetate Com. 85%	gal.	. . .	1.05 - 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		. .	....
Formaldehyde, 40 per cent (nominal)	lb.	25 26	27 - .28
Fusel oil, ref	gal.	-	4.25 - 4.50
Fusel oil, crude (nominal)	gal.	. - .	3.25 - 3.50
Glauber's salt (see sodium sulphate)		... - .	.. . -. ...
Glycerine, C. P. drums extra	lb.	. -. . .	27½ - .28
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	. -. . .	15 - .25
Iron sulphate (copperas)	100 lbs.	2.25 - 2.50	2.75 - 3.00
Lead acetate, normal	lb.	-	13½ - .16
Lead arsenate (paste)	lb.	13 - 14	14½ - .15
Lead nitrate, crystals	lb.	-	.90 - 1.00
Litharge	lb.	12 - 12½	13 - .13½
Lithium carbonate	lb.	-.	1.50 - ...
Magnesium carbonate, technical	lb.	11½ - 12	12½ - .13
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.25	-.
Magnesium sulphate, commercial	100 lb.	.... -..	3.50 - 3.60
Methanol, 95%	gal	-.	2.70 - 2.75
Methanol, pure	gal	. .	2.90 - 3.00
Nickel salt, double	lb.	. ... - .	.14 - .14½
Nickel salt, single	lb.	......-......	.16 - .16½
Phosgene (see carbonyl chloride)		.... -....	. . . -
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	......-.....	.35 - .37
Potassium bichromate	lb.	.22½ - .23	.23½ - .24

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$0.45 - $0 47	$0.48 - $0.49
Potassium bromide, granular	lb.	..... -	.45 - .50
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.17½ - .18	.18½ - .19
Potassium chlorate, crystals	lb.	.18 - .18½	.19 - .20
Potassium hydroxide (caustic potash)	lb.	.16½ - .16¾	.17 - 17½
Potassium iodide	lb.	..... -	3.20 - 3.30
Potassium nitrate	lb.	.14 - .16	.16½ - .17
Potassium permanganate	lb.	.63 - .68	.70 - .75
Potassium prussiate, red	lb.	.73 - .75	.78 - .80
Potassium prussiate, yellow	lb.	.36 - .37	.37½ - .38½
Potassium sulphate (powdered)	ton	$240.00 - 255 00	..... - .....
Rochelle salts (see sodium potas. tartrate)		..... -	..... - .....
Salammoniac (see ammonium chloride)		..... -	..... - .....
Sal soda (see sodium carbonate)		..... -	.....
Salt cake	ton	..... -	52.00 - 55.00
Silver cyanide (nominal)	oz.	..... -	1.25 - .....
Silver nitrate (nominal)	oz.	..... -	.60 - .62
Soda ash, light	100 lb.	2 15 - 2.25	2.30 - 2.50
Soda ash, dense	100 lb.	2.50 - 2 75	3.00 - 3.25
Sodium acetate	lb.	.08½ - .09	.09¼ - .09½
Sodium bicarbonate	100 lb.	2.90 - 3.00	3.25 - 3.50
Sodium bichromate	lb.	.10½ - .10¾	.11 - .11½
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ - .07½	.08 - .09
Sodium borate (borax)	lb.	.09½ - .10	.11 - .12
Sodium carbonate (sal soda)	100 lb.	2.00 - 2.10	2.15 - 2.25
Sodium chlorate	lb.	.14½ - .15	.15½ - .16½
Sodium cyanide, 96-98 per cent	lb.	.28 - .30	.31 - .32
Sodium fluoride	lb.	.20 - .20½	.21 - .22
Sodium hydroxide (caustic soda)	100 lb.	4 10 - 4.30	4 60 - 4.75
Sodium hyposulphite	lb.	.....	.04 .04½
Sodium molybdate	lb.	2 50 -	3.25 - .....
Sodium nitrate	100 lb.	3.00 -	3.25 - .....
Sodium nitrite	lb.	07¾ - .08	.08¼ - .08½
Sodium peroxide, powdered	lb.	.50 - .51	.51½ - .52
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.37 - .38
Sodium prussiate, yellow	lb.	.20½ - .21	.21½ - .22
Sodium silicate, solution (40 deg)	lb.	.01½ - .01¾	.02 - .02½
Sodium silicate, solution (60 deg)	lb.	.02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	2.15 - 2.50	2.60 - 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	07 .07½	.07½ - .08
Sodium sulphite, crystals	lb.	.04 - 0 4½	.04½ - .05
Strontium nitrate, powdered	lb.	.20 - 20½	.21 - .22
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	..... - .....
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	.. -	3.70 4.35
Sulphur, roll (brimstone)	100 lb.	.. -	3.40 - 3.90
Tin bichloride, 50 per cent	lb.	18 - .19	.. - .....
Tin oxide	lb.	..... -	50 - .51
Zinc carbonate, precipitate	lb.	.16 .18	.19 - .20
Zinc chloride, gran	lb.	12 - 13	.13½ - .14
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, XX	lb.	11 - .11½	..... - .....
Zinc sulphate	lb.	.03½ - .03¾	.04 - .06

Coal-Tar Products

NOTE - The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.10 - $1.15
Alpha-naphthol, refined	lb.	1 45 - 1.50
Alpha-naphthylamine	lb.	48 — .50
Aniline oil, drums extra	lb.	.27 — .30
Aniline salts	lb.	.32 — .33
Anthracene, 80%, in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f f c)	lb.	2 00 — 2.10
Benzidine, base	lb.	1.15 — 1.20
Benzidine sulphate	lb.	1.10 — 1.15
Benzoic acid, U S.P.	lb.	.80 — .85
Benzoate of soda, U S P.	lb.	.80 — .90
Benzene, pure, water-white, in drums (100 gal)	gal	.35 — .40½
Benzene, 90%, in drums (100 gal)	gal	.33 — .38½
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta-naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta-naphthol, sublimed (nominal)	lb.	.90 — .95
Beta-naphthol, tech (nominal)	lb.	.46 — .49
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P , in drums (100 lb)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10 — 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 — 1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzene	lb.	.07 — .10
Diethylaniline	lb.	1 45 — 1.50
Dimethylaniline	lb.	.90 - .95
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.27 — .32
Dinitronaphthalene	lb.	.42 — .45
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	38 — .40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.80 — .85
H-acid (nominal)	lb.	1.65 — 1.70
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.18 — .20
Monoethylaniline	lb.	1.75 — 2.25
Napthalene crushed, in bbls. (250 lb)	lb.	.08½ — .09
Napthalene, flake	lb.	.08½ — .09
Napthalene, balls	lb.	.09 — .09½
Napthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.32 — .35
Para-amidophenol, base	lb.	2.50 — 3.00
Para-amidophenol, HCl	lb.	2.50 — 3.00
Para-dichlorbenzene	lb.	.10 — .15
Paranitroaniline	lb.	1.15 — 1.20
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.50 — 2.65
Para-toluidine	lb.	1.85 — 2.00
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .14
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	2.90 — 3.00
Resorcinol, pure	lb.	3.75 — 4.15
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35 — .38
Salicylic acid, U. S. P.	lb.	.40 — .45
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 — .35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .22
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.75 — 1.80
Toluidine, mixed	lb.	.45 — .55
Toluene, in tank cars	gal.	.35 — ..
Toluene, in drums	gal.	.41 — .42
Xylidines, drums, 100 gal.	lb.	.50 — .65
Xylene, pure, in drums	gal.	.45 — .47
Xylene, pure, in tank cars	gal.	.45 — ...
Xylene, commercial, in drums, 100 gal	gal.	.37 — .38
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.31 — $0.33
Beeswax, refined, light	lb.	.34 — .37
Beeswax, white pure	lb.	.55 — 60
Carnauba, No. 1. (nominal)	lb.	.80 — .90
Carnauba, No. 2, regular (nominal)	lb.	.70 — .80
Carnauba, No. 3, North Country	lb.	.25 — .26
Japan	lb.	.19 — .20
Montan, crude	lb.	.12 — .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.08 — .08¼
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.08 — 08¼
Paraffine waxes, refined, 118-120 m p.	lb.	.09 — .09¼
Paraffine waxes, refined, 125 m.p	lb.	.09½ — .09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10¾ — 11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13¾ — .14¼
Paraffine waxes, refined, 135-137 m.p.	lb.	.14¾ — .15¼
Stearic acid, single pressed	lb.	.17¼ — .17¾
Stearic acid, double pressed	lb.	.18¾ — 19
Stearic acid, triple pressed	lb.	.22½ — .23

Flotation Oils

All prices are f o b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls , gross weight, 500 lb.

Pine oil, steam dist , sp. gr , 0.930-0.940	gal.	$1 90
Pine oil, pure, dest dist	gal	1 50
Pine tar oil, ref , sp gr. 1 025-1.035	gal	.48
Pine tar oil, crude, sp gr 1 025-1.035 tank cars f o b Jacksonville, Fla	gal	.35
Pine tar oil, double ref , sp gr 0 965-0 990	gal	75
Pine tar, ref , thin, sp. gr , 1 080 1.960	gal	36
Turpentine, crude, sp gr , 0 900-0 970	gal	1 25
Hardwood oil, f o b Mich , sp gr , 0 960-0 990	gal	35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$12.75 — .
Rosin E-I	280 lb	12.75 — ...
Rosin K-N	280 lb.	12.75 — ....
Rosin W G -W. W	280 lb.	13.00 — 13.25
Wood rosin bbl	280 lb.	11 00 — .
Spirits of turpentine	gal	1.20 — .
Wood turpentine, steam dist	gal	1.16 — .
Wood turpentine, dest dist	gal	1.10 — .
Pine tar pitch, bbl	200 lb.	..... — 8 50
Tar, kiln burned, bbl. (500 lb.)	bbl.	. — 15 00
Retort tar, bbl	500 lb.	15.00 - 15 50
Rosin oil, first run	gal.	.70 — ..
Rosin oil, second run	gal.	.73 — .
Rosin oil, third run	gal.	.90 — .....

Solvents

73-76 deg., steel bbls. (85 lb)	gal.	$0.41
70-72 deg , steel bbls. (85 lb)	gal.	.39
68-70 deg , steel bbls. (85 lb)	gal.	.38
V. M and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.22 — $0.23
Upriver coarse (nominal)	lb.	.15 — .16
Upriver caucho ball (nominal)	lb.	.16½ — .17½
Plantation—First latex crepe	lb.	.19 — ...
Ribbed smoked sheets	lb.	.18 — .....
Brown crepe, thin, clean	lb.	.16 — ...
Amber crepe No. 1	lb.	.17 — ...

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.14½ — $0.15
Castor oil, AA, in bbls	lb.	.15¾ — .16½
China wood oil, in bbls. (f o.b. Pac. coast)	lb.	.13¾ — .14
Cocoanut oil, Ceylon grade, in bbls	lb.	.14 — .14½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.15¾ — .16½
Corn oil, crude, in bbls	lb.	.11 — .11½
Cottonseed oil, crude (f.o.b. mill)	lb.	.08 — .08½
Cottonseed oil, summer yellow	lb.	.11¾ — .12½
Cottonseed oil, winter yellow	lb.	.13¾ — .14
Linseed oil, raw, car lots (domestic)	gal.	1.00 — ...
Linseed oil, raw, tank cars (domestic)	gal.	.95 — ...
Linseed oil, boiled, car lots (domestic)	gal.	1.01 — ...

Olive oil, commercial	gal.	2.75 —	3.00
Palm, Lagos	lb.	.10¼ —	.10½
Palm, Niger	lb.	.09½ —	.09¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¾ —	.09
Peanut oil, refined, in bbls	lb.	.15 —	.15½
Rapeseed oil, refined in bbls	gal.	1.15 —	1 20
Rapeseed oil, blown, in bbls	gal.	1.25 —	1.35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	.11½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.08½ —	.08¾

FISH

Light pressed Menhaden	gal.	$0.65 —	$0 70
Yellow bleached Menhaden	gal.	.67 —	70
White bleached Menhaden	gal.	.72 —	75
Blown Menhaden	gal.	1.05 —	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	- $30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	- 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	— 12.00
Barytes, floated, f.o.b. St. Louis.	net ton	26 50	- 28.00
Barytes, crude, first grade, Missouri	net ton	10.00	— . .
Blanc fixe, dry	lb.	.05	— .05½
Blanc fixe, pulp	net ton	60 00	- 65 00
Caseine	lb.	14	— 18
Chalk, domestic, extra light	lb.	.05	.06
Chalk, domestic, light	lb.	.04½	05½
Chalk, domestic, heavy	lb.	.04	05
Chalk, English, extra light	lb.	.05	— 07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb.	04½	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00	- 12.00
China clay (Kaolin) washed, f.o.b Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f.o b Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f.o.b Virginia points.	net ton	8 00	12.00
China clay (Kaolin) ground, f o b Virginia points.	net ton	15.00	- 40 00
China clay (Kaolin), imported, lump	net ton	25.00	- 35 00
China clay (Kaolin), imported, powdered	net ton	30.00	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	— 14 00
Feldspar, crude, f.o.b. Maine	net ton	7 50	10 00
Feldspar, ground, f o.b Maine	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	- 21 00
Feldspar, ground, f.o.b. N Y State	net ton	17 00	— 21 00
Feldspar, ground, f o.b Baltimore	net ton	27.00	- 30 00
Fuller's earth, granular, f o b Fla ,	net ton	25 00	—
Fuller's earth, powdered, f.o.b Fla ,	net ton	18 00	—
Fuller's earth, imported, powdered	net ton	35.00	- 40 00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.		— .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	07	09
Graphite, higher lubricating grades	lb.	11	— 40
Pumice stone, imported, lump	lb.	04	- 50
Pumice stone, domestic, lump	lb.	06	
Pumice stone, ground	lb.	04	07
Quartz (acid tower) fist to head, f o b Baltimore	net ton		10 00
Quartz (acid tower) 1½@ 2 in , f o b Baltimore.	net ton	.	— 14 00
Quartz (acid tower) rice, f o b Baltimore	net ton	..	17 00
Quartz, lump, f.o b North Carolina	net ton	5.00	7.50
Shellac, orange fine	lb.	.	
Shellac, orange superfine.	lb.	1 05	1 10
Shellac, A C garnet	lb.	90	- 95
Shellac, T N	lb.	.85	95
Soapstone	ton	15.00	25 00
Talc, paper-making grades, f o b Vermont.	ton	12.00	- 22 00
Talc, roofing grades, f o b. Vermont	ton	9.50	15 00
Talc, rubber grades, f o b. Vermont	ton	12.00	18 00
Talc, powdered, Southern, f o b. cars	ton	12 00	- 15 00
Talc, imported.	ton	60 00	70 00
Talc, California Talcum Powder grade	ton	20 00	45 00

Refractories

Bauxite brick, 56% Al , f.o b Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55–60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o b. Eastern shipping points	net ton	60–65
Fire clay brick, 1st quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	55–60
Fire clay brick, 2nd quality, 9-in shapes, f.o.b Pennsylvania, Ohio and Kentucky works	1,000	45–50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f.o b. Mt. Union, Pa	1,000	55 60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18 —	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.17 —	.18
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00 —	175.00
Ferro-manganese, 76-80% Mn, English	gross ton	165.00 -	170 00
Spiegeleisen, 18-22% Mn	gross ton	75.80 —	80.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.50
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	85.00
Ferro-silicon, 75%	gross ton	...... -	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.75 —	.90
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	8.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 11 4% moisture	gross ton	$10.00 —	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70	.75
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.65 —	.75
Coke, foundry, f o.b. ovens	net ton	12.50 —	13.00
Coke, furnace, f.o.b. ovens	net ton	11.50 —	12.00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00 —	26.00
Fluor spar, lump, f o b Tonuco, New Mexico	net ton	17.50 —	.
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00 -	27.50
Ilmenite, 52% TiO_2, per lb. ore.	lb.	.01½ —	.01¾
Manganese Ore, 50% Mn, c i f Atlantic seaport	unit	60 —	70
Manganese ore, chemical (MnO_2)	gross ton	70.00 -	80.00
Molybdenite, 85% MoS_2, per lb of MoS_2, N Y	lb.	65 —	70
Monazite, per unit of ThO_2, c i f , Atlantic seaport	unit	35 00 —	...
Pyrites, Spanish, fines ,c i f , Atlantic seaport	unit	12 —	
Pyrites, Spanish, furnace size, c i f, Atlantic seaport	unit	.17 —	
Pyrites, domestic, fines, f o b mines, Ga	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore.	lb.	.15 —	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	6.00 —	.
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y C	unit	4.50	5 00
Uranium Ore (Carnotite) per lb of U_3O_8	lb.	2 75	3 00
Uranium oxide, 96% per lb contained U_3O_8.	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb of V_2O_5 contained	lb.	2.00 —	
Zircon, washed, iron free	lb.	.05 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	14.75
Aluminum, 98 to 99 per cent	32.90
Antimony, wholesale lots, Chinese and Japanese	6.12@ 6 25
Nickel, ordinary (ingot)	43 00
Nickel, electrolytic	45.00
Tin, 5-ton lots	39 00
Lead, New York, spot	7.00 7.25
Lead, E. St Louis, spot	6.80–7 05
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.60

OTHER METALS

Silver (commercial)	oz	$0 91¼
Cadmium	lb.	1 40@ 1 50
Bismuth (500 lb. lots)	lb	2 55
Cobalt	lb	6 00
Magnesium (f o b. Niagara Falls)	lb	1 75
Platinum	oz	85 00@ 90 00
Iridium	oz	350 00@ 400 00
Palladium	oz	80 00@ 85 00
Mercury	.75 lb.	58 00@ 60 50

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb
Copper sheets, hot rolled	24 50
Copper bottoms	34 00
Copper rods	29.00
High brass wire and sheets	27 50
High brass rods	19 00
Low brass wire and sheets	30.50
Low brass rods	24 00
Brazed brass tubing	36.25
Brazed bronze tubing	41.50
Seamless copper tubing	28 00
Seamless high brass tubing	27 00

OLD METALS —The following are the dealers' purchasing prices in cents per pound.

	New York — Current	New York — One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 50	17 00	12 00	13 50
Copper, heavy and wire	12 00	16 00	11 75	12 50
Copper, light and bottoms	10 00	14 00	10 00	11 00
Lead, heavy	5 50	4 75	5 50	6 00
Lead, tea	4 50	3 75	3 75	5 00
Brass, heavy	7 00	10 50	8 00	12 50
Brass, light	5 50	7 50	5 00	6 50
No. 1 yellow brass turnings	7 00	10 00	6 00	6 75
Zinc	4 50	5 00	3 75	5 00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named.

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.15	$4.47	$3 47	$3.44	$3 37	$4.08	$3 47
Soft steel bars	4.15	4 62	3 37	3 84	3 27	3 98	3 37
Soft steel bar shapes	4.15	4.62	3.37	3 84	3 27	3.98	3 37
Soft steel bands	5.50	6 32	4.07	6 25	..	...	
Plates, ¼ to 1 in thick	4.15	4.67	3 67	3 64	3 57	4 28	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

NORWALK—The St. George Pulp & Paper Co., 6 Smith St., has awarded the contract for the construction of a 1-story, 65x65-ft. addition to its manufacturing plant on Smith St., to A. R. Malkin Co., 3 Mechanic St. Estimated cost, $15,000.

District of Columbia

WASHINGTON—The General Purchasing Officer of the Panama Canal will receive bids until Nov. 26 for furnishing 6,000 lb. Venetian red, in oil, 300 gal. black locomotive black, grade No. 2, 1,000 lb. Indian red, in oil, 300 lb. green commercial chrome, dry, medium, 10,000 lb. lampblack, in oil, 300 gal. green enamel, 1,000 gal. varnish, damar, white, 3,000 gal. creosote oil, 150 gal. sperm oil, 10,000 gal. linseed oil, 200 gal. muriatic acid, 3,000 lb. lump sulphur, 20,000 lb. lump calcium chloride, 2,000 lb. chloride of lime, 15,000 lb. lye, 100,000 lb. soda ash, 6,000 lb. caustic soda, 3,000 lb. oakum.

Idaho

IDAHO FALLS—The Howard Pulp & Paper Co. is having plans prepared for the construction of a news print paper factory including a power plant. Estimated cost, $4,000,000. T. L. Tomlines, City Bank Bldg., Syracuse, N. Y., engr.

Illinois

CHICAGO—The Alemite Die Castings & Mfg. Co., 314 West Chicago Ave., has awarded the contract for the construction of a 1-story, 150x272-ft. building at 2640 Belmont Ave., to C. B. Johnson & Sons, 111 West Washington St. Estimated cost, $150,000. Equipment to cost $200,000 will be installed in same.

CHICAGO—The Purity Packing Co., 1620 West 21st St., plans to construct a 2-story addition to its present plant.

CHICAGO—Theonett & Co., 2558 Armitage St., plans to build a bottling plant on Belden Ave. between Springfield and Crawford Aves. Estimated cost, $150,000.

Iowa

FORT DODGE—The Bd. Educ. has awarded the contract for the construction of a 3-story, 190x260-ft. high school to Madsen & Peterson, 616 Builders Exch., Minneapolis, Minn. A chemical laboratory will be installed in same. Estimated cost, $645,300. Noted Oct. 13.

SHELLSBURG—The Bd. Educ. will receive bids about Jan. 15 for the construction of a 3-story, 80x110-ft. grade high school. A chemical laboratory will be installed in same. Estimated cost, $160,000. A. K. Rife, secy. J. G. Ralston, 709 L. & J. Bldg., Waterloo, archt.

Kansas

CANEY—The city is having plans prepared for the construction of a filtration plant. Black & Veatch, Mutual Bldg., Kansas City, Mo., engrs.

Maryland

BALTIMORE—The City Council has awarded the contract for the construction of a 3-story, 76x271x50x241-ft. school at 76 Latrobe Park to the Standard Constr. Co., 1713 Sansome St., Philadelphia, Pa. Estimated cost, $195,000.

Massachusetts

SOMERSET—The Somerset Stove Fdry. Co. has awarded the contract for the construction of a 1-story, 70x160-ft. foundry to Beattie & Cornell, 33 North Quarry St., Fall River. Estimated cost, $50,000. Noted Oct. 6.

SOUTH HADLEY—Mt. Holyoke College plans to build a science building. Estimated cost, $500,000. M. E. Wooley, pres.

Michigan

RIVER ROUGE—The Bd. Educ. will soon award the contract for the construction of a 3-story high school on Dearborn Rd. A chemical laboratory will be installed in same. Estimated cost, $750,000. A. R. Heuer, pres. Van Leyen, Schilling, Keough & Reynolds, 556 Cass Ave., Detroit, archts.

Minnesota

ATKIN—The Bd. Educ. is having plans prepared for the construction of a 2-story, 102x125-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $175,000. Henry S. Swanson, Crosby, archt. and engr.

New Jersey

ATLANTIC CITY—The Bd. Educ., Atlantic and Pacific Aves., plans to build a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $1,000,000.

RIDGEFIELD—The Continental Folding Paper Box Co., 122 Washington St., Brooklyn, N. Y., will soon award the contract for the construction of a 2-story, 100x500-ft. factory on Grand Ave. and Hall St. W. B. Wills, Inc., 1181 Myrtle Ave., Brooklyn, N. Y., archt. and engr.

New York

POUGHKEEPSIE—The State Hospital Comn., Capitol, Albany, will receive bids until Dec. 1 for the construction of additions and alterations to the water supply system, including additional filters, etc., at the Hudson River State Hospital here.

Ohio

IRONTON—The Ironton Firebrick Co., Hayward Bldg., plans to build an addition of two 30-ft. round downdraft kilns.

MARION—The city is having plans prepared for the construction of a sanitary sewer system and sewage disposal plant. Estimated cost, $1,000,000.

YOUNGSTOWN—The city is in the market for laboratory equipment, etc., at the Municipal Contagious Hospital. Estimated cost, $60,000.

Pennsylvania

GREAT BEND—The N. H. Parke Leather Co. is having plans prepared for the construction of a 3-story, 75x200-ft. tannery. Estimated cost, $150,000. Lockwood, Green & Co., 101 Park Ave., New York City, archts and engrs.

PHILADELPHIA—The Belmont Packing & Rubber Co., 133 North 2nd St., has awarded the contract for the construction of a 2-story, 130x190-ft. addition to its plant on Coral and Wheatsheaf Sts., to G. Kessler Constr. Co., Drexel Bldg., Philadelphia, Pa. Estimated cost, $60,000.

Texas

DALLAS—The Baptist Memorial Sanitarium, Junius and College Sts., is having plans prepared for the construction of a 5-story, 100x120-ft. hospital. Chemical laboratories will be installed in same. Estimated cost, $800,000. C. D. Hill & Co., S. W. Life Bldg., archt.

DALLAS—The City and Dallas Co. are having plans prepared by H. M. Greene, archt., North Texas Bldg., for the construction of a hospital to cost about $450,000. The city voted $225,000 bonds, county will vote equal amount. Chemical laboratory equipment, including X-ray, etc., will be installed in same. F. W. Wozencraft, mayor.

LUBBOCK—The West Texas Sanitarium Association is having plans prepared for the construction of a 4-story sanitarium. A chemical laboratory will be installed in same. Estimated cost, $110,000. Henry T. Phelps, Gunter Bldg., San Antonio, archt.

RANGER—The Ranger Boiler Wks. plans to build a sheet steel and sheet iron manufacturing plant. Estimated cost, $100,000. L. C. McFall, pres.

Wisconsin

CLEAR LAKE—The Bd. Educ. will receive bids about Dec. 15 for the construction of a 2-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, $75,000. E. Enderbohn, clk.

MERRILL—The Secretary of the Bd. Educ. will receive bids about Dec. 15 for the construction of a 2-story, 140x178-ft. grade school and a 75x120-ft. addition to the high school. A chemical laboratory will be installed in same. Estimated cost, $260,000. Parkinson & Dockendorff, Linker Bldg., Lacrosse, archts. and engrs. Noted Oct. 6.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deshler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN GAS ASSOCIATION is holding its second annual convention at the Hotel Pennsylvania, New York, Nov. 15 to 20.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS is holding its convention in Denver Nov. 15 to 19.

AMERICAN PETROLEUM INSTITUTE will hold its annual meeting on Nov. 17, 18 and 19 in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

AUTOMOTIVE EQUIPMENT ASSOCIATION is holding its second annual exposition in the Coliseum, Chicago, Ill., this week. Trucks, automobiles, tractors, motor buses and equipment for airplanes and submarines will be displayed. Meetings are at the Congress Hotel.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

FEDERATED AMERICAN ENGINEERING SOCIETIES will hold its first meeting in Washington, D. C., Nov. 18 and 19. American Engineering Council will hold its organization meeting Nov. 20. Headquarters for both will be at the New Willard Hotel.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY, will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

TAYLOR SOCIETY will hold its annual meeting Dec. 2, 3 and 4 in the Engineering Societies Bldg., New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Volume 23 — New York, November 24, 1920 — Number 21

New Import and Export Classification Needed

WITH the expansion of the chemical industries, it has become necessary to rely more and more for commercial information upon the statistics of imports and exports compiled by the Bureau of Foreign and Domestic Commerce. There is urgent need for a new classification of these figures, as well as for the consolidation of the Bureau of Customs Statistics of the Treasury Department and the Bureau of Foreign and Domestic Commerce of the Department of Commerce. A plan to put these reforms in effect has been agreed upon by all concerned, but unless Congress can be induced to provide the necessary funds before Jan. 1, it will be necessary for the improvement to be delayed for another year.

As a result of studies begun some time ago, new classifications have been arranged. The new import classification covers 984 separate commodities, as compared with 700 in the present schedule. The export classification likewise has been increased from 700 items to 1,234. It was expected that these new schedules would be put into effect Jan. 1, 1921, but the additional work demanded of the Statistical Division of the Bureau of Foreign and Domestic Commerce, owing to the tremendous growth of chemical imports and exports since the war, makes it impossible to start work under the new classification unless Congress provides additional funds for statistical work.

At its last session Congress was asked by the Secretary of Commerce for $400,000 for compiling foreign trade statistics, but no appropriation was made. It was proposed at the same time to transfer the control and expense of operation of the Bureau of Customs Statistics in the New York Custom House from the Treasury Department to the Department of Commerce and perhaps consolidate it with the Division of Statistics of the Bureau of Foreign and Domestic Commerce. The estimate of $400,000 is approximately double the present cost of these two statistical bureaus which it is proposed to unite, but the additional amount was expected to take care of extension of import and export classifications; introduce more efficient methods for compiling and publishing monthly and annual reports; compile statistics of exports by states of origin; furnish special statistical statements to interested parties in more detailed form than is customary in the monthly summary; and otherwise improve the statistical service for the benefit of the Government, trade and commercial organizations and firms engaged in foreign trade. The advantages of this consolidation and improved service will be quite obvious to those who now have to deal with the separate bureaus.

It is now planned to request the Appropriations Committee of Congress to hold a special hearing on this estimate in advance of the hearings on the annual appropriations for the fiscal year commencing with July, 1921, for the purpose of explaining the necessity for additional appropriations for statistical work in order that the revised import and export schedules may be put into effect Jan. 1, 1921. According to law the annual report on statistics of commerce and navigation of the United States with foreign countries is published with the close of a calendar year, thus making it necessary to initiate changes in the classification at the beginning of a calendar year. It is to be hoped that a post-war measure of such importance will receive sympathetic treatment at the short session of Congress, and we suggest that representatives of the industries concerned exert all legitimate influence to bring this about.

Production Costs And Commodity Prices

NO DOUBT a great many persons would disagree with a statement that in the orgy of high commodity prices from which the country has now begun to emerge prices were dictated by costs, and yet as to many industries there is ground for maintaining such a position. Of course the qualification must be made that very large profits were added to the costs before the selling prices were named, but that is another story. The manufacturer saw that it was a "sellers' market" and in endeavoring to produce at the maximum rate possible he had no incentive to hold down his costs, for any extra cost could be added to the selling price, with a liberal toll in profits.

The new idea in manufacturing is that selling prices are going to dictate costs. The seller is not going to make prices in future, as there is to be a "buyers' market." The buyer knows very little about costs, but is good at making comparisons between prices of the various things he buys. He may not be able to tell from its looks whether a factory makes overcoats or shoes, but if he finds that overcoats have come down to a certain relation with the pre-war price he expects shoes to do the same, or *vice versa*, according to which is the lower. When copper is selling at less than its 1913 price and less than its ten-year pre-war average he is suspicious of pig iron when it does not do the same thing. If the pig iron producer cites his costs the buyer, having now an opportunity to speak, is likely to say, "So much the worse for your costs." Then the merchant-furnaceman is likely to have a conference with the coke producer and the iron ore producer.

The great explosion has been the explosion of the theory that the dollar is worth only fifty or forty cents, or perhaps the proverbial thirty cents. One can spend

his dollars for copper, or pig iron, or wheat, or cotton, or movie shows, or various other things. The tables are turned. The profiteers talked about forty-cent dollars. Now the buyer has an opportunity to talk and he will inquire why his dollar will not buy as much of one thing as of another.

Time is a great corrective, and time is going to aid the buyer in coming into his own. If the producer has costs that are too high he will be given time to correct the situation. If the workman is still spending money and does not want to work hard he will be given time to spend the money and reform his mind.

In the readjustment of costs two distinct elements that make up costs are to be recognized. One of the elements is the efficiency of the manufacturing organization that produces, while the other is the profit of some one from whom raw materials or supplies are purchased. The first item is being shaken out. Machinery is as efficient as formerly, while some workmen are not. They do not produce as much per day as formerly. Every day of late one has heard of cases of a factory closing for one day or two days a week and finding its output increased instead of diminished, or of cases of 10 or 15 per cent of the workmen being "laid off," with the remainder producing more than the full quota had previously produced.

There are few manufacturing industries that do not buy large quantities of supplies. Those supplies have been high priced and have increased the cost. When inordinate profits are eliminated the costs of the manufacturer or assembler will be reduced. If the reduction does not occur voluntarily time will be given for reflection. While in the past increases have been handed up the line to the final selling price to the ultimate consumer, reductions will now pass down the line. The country will not be really active industrially until it engages in the construction work that is so much needed, the work for which the investor pays, and the investor will have definite ideas of what a construction job should cost him.

Western Industrial Growth
And Its Influence on Chemical Development

ECONOMICALLY the increase in population of the Western states is of more than local interest. The rapid growth of a few rather limited areas has resulted from agricultural or from industrial developments that have gained impetus during the last decade. Arizona and Montana, through irrigation, have become agricultural, no longer to be considered as mining states only. California south of Tehachapi is becoming an industrial region. Even in the San Joaquin and Sacramento valleys, which have become one almost continuous garden, there is considerable manufacturing in the larger cities. The San Francisco Bay district, at the gateway of an important avenue of trade, no longer handles only the articles of commerce passing through the port, but is supplying manufactured products of its own for export and for shipment to other sections of the country; in 1919 the value of manufactures was over $750,000,000. More than two hundred new industries have been established during the first nine months of this year in the San Francisco district, and this number has been exceeded in the territory contiguous to Los Angeles. The Columbia River basin is developing along manufacturing lines and, together with British Columbia has established a paper and pulp industry which should become of more than local importance. While the Puget Sound country and the Northwest as a whole is principally a lumber-producing region, the output of manufactured products is increasing. So the mountain states are emerging from the mining and grazing into the agricultural, and the Pacific Coast states from the agricultural and lumbering into the industrial stage of economic development.

The chemical industry is not a pioneer; it follows rather than leads and grows best where general manufacturing has become well established. Along the Pacific Coast where raw materials are available the chemical industries have a fertile field for growth, not only to meet local needs but also to supply the rapidly developing Oriental market for chemical products.

Good Rails Are More
Than Sulphur Prints

TO WHAT end are all Dr. BURGESS' tests? "Why, to separate good rails from bad ones," is the ready rejoinder. But do they? These tests, probably the most minute study ever made of a rail rolling, performed in painstaking detail, picture rails of all sorts, like men from all over the globe—black, yellow, high cheek-boned, dolichocephalic. And they're all good! Witness the report from the railroad company: "There have been no failures of Hadfield rails or of the Maryland Specials."

A metallographist, if asked to state the fundamental axiom of his science, might respond that metallographical uniformity is synonymous with metallurgical excellence. But he would be placing the cart before the horse, for it is not always true even that metallurgical excellence demands microscopic homogeneity; furthermore excellence certainly does not stop with uniformity, nor is metallurgy limited by the microscope. Following analogous sophisms, are not metallographists, chemists and testing engineers in danger of building up a picture of what good metal ought to look like, analyze like, and test like; and then when they find a piece of metal which approximates this masterpiece, say, "Behold, here is a really excellent rail"?

Perhaps Dr. BURGESS has fallen into this trap when he says, "Recalling the greater uniformity of the sink-head over the comparison ingots as shown in nearly all other mechanical tests, in less segregation, greater homogeneity as shown by sulphur prints and etching, less amount and variability in discard to sound steel, the question of the significance and interpretation of the drop test may, it would seem, be raised with propriety," and then cites as evidence against the drop test the fact that it failed to show differences among the three Maryland heats. It was unmistakably able, however, to distinguish between the Hadfield ingots and the Maryland ingots, and the latter stood punishment better, something apparently which was not expected.

What does Service, the court of last resort, say? Its only remark as to relative quality is: "The average abrasion of the No. 1 Hadfield rails was 0.42 sq.in., that of the Maryland Special rails 0.37. Abrasion for No. 2 rails was 16.1 per cent for Hadfield and 9.7 per cent for Maryland Special."

CHEMICAL & METALLURGICAL ENGINEERING has been glad to devote all necessary space to present the record of the work described by Dr. BURGESS. It is instructive in many obvious ways, possibly not least of which is the reflections it ought to excite in the mind of a philosophical metallurgist—if there is such a person.

Trade Wastes and Stream Pollution

ATTENTION is directed by WILLIAM H. WELLS, of the New York State Conservation Commission, in a recent number of *Science*, to the need of more intensive study of the pollution of streams from trade wastes. When we consider the millions spent in carrying water to cities, in protecting watersheds, in filtering, etc., we observe how needful is uncontaminated water. A stream is, in a way, a living thing in which a great biological equilibrium is and must be maintained. As soon as this is disturbed we meet dangers to health and disturbance in the cycle of life. Sometimes one small industry is enough to bring this about, and unless precautions are taken the wastes of many industries are almost certain to do it. If the oxygen dissolved in water becomes diminished, the fish will suffocate, for water is to fish what both earth and air are to land animals. Organic wastes have the power to absorb oxygen from the water, and thus make it uninhabitable for fish life. It is rare indeed that fish are no more found in streams because of overfishing. They swim away to other waters because they cannot get enough air, or because they meet some trade waste that makes life unbearable to them.

The amount of contaminating material a water can absorb without injury to its various uses is strictly limited by the rate at which such substances may undergo physical or chemical change. This, in turn, depends upon the biological capacity of the stream to bring about this change.

Every trade waste needs special study, and splendid work has been done in individual instances. Generally speaking, however, we let by far too much pollution into our streams, using them merely as vehicles of transportation to carry offensive matter from our neighborhood to another whence fish have long since departed. There is room for much improvement in this connection. So far as pollution by sewage is concerned we believe that as soon as some practical method of drying sewage is discovered we shall see all of the sludge turned to inoffensive nitrogen fertilizer, while the chlorinated effluent will harm neither man nor beast.

Only Applied Research Produces Profit

A SOUND theory is always valuable, a correct result of careful research is always an asset; but until translated into useful and used form neither produces any dividends. In no field is this more certain than in chemical industry.

In his recent address, "Thrift in Coal," delivered before the Iron and Steel Institute on Oct. 22, GEORGE OTIS SMITH stressed this point very effectively. He was speaking of boiler-firing results in a large plant which prided itself on the high-grade fuel burned, about 15,000 B.t.u. per pound. This plant was getting only the equivalent of about 11,000 B.t.u. because of poor operating practice, and it is with full justification that Dr. SMITH said of the manager: "That coal user needed expert firemen more than chemists—better practice rather than more theory."

Such a situation might seem at first thought to be an indictment of the chemist. In some cases the defect is chargeable to the research man or the chief of the laboratory, but more frequently it is probably the manager or superintendent who is at fault. Any competent chemist, whether engaged only for the control laboratory work or for original research, is a potential asset. However, his value as an operating asset is only potential until the manager gives him an opportunity, indeed, encouragement, for direct application of laboratory results in the plant.

Teamwork in the relationship between chemist and superintendent or chemist and manager is a first essential. Each has an important element to contribute in the application of the laboratory results. The laboratory data are cold figures without the interpretation of the chemist. But an impossible situation and impractical results may often result if the interpretation is solely upon the basis of laboratory ideas. A sympathetic understanding of the limitations of the laboratory as well as cordial appreciation of its possibilities will do much to vitalize the product of the workers with beaker and test-tube. On the other hand an intelligent study of the practical plant problems by the chemist, combined with tact and patience in seeking to apply laboratory results, is also an essential prerequisite to success.

Knowing Something About The Other Fellow's Business

DURING the discussion of a paper before the American Zinc Institute in Chicago recently someone stated that one of the reasons for the high recovery of zinc in European smelting practice was the fact that the clays used in making the retorts were of better quality abroad. If the Institute had been informed in the work of the American Ceramic Society this erroneous observation would have been immediately challenged, for the fact is that the United States produces clay of every sort equal to or better than the European product; and that several grades of German clay held at a premium previous to the war now sell at a discount on the American market. The metallurgist must work with the ceramist to find the solution of the problem of iron, lime and silica content in zinc slags, and the consequent reactions on retorts; to know that a refractory composition is often made less refractory by the addition of a more refractory material to the mix, as shown in eutectic diagrams. In turn the ceramist must be advised as to the composition of various ores and slags in order to select the better clays for refractories. Only by a constant interchange of ideas during the rapid progress of both industries can the best results obtain.

It is equally necessary that the chemical engineer be informed as to the efforts of the mechanical engineer in improvement of machine design. Glaring examples of lack of such knowledge exist in many chemical plants today, with absurd designs worked out by chemists where standard machinery might have been applied. Likewise the chemical engineer must also know the better structural methods developed by the civil engineer, or much waste results.

And so on in every line of engineering practice. Instances might be multiplied, all leading to the conclusion that progress will be most effective when we have the closest co-operation among related interests. Just how this can best be accomplished is problematical. Much depends upon the general intelligence and breadth of vision of the individual—upon a natural realization of the incompleteness of his own profession and its probable dependence in some detail or other on a related subject. The next best thing to knowing a subject first-hand is to know where to look for the information. Usually it is to be found close at hand, though sometimes in unexpected places.

Readers' Views and Comments

The Chemist and the Coking Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much pleasure the article by R. S. McBride on "The Chemical Profession, Its Opportunities and Responsibilities," which appeared in CHEMICAL & METALLURGICAL ENGINEERING of Sept. 8.

In this article I note the following paragraph:

> We have whole industries neglected by the chemist. Coking, except in a very few cases, is undirected by science. It remains a mechanical-engineering art, almost, in fact, a trade, so largely is it guided by rule-of-thumb methods.

I presume that in writing the above the author had especially in mind the beehive coking industry, regarding which the statement is entirely correct. I think we can say, however, that the coking industry in America is today the byproduct coking industry. It is some years since the production of byproduct coke exceeded that of the beehive oven and the problems that are before the producers and users of coke are essentially confined to the byproduct oven. The United States Geological Survey stated in its last annual report on this subject that the capacity of the byproduct coking plants of the country is now approximately 80 per cent of the total requirements of the metallurgical coke users.

If we accept this statement, I believe there is no doubt that there are only a very few industries in America in which the chemist plays a more important part. The two systems of byproduct coking which are prominent in this country are represented by the Koppers Company of Pittsburgh and ourselves. The Mellon Institute of Pittsburgh is very largely given over to research work. This was founded by the financial interests which control the Koppers Company and it is working very closely with that company in the solution of chemical problems which constantly come up in the development of the byproduct coking industry. Our own company has an organization of considerably over one hundred chemists, outside of those doing routine work, and the time of these men is largely taken up in the study of problems connected with the development of the coking process and the use of the products obtained therefrom. Practically every proposed modification of an old method and every problem connected with a new method, or with a different or more complete utilization of products, is submitted to be worked out by these research men, and every process connected with the industry, from the routine analyses of the coals used clear through to the finished products ready for shipment, is constantly checked by our chemists.

Not only is this the case in the operations of the two companies named, but every independent operator of byproduct ovens has its organization of chemists, and the United States Steel Corporation, which operates a considerable number of plants, has an important central laboratory in which the men are constantly engaged in research work, looking to the betterment of the operation in addition to the routine checking of every part of the process which, as far as I know, is carried out at every byproduct coking plant in the country.

I know you will be glad to have these facts and I believe the byproduct coking industry is one of the best examples of the importance of the chemist in the development of modern industry.

Semet-Solvay Co.,
Syracuse, N. Y. **W. H. BLAUVELT.**

Synthetic Production of Hydrocarbon Fuels

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest Mr. Acheson's letter in your issue of Aug. 18, and comment thereon by Mr. Birdsall on page 606 of the Sept. 29 issue.

The question raised by these gentlemen is one which will well merit attention. Mr. Birdsall's suggestion as to the production of a pure hydrocarbon i.e., pentane —in place of the natural mixed products is a likely result. In other words, when man produces a hydrocarbon he will probably excel nature, just as he generally excels her when he duplicates any natural product by controlled processes.

The gentlemen mentioned may be interested to know that I have developed a successful method of effecting an aqueous solution of carbon from cheap materials such as coke, etc., but have not as yet succeeded in producing synthetic products of commercial use.

Cleveland, Ohio. ARTHUR R. BULLOCK.

A Note on Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—Permit me to second most heartily the thought expressed in the editorial entitled "A Note on Research," published in your Oct. 13, 1920, issue. There is very grave danger that the periodical effort to "organize" and "systematize" research, which is just now in full swing, may defeat its own end. It is no more possible to place real research on a business basis than to organize the writing of poetry and music. Who, for instance, would look for a *real* contribution to dermatology from the chemist to a state geological survey, and yet this has recently happened.

University of Alabama,
Dept. of Chemistry and Chemical Engineering. STEWART J. LLOYD.

German Exporter Asks Cash Against Documents

A prominent German house exporting chemicals, drugs and related articles has published in Argentina the following statement of its terms of sale:

> In regard to our conditions of sale, we must demand payment against delivery of documents by reason of the present economic conditions. The unfavorable state of German exchange carries with it a great risk since we sell in Swiss francs. Should our exchange improve, we will experience a loss which may be very considerable between the date of the invoice and receipt of payment against documents.
>
> By giving credit to our clients this risk would be too great and we would be obliged to invoice in German marks, leaving to our customers all the risk of the exchange, a thing which is not to their interest. The payment of our invoices made out in Swiss francs may be made, according to the desire of the client, also in marks or American dollars at the exchange of the day.

Chemistry and the Food Industry

An Outline of the Far-Reaching Importance of Applying the Principles and the Technique of Biochemistry to the Solution of Problems Relating to the Industries That Use Agricultural Raw Materials

BY CARL L. ALSBERG*

THE food industry is the basic industry and the largest industry of every country. It is the key of all key industries. The value of its products far exceeds that of any other industry or of any group of them. In 1914 the foods manufactured in the United States were valued at $4,816,709,000—and this figure does not include foods which were sold for consumption without going through some form of manufacturing process. In that year iron and steel products had a value of $3,223,144,000. The largest single food industry in point of value of the finished product is that of the slaughter house, the products of which in 1914 were estimated to be worth $1,651,965,000. Improvements and economies affecting the production, preparation, distribution and preservation of food hold a place of vital importance to the people far above that occupied by any other industry.

LIMITED APPLICATION OF SCIENTIFIC RESEARCH TO FOOD INDUSTRIES

Despite the tremendous importance of the food industry, the application of the results of scientific research to it hitherto have been limited. Such efforts have been toward improving the methods of producing raw materials—that is to say, to increasing either the yield of crops per acre or reducing the labor required for the production of each food unit. Until recently, with a few exceptions such as sugar refining, milling and brewing, but little application of chemistry or chemical engineering has been made to the manufacturing of the raw material produced in agriculture into the finished product suitable for use upon the table.

The reason for this is very simple. The manufacturing of the raw materials into products fit for food was conducted practically entirely in the home. Just as carding, spinning and weaving were transferred from the home to the factory more than a century ago, so during the past few decades there has been a similar gradual transfer from the home to the factory of many of the processes of manufacturing finished food out of the raw materials. This translocation is only in its beginning. Ultimately it will have a more profound effect upon civilization than the development of the textile industries, for it will open the gates of an immense reservoir of labor, the labor of women, who comprise half the population. Whether or not the prospect is a pleasant one is another matter. Even today the demand for canned goods is a good index of unemployment. The urban laborer's wife seeks to lighten her burden, when the family is prosperous, and the first method that suggests itself is the purchase of ready-to-serve foods.

In this transfer the methods of the home were the first to be used in the factory. Usually these methods, satisfactory enough for small-scale operations, are wasteful and impracticable on a large scale. A process that may be sanitary and cleanly in the kitchen often becomes filthy and dangerous in the factory.

CHEMICAL CONTROL IN FOOD MANUFACTURING AS A RESULT OF THE FEDERAL AND STATE PURE FOOD LAWS

Until very recently, but few factories had introduced chemical methods of control. The introduction of these methods has been hastened by the necessity of controlling products to meet the requirements of Federal and state pure food laws. It is not the least of the services rendered by such legislation that it has opened the eyes of many a manufacturer to what trained men can accomplish in improving processes, reducing waste and eliminating uncertain rule-of-thumb methods. Today, in most of these plants, chemists would be retained if all food legislation were wiped off the statute books.

Food manufacturing, since it is so new as an industry, presents to the chemist a multitude of problems, many of them of the most profound economic importance.

CHEMICAL PROBLEMS TO BE SOLVED IN THE MILLING INDUSTRY

In the milling industry, which was among the first to introduce exact factory control, there remain problems well worthy of any chemical engineer's attention; problems, the solution of which would influence human affairs as profoundly as any discovery in metallurgy. Thus wheat must be moistened—"tempering," the miller calls it—before milling. How much it is moistened depends upon the head miller's judgment. He must base his judgment not merely upon the characteristics of each lot of wheat to be milled but also upon the weather. It is self-evident that on a humid day fewer fine particles pass through a given sieve than on a dry day. If the wheat is too moist or not moist enough, or there is a change of weather which checks the dessication of the stock as it passes through the mill, particles of flour may pass over sieves that should pass through them. Thus perfectly good flour may pass into the feed-bin instead of into the flour sack. It is one of the head miller's duties, by constantly readjusting the equipment, to see that this does not occur. In doing this he relies chiefly on his judgment. There can be no doubt that if the tempering of wheat were to be done in all mills on some still-to-be-determined scientific basis; and if the operation of milling were to be conducted under controlled conditions of temperature and humidity, say in an inclosed system, the amount of perfectly good flour that could be saved for human consumption would be tremendous.

Though wheat is not a particularly good food, it is supplanting other bread grains all over the world. This is partly because it is, in a sense, a time-saving crop, and partly because it contains gluten. An hour's labor

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will produce more food energy in the form of wheat than in almost any other form. By virtue of the properties of its gluten, wheat flour when mixed with water yields a tenacious elastic mass, dough. The carbonic acid gas generated by the yeast used to leaven the dough cannot therefore escape into the atmosphere as it does from a mixture of corn flour and water. The gas bubbles are held enmeshed in the gluten in such manner that when the gluten is set by coagulation in the oven, the bread has a peculiarly desirable flavor and texture. The property of gluten to yield a tough elastic dough makes it possible to bake leavened bread. This property it owes to its physical state, and not, so far as present knowledge goes, to the chemical structure of the molecule of the proteins of which it is composed. There is, as far as it is possible to foresee at the present time, no theoretical reason why other proteins in other bread grains are not susceptible of such manipulation as to give to them the physical properties of gluten. It is a problem of colloid chemistry. To discover the method by which this can be brought about will make it possible to produce a loaf of leavened bread from other materials than wheat. The economic significance of such a discovery is so obvious that it does not require elucidation.

This is not the only problem of the cereal industries. Baking is still largely an art and not a science. Even the grading and standardizing of its basic raw material, flour, is in its infancy. Years of research will have to ensue before it will be possible to standardize fully the processes of baking and to control such factors as the reaction and moisture content of the dough and the conditions of yeast growth. Even the factors that control the "going stale" of bread are not understood. It certainly is not a mere drying out. In some localities at times as much as 7 per cent of the commercially baked bread has gone stale before it was sold.

Economic Importance of the Utilization of Grain Sorghums

One of the biggest problems of the cereal industries of the United States is the utilization of the grain sorghums, such as kafir, feterita, proso, milo maize and their relatives. The amount of land that can be kept under cultivation in the semi-arid portion of the United States, which includes much of western South Dakota, Nebraska, Kansas, Texas and much of the Southwest generally, depends to no inconsiderable degree upon the price of grain sorghum. Anything that will widen the market for this crop will inevitably make agriculture in this section more profitable and will extend the area of this very large portion of the United States that can be subjected to cultivation.

Grain sorghum has about the composition of corn. Before the war it was sold at a considerable discount under corn because practically the only outlet for it was in competition with corn as stock feed. Under normal conditions the price should be something like 15 per cent under that of corn, since it has a corresponding lower feeding value. There is, therefore, a demand for a commercial outlet for grain sorghum and it is already beginning to be used for alcohol production.

It should be possible to find a future outlet in the creation of a kafir corn products industry producing essentially the same materials as the corn products industry—i.e., starch, glucose, dextrine, oil and byproduct feeds. In addition, there are indications that wax may also be obtained. The man who creates this or a similar industry using grain sorghum as raw material will as surely confer a tremendous blessing upon the semi-arid regions of the United States as he who builds an irrigation system. This man must be a chemist or a chemical engineer.

Other Chemical Problems in the Dairy Industry

There are many other problems in the dairy industry demanding study. The production of butter and the control of its composition and texture involve problems in the chemistry of emulsions worthy of any physical chemist's attention. Indeed, it is by no means inconceivable that there is some more efficient way for cutting the emulsion which we call milk than by the ancient mechanical process of churning. The production of butter substitutes, a rapidly growing industry, presents quite analogous problems. To give to these substitutes all the nutritive qualities of butter is a problem quite capable of solution. It awaits the attention of some biochemist.

Chemical Problems in Cattle Feeds

Dairying is not the only part of animal production that is in process of being made over by the chemist. He is bringing about a revolution in the use of feeding stuffs for beef, pork and milk production. Corn, for example, is not a very efficient feed, and biochemists have shown that this is due in part to a deficiency of the corn proteins in certain amino acids. They have shown that these acids are present in abundance in such materials as cottonseed, copra and peanut cake. Such materials added to corn should make of it an efficient feed. This has been demonstrated conclusively for one of the feeding stuffs derived from corn and inappropriately known as corn gluten. Upon a diet containing corn gluten alone as the only protein, a young animal will grow but slowly. If, however, as little as one-third of copra cake, which is cheaper than corn, be added, the animal will grow rapidly. With a suitable mixture of corn and such materials as copra cake or peanut cake it is possible to produce an optimum rate of growth with as little as 10 per cent of protein, the costly ingredient of the diet. The result is that a vastly smaller amount of feed need be used to produce a pound of live weight, while the time required is immensely shortened. What the application of principles like this means to the cost of producing meat and milk and what they mean to the mixed feed industry with an annual output amounting approximately to $700,000,000 is obvious.

Chemistry in the Sugar Industry

Even the sugar industry, upon which chemists, in the creation of the beet sugar industry, have already exerted a profound influence, still presents a multiplicity of problems. It is by no means certain that sugar cane and sugar beets are the ideal sugar plants for all climates and soils. At least one other plant, the nipa palm, shows great promise, and there is no telling what of commercial value a systematic chemical survey of the vegetable kingdom would uncover. Moreover, sugar refining demands simplification so as to make possible the economical production of white sugar upon the plantation with all the economies in labor, transportation and handling therein involved. These, too, are problems that will be solved by the application of the principles of colloid, physical and biological chemistry, for they involve the removal from the sugar plant juices of colloidal materials and the control of enzyme action,

factors that are intimately connected with the formation of molasses, which the sugar house chemist usually endeavors to suppress.

Chemistry in the Industries Utilizing Sugar

There is a very great amount of work to be done in the industries that utilize sugar as their raw material, particularly the confectioner's industry. The going stale of candy is, in the majority of instances, merely the crystallization of the sugar. It should be possible by the application of the principle of physical chemistry to prevent most of these losses. Hard candies are boiled to a definite temperature mainly for the purpose of inverting a certain proportion of the sugar that they contain. This is, therefore, a more or less haphazard matter. If too little invert sugar is formed in the process of boiling the candy, the sugar will crystallize and the candy will rapidly become stale. If there is too much invert sugar formed, the candy will be hygroscopic and will become sticky in hot weather and not salable for these reasons. This is a very important problem to the confectionery industry and one that should be capable of solution by very simple chemical studies.

Chemistry of Food Flavors

Another carbohydrate industry that demands the attention of physical chemists is the manufacture of jams, jellies and preserves. The conditions for jell formations, for the inversion of the sugar, the preservation of the rich ripe flavor of fruit and the achievement of the best possible texture are all problems of colloid or physical chemistry to which practically no attention has been paid by properly trained men. It should be possible for such men to vastly improve the methods of producing these materials and to introduce very important economies and improvements in the processes. Indeed the whole matter of the chemistry of food flavors is one of tremendous economic importance, for food prices often depend not upon food value, but upon palatability. With a complete knowledge of the chemical nature of flavoring materials it would be possible to give to cheap but nourishing foodstuffs a high degree of palatability.

These problems are of the utmost importance to the canning industry since the retention in the preserved finished product of color, flavor and texture is one of the ends it is striving for. Moreover, containers and methods of sterilization have by no means been perfected. The prevention of the deterioration of canned goods, of the rusting and perforation of the cans, of the blackening and change in color of corn and other products—these are but a few of the problems that confront the chemical adviser to the canning industry. Some of these problems, no doubt, will be solved in part by abandoning canning as a means of preservation and substituting dehydration—a new and, at the moment, rapidly developing industry that presents to the chemist and the chemical engineer a host of its own peculiar problems.

Importance of Biochemistry in the Solution of Food Manufacturing Problems

An innumerable number of examples might be cited to show what the chemist has accomplished in the food industry. Such examples have been avoided on the assumption that what has been done, as, for example, in the hydrogenation of oils, will be known to the readers of this journal. It seemed preferable to give a few examples from the field that remain to be developed. It is evident from the examples given that these opportunities belong very largely to the biochemist and that future developments must follow the performance of fundamental laboratory research which, in this field as in any other, must precede practical application in the industry. Until recently the science of biochemistry has been cultivated only in medical faculties. Biochemistry in this and in other countries has been a handmaiden to medicine. The time has come when a new type of biochemist must be developed who applies the principles and the technique of biochemical research to the problems of agriculture and the problems of the industries that use agricultural raw materials. The time has come when chairs of biochemistry should be found in technical schools as well as in schools of medicine.

The Arsenic Industry in Japan

Arsenic is found in Japan as an ore, as well as being a byproduct from the smelting of copper and lead, reports Vice-Consul Goodier of Yokohama.

Ore deposits are said to be fairly large in the Prefectures of Oita, Miyazaki, Hiroshima, Hyogo, Shimane and Okayama, their percentage of arsenic ranging from 15 to 30 per cent.

In 1918, 1,828,198 lb. of ore valued at $9,204 was produced. The output increased to 2,133,281 lb. in 1919, but its value decreased to $6,975. This did not include ore used at the mines by the companies for producing arsenious acid, or crude "arsenic."

Concerning this "acid" available statistics give the total production in 1918 as 877,651 lb. and 2,862,653 lb. in 1919. Its exact value is unobtainable but may be estimated from the declared export returns of consulates in Japan, excluding Taiwan and Dairen. The total export to the United States in 1919 is given as 1,821,340 lb. with a value of $70,739, of which 1,387,388 lb., valued at $48,337, was from Yokohama. The total export from Yokohama to the United States during the first seven months of 1920 is stated as 1,102,020 lb., valued at $39,510.

Methods of Production

Arsenious acid is produced in Japan by direct reduction of arsenic ore and also as a byproduct in copper and lead smelting. The former method has been used on a small scale for the last ten years, but only quite recently have byproduct methods been installed by certain copper and lead mining companies in endeavors to consume poisonous gases, etc., from smelting operations.

Under the direct method of producing arsenious "acid" one company is said to have a capacity of about 3,333 lb. at a firing. The charge is renewed about twenty times a month. From ore of 20 per cent arsenic the output of one furnace will make approximately 13,333 lb. of crude arsenic each month.

About 20 per cent is lost in refining.

The three largest manufacturers of arsenious acid in Japan are said to approximate a monthly output of seventy tons (crude only), thirty and fifteen tons (both refined), respectively.

The arsenic content of acid thus produced by both methods is, roughly, 95 per cent in the crude and about 97 to 99 per cent in the refined.

If the industry is given adequate support by large companies, it is claimed that 4,000 tons of acid per year can be produced from known sources.

Electric vs. Combustion Furnaces for Low Temperatures

Electric Furnaces Have the Advantage in Temperature Control, Reliable and Permanent Source of Heat, and Maintenance—Cost of Power Is Counterbalanced by Economy in Space, Auxiliaries, and Operation, While the Quality of Product Is Greatly Enhanced

By FRANK W. BROOKE AND GEORGE P. MILLS

As a heating agent, electric energy was first used in a commercial way about fifteen years ago. The application made at that time was in a single-phase melting furnace. The development of the electric arc-melting furnace is well known. The application of electric energy to processes requiring low temperatures ranging up to 1,800 deg. F. (1,000 deg. C.) is more recent, but has now reached a state of perfection and during the last three years has made remarkable strides in the steel industry, many important large installations having been made during this period.

Probably one of the best means of explaining the salient points of an electrically-heated furnace is by comparing its characteristics with the characteristics of fuel-fired furnaces in general use. It is recognized that excellent results in the heat-treating field have been obtained by the use of various types of combustion furnaces, and it is our purpose not to minimize this development, but to emphasize the direction of the most recent progress.

Principle and Design

An electric furnace, whether of standard or special design, consists essentially of a steel shell properly reinforced and supported. Against the shell is laid up an ample thickness of high-grade heat-insulating brick arranged in three or four courses with all joints broken. The furnace lining of firebrick is placed inside and bonded to the insulating brick. The heating element preferably consists of very rugged ribbon resistors hung on insulating brick, which are built into the firebrick lining.

The rugged construction of the electric furnace compares most favorably with the construction of the hearth, walls and roof of the combustion type of furnace, which are necessarily cut up by ports, flues, combustion chamber, etc. These openings, being subjected to the high flame temperatures, constitute one of the chief weaknesses in the construction of the combustion furnace. The elimination of these features not only allows the most rugged construction and requires the most limited floor space, but reduces the design of the electric furnace to a scientific problem. Known quantities are dealt with throughout.

On account of the simplicity of principle and design, the electric furnace lends itself admirably to many forms of construction. Some of the more common forms are:

(1) Horizontal chamber type, in which the work is charged and withdrawn through the same door.

(2) Vertical cylindrical type with top cover.

(3) Horizontal tunnel type, in which the work is charged in one end and discharged at the other end.

(4) Car bottom type.

(5) Conveying type.

(6) Recuperative type, in which the hot outgoing work provides energy for preheating the cold incoming work.

Character of Heat

In the best type of fuel-fired furnace, the heat is generated by the combustion of the fuel with the oxygen of the air at a temperature far in excess of the actual degree required in the work to be treated. This heat is produced in a separate combustion chamber and has to be carried through a series of flues, false bottoms, double arches and port-holes, all of which absorb a considerable amount of useful heat. Even then there is a great element of uncertainty in distributing the heat uniformly over the material treated. Another phase to be considered is that, where the material to be treated is not all of uniform section, the result of the high temperature gradient is to overheat the thinner sections in order properly to heat the thicker sections. Gases leave the furnace at a high temperature, and even with the regenerative type of combustion furnace a large percentage of the heat developed is wasted.

Heat in the electric furnace is generated in resistor units distributed over the interior of the furnace, and may be produced at a temperature only slightly higher than that to which it is utilized by the work. This is important, as it eliminates the possibility of the surface of the work being overheated or burned while the inner masses are coming up to temperature. As no combustion takes place, no gas or air is blown through the furnace. On the other hand, the atmosphere in the furnace is dead or quiet, and full advantage is taken of penetrating, uniform radiant heat. The energy being confined, it is taken up by the work at the maximum rate at which the surface will conduct heat to the inner masses.

Temperature Control

Accuracy and uniformity of temperature control are obtained in the electric furnace to a degree that cannot be produced in any combustion furnace. On a small furnace all of the heating elements are connected to the power supply circuit through one automatic control panel. In larger furnaces, or where the process requires two or more different temperatures in the same furnace, the processed material being conveyed through the furnace, the heating elements are divided into separately-controlled zones. It is an easy matter to provide a complete heating, holding and cooling cycle, with time and temperature automatically controlled for the complete cycle.

On account of the fact that the heating elements may be so distributed as to radiate additional heat energy in the zones subject to the greatest losses from radiation, excellent uniformity of temperature is maintained throughout the furnace. Temperature uniformity throughout the furnace within plus and minus 5 deg. F. is the usual condition obtained.

With any form of combustion furnace it is necessary to regulate the temperature by means of rate of firing, operation of dampers or valves, which means that the temperature control is entirely dependent upon the ability of and care taken by the operator. In the combustion type of furnace it is very difficult to arrive at a true indication of the temperature of the material to be treated, owing to the fact that there is a large difference of temperature between the source of the heat namely, the flame - and the material to be treated, and also because the most usual location of a pyrometer tube is such as causes the gases to impinge upon it, which again gives an erroneous reading, both of them higher than the true reading of the work itself.

It is also a very common practice, especially in the steel industry, to "soak" the steel to be treated. This practice of soaking in combustion furnaces is usually a matter of playing safe, because there is no true method of ascertaining when the steel itself is at the correct desired temperature for the heat treatment, and the length of soaking is invariably decided on from past experience, always at the expense of the amount of fuel required per ton of steel to be treated. There is also a practice of going to a higher temperature than is really necessary, for the same reason, as the metallurgist wishes to make absolutely sure that he has gone above the recalescence point of the particular steel he is treating.

The electric furnace fulfills two very desirable objects, the first being that with first-class recorders the true point of soaking can be determined as soon as it is reached. The recorder also shows not the temperature of the furnace nor the temperature of any inpinging flame, but the true temperature of the work itself, and if the metallurgist requires a very fine grade of steel for any particular purpose he may go just as near to the recalescence point, with perfect safety, as he desires.

FUEL COMPARISONS

Oil as a fuel, especially under present-day conditions, has the following objections: It requires in proportion a very large amount of air, quite a lot of which, unless the furnace is of the muffle type, comes in contact with the material to be treated, and if this material is of an oxidizable nature it will scale. Other materials, such as enamel, may be affected or completely destroyed by contact, not only with the air, but also with the oil or products of combustion. If these features are to be avoided in combustion furnaces, muffle types of furnaces have in a good many cases to be resorted to, or else the material has to be packed with some packing material in boxes, both of which very seriously affect the thermal efficiency of the furnace and thereby the cost of fuel.

Natural gas in nearly all its present fields has to be supplemented, during certain parts of the day, by artificial gas, which at once lowers its heating value. This occurs at the time that most manufacturers require the greatest supply and, because of this demand, artificial gas has to be supplied to the main, thereby reducing its heating value at a time when it is most needed.

One of the most important political questions in the world today is to assure an adequate supply of oil for the future. Some of the figures published by the Government must give every manufacturer serious consideration for the future. In addition to this, the supply is also subject to a good many economic conditions, such as strikes, embargoes, car shortages, for which there is only one practical solution to the individual manufacturer, which is to put in a very large storage capacity. This calls for a high first cost installation and automatically increases the seriousness of the congested condition.

In the case of coal, while our future supply is undoubtedly adequate for some time to come, the same economic conditions exist.

In the case of electricity as a fuel, the manufacturer need not have any consideration for storage or future supply. The storage is taken care of for him by the large public utility companies, which by their charter, have first priority on fuel supplies, and the wonderful water-power resources have been tapped only to a small extent.

ITEMS TO INCLUDE IN FIRST COST

In comparing the first cost of heat-treating furnaces, the purchaser often compares the cost of the furnaces only. This is decidedly unfair toward the electric furnace, and a true comparison can be made only by figuring up the total first cost, not of the furnaces, but of the complete installation. Thus, in an oil-fired furnace, it is only fair to figure in the cost of storage tanks, the cost of all the piping and the cost of the blowers or compressors, as the case may be, for the air supply, and, in a good many cases, new railway sidings. In the case of coal and other fuels, it is often necessary to put in new or additional sidings, or to have trestle work, supply bins or cranes, together with handling apparatus.

The space occupied by any type of combustion furnace for a given tonnage of material to be treated per day is very much larger than any type of electric furnace. When to this is added the extra space that is always required by combustion furnaces for their auxiliaries, such as storage tanks, siding, compressor rooms, ash disposals, etc., the comparison should be given very serious consideration.

MAINTENANCE

Four or five years ago, in discussing electric furnaces of the resistance type, one of the most usual questions was: What is the life of the heating units? And the makers of the electric furnaces had to reply in terms of hours, such a thousand hours or two thousand hours, as the case may have been.

With the remarkable progress made, however, during the last three years, this has been entirely eliminated, and the life of a heating unit today may be stated to be indefinite, as heating units that have been in operation for over two years on a commercial basis, day in and day out, are still as good today as the day they were installed, and their only source of breakdown would be mechanical, when the furnace is of a poor design. The refractory lining of an electric furnace has a remarkably long life. This is because of the principle on which the furnace works, whereby the temperature of the heating units is only slightly above that of the temperature desired, and for all purposes where the electric furnace of the ribbon resistance type is used the temperature is so well within a safe limit for refractory material that there is no burning out of the bricks in the furnace.

This is not the case in combustion furnaces, where high local temperatures and impinging of the flame on such parts as baffle walls, flues, portholes, etc., cause a

very serious wearing out or breakdown of the brick lining. In the case of oil, too, there is always a lot of mechanical maintenance, due to either dirt in the oil or, during the cold weather, the oil being very heavy and choking up small parts so necessary in this type of installation. Whereas, in the case of electricity, once the busbars and wiring are installed the flow of electricity is absolutely constant.

Cost of Operation

There is one correct way in which the cost must be figured in order to arrive at a true conclusion. This is to figure the total cost of a given process per unit of salable output. The total cost must include overhead—such as taxes, interest and depreciation—which vary with the initial cost of the installation and its lasting qualities; factory space occupied; repairs and maintenance; cost of fuel, including all labor incident to the handling of the fuel and disposal of ashes and refuse.

When the total cost per day or per week is arrived at by including all of the above items, it should be divided, not by the total number of units produced by the furnace, but by the number of units which pass inspection.

It is most unfair to compare, as is often done, the cost of electricity with the cost of oil or coal on the car. With the electric furnace the heating agent—that is, the electric power—is measured by meter at the control panel and the total cost of the "fuel" is the number of kilowatt-hours used, times the rate. With the coal-fired furnace expensive labor is used from the time the coal car is placed on the siding until the ashes are placed on the dump. With the oil-fired furnace labor is necessary for the keeping of the oil storage, pumps, piping and burners in good operating condition.

High temperature gradient is not necessary in the electric furnace. The repairs and maintenance on the electric furnace, therefore, are negligible. With the oil- or coal-fired furnace, temperatures up to 3,000 or 3,300 deg. F. (1,700 deg. C.) must be taken care of in the combustion chamber and flues. The maintenance of these parts of the combustion furnace, therefore, is quite an item and must be figured.

Space occupied by the electric furnace is always less than that occupied by a combustion type of furnace. When the fuel storage capacity required by the combustion type of furnace is considered, the comparison is greatly is favor of the electric furnace. This is an item to be considered in the cost of operation.

Due to the remarkable temperature control and uniformity of heating obtained in the electric furnace, rejections due to spoiled work have always been less in the electric furnace than in any combustion type of furnace. In some classes of product very few rejections will double the cost of the heat-treating process.

The cleanliness surrounding an electrical installation of any type is too well known to require description. The high degree of insulation and the remarkable degree of thermal efficiency which can be maintained in the electric furnace result in a clear surrounding atmosphere that is never higher than the normal temperature of the shop—a feature worthy of consideration. Voltage on the furnaces is never of high order. In most furnaces arrangements can be made where the current, and thereby the heat, is automatically cut off as soon as the doors begin to open. There is no danger from explosions or "gassing," and from the safety engineer's point of view these installations are ideal.

Summary

The advantages of the electric furnace over combustion furnaces may briefly be summarized as follows:

1. Absolutely automatic temperature control.
2. Saving in labor—no handling of coal, ashes, oil, storage, pumps, etc.
3. Upkeep cost so small as to be inconsiderable.
4. Saving in space occupied.
5. Large saving in costs due to reduction of rejections in finished product.
6. Improved product.
7. High thermal efficiency.
8. Ideal shop conditions.

Philadelphia, Pa

South African Trade in Soap

The total amount of common and brown soap imported into the Union of South Africa in 1913, a pre-war year, was 6,626,476 lb., valued at $273,331, says Consul General George H. Murphy of Cape Town in *Commerce Reports*. The principal countries supplying this soap were the United Kingdom, 5,508,884 lb., valued at $224,681; Australia, 857,171 lb., valued at $37,326; and the United States, 213,169 lb., valued at $8,145.

In 1918 the total imports amounted to 725,692 lb., valued at $63,460. This was supplied as follows: United Kingdom, 172,843 lb., valued at $15,558; Australia, 154,142 lb., valued at $9,868; and the United States, 369,179 lb., valued at $34,892. The total exports in 1918, consisting almost entirely of domestic produce, amounted to 3,112,966 lb., valued at $317,325. Most of these exports went to contiguous countries in the following proportions: Madagascar, 1,162,845 lb., valued at $109,077; Southwest Protectorate, 723,441 lb., valued at $14,488; Portuguese East Africa, 337,744 lb., valued at $35,374; Belgian Congo, 258,144 lb., valued at $30,921; British East Africa, 242,299 lb., valued at $27,290; and Zanzibar, 222,437 lb., valued at $23,694.

This decrease in the imports and the large increase in the exports are due almost entirely to the establishment in South Africa during the past few years of several large soap manufacturers, among which are Lever Bros. (Ltd.), of England, which now has a practical monopoly of the laundry-soap business in South Africa. This soap retails for 1s. 9d. (42c.) for a package of six cakes, each cake being approximately 1 x 2½ x 3 in. in size.

The customs duty in the Union of South Africa on imported laundry soap is 4s. 9d. ($1.14) per 100 lb. or 25 per cent ad valorem, whichever duty shall be the greater. A rebate of 7d. (14c.) on each 100 lb. or 3 per cent ad valorem, as the case may be, is granted on the product or manufacture of the United Kingdom or reciprocating British colonies.

While the market is limited and will be even more so with the growth of the domestic industry, the only possible way in which to reach it would be by a great amount of advertising and by placing an agency in the hands of a progressive manufacturers' agent. Such manufacturers' agents often cover the whole Union, calling upon the entire wholesale trade. In placing products with one wholesale house this often restricts the business to the clientèle of that particular house, as most of the wholesalers prefer to have exclusive agency rights in the products that they handle.

The Fundamentals of the Electrolytic Diaphragm Cell*—I

Detailed Study of Brine Composition and Products During Electrolysis in Diaphragm Cells—Current, Decomposition and Energy Efficiencies—Pounds of Caustic Soda Diffused per Sq.Ft. of Diaphragm per Hour Into Saturated Brine at Varying Decomposition Efficiencies

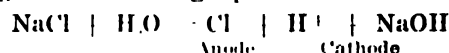
BY HUGH KELSEA MOORE

IN 1897 E. A. Allen and H. K. Moore introduced a cell in which was claimed the basic principle of having the cathode unsubmerged in the electrolyte. During the twenty-three years which have elapsed since this time this principle has revolutionized the entire cell industry in the United States.

The first experimental cells built had horizontal diaphragms submerged in a bath of kerosene oil and the caustic as it was formed on the cathode sank to the bottom of the oil and was siphoned off from the bottom. On account of danger of fire, experiments on this line were discontinued and the experiments were conducted having the cathode unsubmerged in the electrolyte but with no oil to balance the static head of the liquor in the anode compartment. Owing to the importance which the unsubmerged diaphragm cell has assumed in the electrolytic industry, it might be well to discuss the fundamental principles involved.

In order that there may be no misunderstanding in regard to the unsubmerged diaphragm cell, I wish to mention that one type of cell represented by the Hargreaves-Bird cell, used for the production of carbonate of soda and chlorine, had an unsubmerged cathode. This type of cell, however, was not available for the production of caustic soda and so far as I know has never been capable of producing caustic soda. In this cell the diaphragm was so impregnated as to prevent the percolation of the electrolyte. The unsubmerged diaphragm type of cells to which I refer allows the electrolyte to percolate through the diaphragm.

Suppose we start with the fundamentals. If a compartment filled with salt brine is divided into two parts by a permeable diaphragm and an anode is inserted in one compartment and a cathode in the other and a direct current is passed through, we have chlorine liberated at the anode and caustic soda liberated at the cathode according to the following equation:



$$NaCl + H_2O = \underset{\text{Anode}}{Cl} + \underset{\text{Cathode}}{H + NaOH}$$

If the passage of the current is continued, we obtain an electrolyte constantly decreasing in percentage of salt and constantly increasing in percentage of caustic soda. There will also be a slight increase in the percentage of water in spite of the fact that water is used up in the production of caustic soda. This is due to loss of chlorine which overbalances the loss of water. (See Table I and Fig. 1.)

In Fig. 1 it will be noticed that the term "Decomposition Efficiency" has been used and in order to prevent any misconception of terms, the author's own definitions are included throughout. Therefore this article should be read and criticised in accordance with them and not by any other definitions with which the reader may have previously been familiar.

CURRENT DECOMPOSITION AND ENERGY EFFICIENCIES

A given number of amperes will theoretically produce a given amount of caustic soda in a given time. (See Appendix.) The amount of caustic actually formed, divided by that which should be theoretically formed, is the current efficiency. For example, 303 amp. will produce 1 lb. of caustic per hour. Consequently if we have 1,212 amp. running through a brine solution for one hour and actually obtain 3 lb. of caustic soda, we have

$$3 \div \frac{1212}{303} = 75 \text{ per cent current efficiency.}$$

Decomposition efficiency is the percentage of the salt actually decomposed. Suppose a given sample of caustic effluent takes 6 c.c. of N/10 H_2SO_4 and 4 c.c. of N/10 $AgNO_3$, we have $6 \div (6 + 4) = 60$ per cent decomposition efficiency. There is a certain theoretical voltage required for the electrolysis of every electrolyte and any excess of voltage above the theoretical voltage means lost power. For example, we may consider the electromotive force required to electrolyze salt and water into caustic soda, chlorine and hydrogen as 2.3 volts. (See Appendix.)

Now if a cell runs at a current efficiency of 75 per cent with a voltage of 4.1, we have an energy efficiency of $(2.3 \div 4.1) \times 75 = 42.7$ per cent energy efficiency or power efficiency. That is, the energy efficiency is obtained by dividing the theoretical energy required to produce a certain amount of product by the energy actually required to produce that amount of product. Or in other words, the energy efficiency is the percentage of power actually used which is represented by production.

The commercial cell plant endeavors to use a satur-

TABLE I. PRODUCTS RESULTING FROM ELECTROLYTIC DECOMPOSITION OF 26 PER CENT BRINE SOLUTION

(Begin with 100 g of 26 per Cent Brine Solution)

Per Cent Decomp.	G. H_2O Remaining	G. NaCl Remaining	G. NaOH Produced	G. Cl_2 Evolved	G. H_2 Evolved	Per Cent NaCl (Resulting Solution)	Per Cent NaOH (Resulting Solution)	Per Cent H_2O (Resulting Solution)
0	74.0	26.0	0.00	0.00	0.00	26.00	0.00	74.00
5	73.6	24.7	0.89	0.79	0.02	24.90	0.90	74.20
10	73.2	23.4	1.78	1.58	0.04	23.79	1.81	74.40
15	72.8	22.1	2.67	2.37	0.07	22.66	2.83	74.51
20	72.4	20.8	3.56	3.16	0.09	21.50	3.68	74.82
25	72.0	19.5	4.44	3.94	0.11	20.32	4.64	75.04
30	71.6	18.2	5.33	4.73	0.13	19.13	5.60	75.27
35	71.2	16.9	6.22	5.52	0.16	17.92	6.59	75.49
40	70.8	15.6	7.12	6.31	0.18	16.68	7.62	75.70
45	70.4	14.3	8.00	7.10	0.20	15.45	8.62	75.95
50	70.0	13.0	8.88	7.89	0.22	14.15	9.66	76.19
55	69.6	11.7	9.78	8.68	0.25	12.84	10.74	76.42
60	69.2	10.4	10.67	9.47	0.27	11.51	11.84	76.65
65	68.8	9.1	11.55	10.25	0.29	10.17	12.90	76.95
70	68.4	7.8	12.44	11.04	0.31	8.80	14.02	77.18
75	68.0	6.5	13.33	11.83	0.33	7.40	15.17	77.43
80	67.6	5.2	14.22	12.62	0.36	5.98	16.35	77.67
85	67.2	3.9	15.11	13.41	0.38	4.52	17.54	77.94
90	66.8	2.6	16.00	14.20	0.40	3.05	18.74	78.21
95	66.4	1.3	16.89	14.99	0.42	1.54	20.08	78.48
100	66.0	0.0	17.78	15.78	0.44	0.00	21.23	78.77

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

ated brine for reasons hereinåfter explained. Complete saturation, however, is rarely reached, but it is practical to obtain a brine of 99 per cent saturation or a brine containing approximately 26 per cent salt.

Table I, illustrated graphically by Fig. 1, shows the verying percentages of caustic soda, salt and water resulting from the electrolytic decomposition of a brine solution containing 26 per cent salt. These figures are theoretical, for they make no allowance for the small amounts of water evaporated according to the energy efficiency of the cell, for it will be readily seen that the less the energy efficiency of the cell the greater is the amount of heat generated in the cell and consequntly the greater the amount of evapporation, provided of course that this is not compensated for by external cooling. The abcissæ show the per cent decomposition efficiencies and the ordinates the varying composition percentages of salt, caustic soda and water.

Fig. 1A shows this in a different manner on a three co-ordinate chart, all values lying on the straight line *AB*. Fig. 1B shows the weights in grams of different chemicals, present or formed, in terms of decomposition efficiencies, obtained by electrolyzing 100 g. of a 26 per cent salt solution. Now as the caustic soda increases in strength there is a tendency for this to diffuse by osmotic pressure into the anode compartment.

Diffusion Through Diaphragms

In Table II, illustrated graphically by Fig. 2, will be seen the pounds of caustic which will diffuse through a square foot of diaphragm in an hour with a 26 per cent salt solution from a brine containing different percentages of caustic soda and salt according to the decomposition efficiencies on Fig. 1.

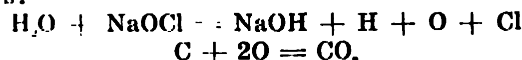
The solid line shows the pounds of caustic per sq.ft. of diaphragm which will diffuse from cold solutions of salt and caustic according to decomposition efficiencies (see Table I) into a 26 per cent brine solution. The temperature of both solutions is 70 deg. F. There is no static head of one solution over the other. While these figures will undoubtedly vary according to the nature of the diaphragm, yet they represent well-known tendencies. These figures are also taken from asbestos such as is used in practice in making diaphragms.

It will be seen from Fig. 2 that the diffusion of caustic into the anode compartment increases very rapidly with the concentration. In order to lessen this diffusion of caustic in cells of the submerged diaphragm type it has been customary to keep the brine in the anode compartment at a higher level than in the cathode compartment, thus retarding the inward diffusion of caustic by the outflow of brine. In addition to the above it has been customary to reduce the concentration of caustic in the cathode compartment by the addition of water. This adds to the evaporating cost, but more than compensates for this by increasing the efficiencies of the cells and reducing the loss of the carbons. I think we can illustrate this loss by the following equations which take place in the anode compartment:



$$2Cl + 2NaOH = NaOCl + NaCl + H_2O$$

The sodium hypochlorite may be electrolyzed as follows:



$$H_2O + NaOCl = NaOH + H + O + Cl$$
$$C + 2O = CO_2$$

It will be seen that this nascent oxygen attacks the carbons with the formation of carbon dioxide and heat. Thus we have a serious waste of carbons as well as a loss of power.

The diffusion of caustic also tends to increase as the temperature rises. See Table IIA, illustrated by the broken line on Fig. 2.

The broken line shows the same factors as the solid line, with the exception that the caustic solution is at

TABLE IIA

Lb NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies

Temperature NaOH, 120 Deg.; Temperature NaCl, 74 Deg.

Per Cent Decomp. Eff.	11.2	20.0	30.3	39.9	49.9	59.8	69.9	79.6	89.8
Lb . .	0.0254	0.0566	0.0758	0.09[illegible]7	0.1237	0.1591	0.2113	0.2483	0.302[illegible]

120 deg. F. instead of at 74 deg. F. The brine temperature has been kept at 74 deg. as in the first case mentioned. It will be seen from this curve that a rise in temperature in the cathode compartment increases markedly the rate of diffusion of caustic into the 26 per cent brine solution. To illustrate this tendency still further I submit Table IIB, illustrated by the dotted line in Fig. 2.

The dotted line shows the same factors as the solid line, with the exception that both the caustic and brine solutions are kept at 120 deg. F. It will be seen from

TABLE IIB

Lb NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies

Temperature NaOH, 120 Deg Temperature NaCl, 120 Deg.

Per Cent Decomp. Eff.	10.0	19.4	30.2	40.0	49.8	59.0	70.5	80.3	89.9
Lb .	0.0451	0.0765	0.0968	0.113	0.147	0.229	0.258	0.293	0.346

the above that anything which tends to reduce the temperature tends to slow down the diffusion of caustic. Cells with submerged diaphragms should not be insulated against loss of heat.

I might add that the addition of water to the cathode compartment of a submerged cathode cell tends to lower the temperature of the cathode electrolyte and thus also tends to check this diffusion from this cause in addition to checking the diffusion by lowering the concentration of the electrolyte.

Introduction of Acheson Graphite Electrodes

It must not be thought from what has been said that the losses caused by diffusion of caustic into the anode compartment ended with those mentioned. In the old days gas-retort carbon was the only carbon available for electrolytic purposes, as Acheson's remarkable product had not then been invented. I might add that, as far as I know, I was the first user of Acheson's graphite in

TABLE II.

Lb. NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies

Temperature of Both 74 Deg.

Per Cent Decomp Eff.	5	10	15	20	25	30	35	41	50	60	70	75	85	97
Lb	0.004	0.0085	0.013	0.017	0.026	0.037	0.055	0.062	0.080	0.105	0.138	0.142	0.181	0.188

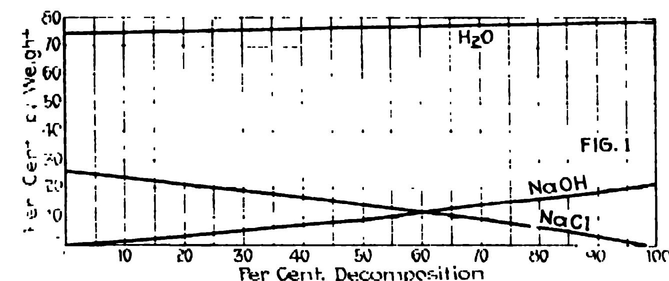
electrolytic cells. The retort-gas carbon anodes used prior to Acheson's invention were rapidly attacked by the nascent oxygen liberated on them and the mixture of carbon dioxide and chlorine went to bleach chambers, where the carbon dioxide, having a greater affinity for the slaked lime than the chlorine, liberated chlorine from the bleach already formed. In order that the bleach should not test below 35 per cent available chlorine, it was necessary to skim the carbonate of lime crust formed on the top of the bleach from the bleaching powder underneath.

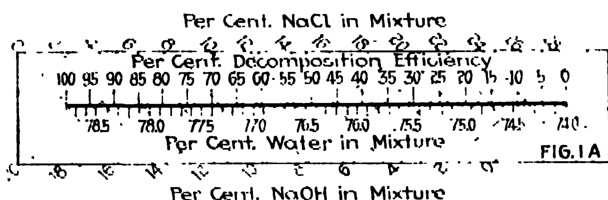
Thus, you see, this diffusion of caustic caused not only a waste of electrolytic carbons and power but it also caused a waste of lime, chlorine and labor. There were also other losses,' but I will not go into them here. Graphite carbons are also attacked by the nascent oxygen liberated thereon, though not to the same extent that gas carbons are attacked.

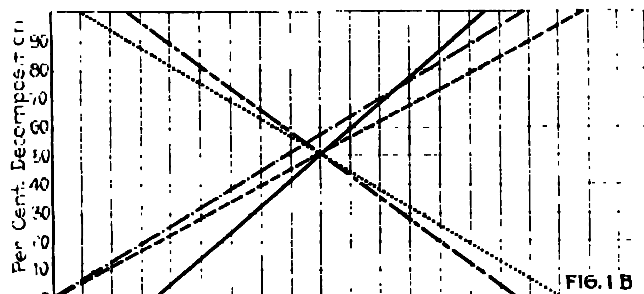
Realizing all these difficulties, Moore and Allen attempted to do away with this diffusion by allowing the caustic to run away as fast as formed, either through oil or otherwise.

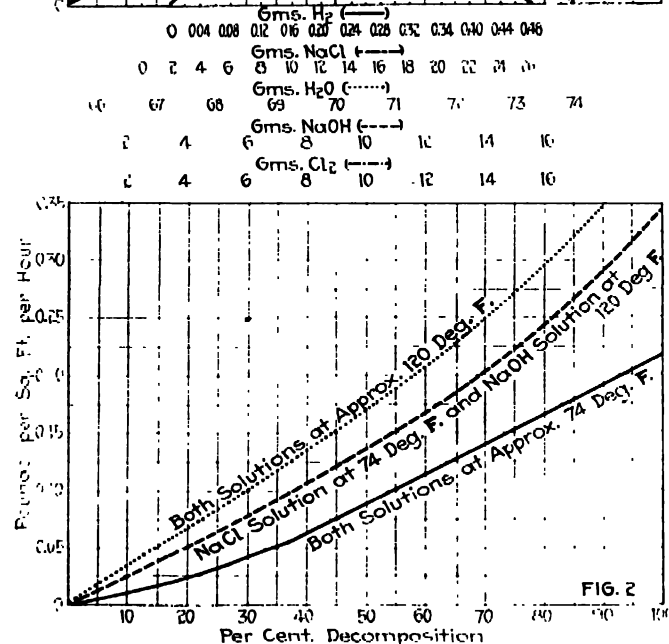
Rate of Flow

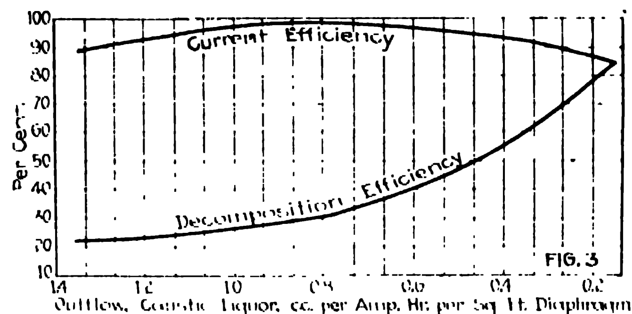
In experimenting with different cells it was noticed that sometimes the current efficiency of a cell starting

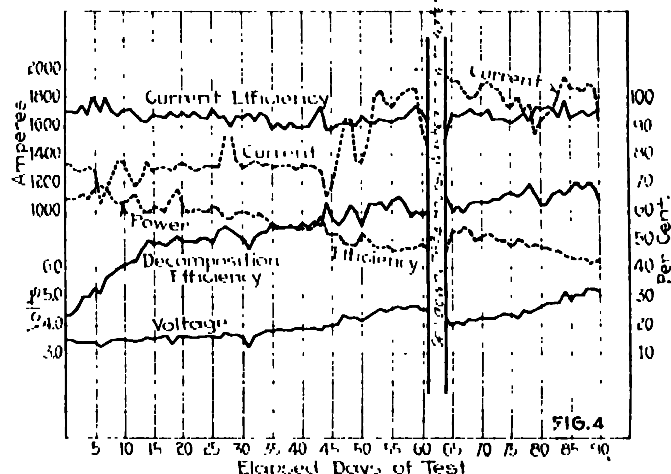


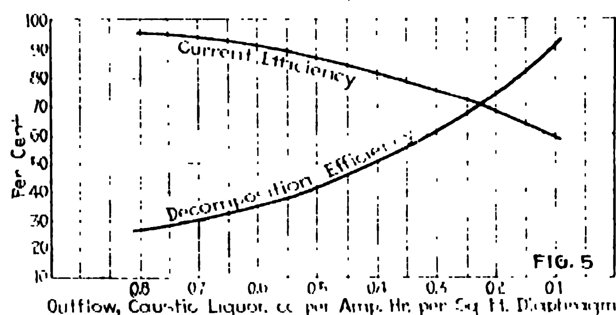












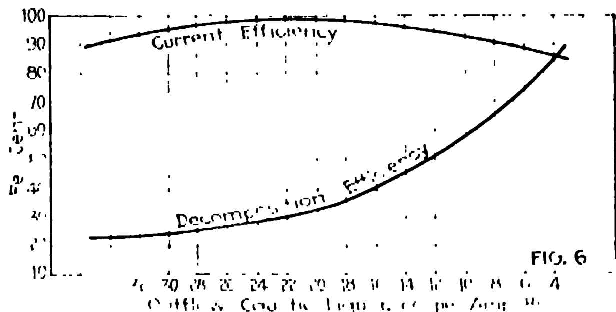


Fig. 1. Composition curves for solution remaining after the electrolysis of 26 per cent brine solution. Fig. 1A. Products resulting from electrolysis of 26 per cent brine solution. Fig. 1B. Products resulting from the electrolytic decomposition of 100 g. of 26 per cent brine. Fig. 2. Diffusion of NaOH from NaOH-NaCl solution through asbestos diaphragm into 26 per cent brine. Fig. 3. Flow of caustic liquor per ampere hour per square foot of diaphragm. Fig. 4. Variations of operation as shown by recording amperes, volts, etc. Figs. 5 and 6. Current and decomposition efficiencies at lower ranges.

up was somewhat lower than after the cell had been running a day or two. It was also noticed that as the cell got older the current efficiency generally rose for a short period, after which the current efficiency gradually declined. These results were not apparent at first because they were obscured by a varying current. In studying the reasons for this we tried to adopt a standard unit of measure by which the operation of two cells might be compared, irrespective of their ages, sizes and the current passing through them. C. B. Barton suggested the measure which we now term as the Rate of Flow and Mr. Barton and Mr. Moore, working independently, made many experiments developing this measure so that they had absolute control of the efficiency of any cell. The pounds caustic solution per ampere hour per square foot of diaphragm was called the Rate of Flow. Since then this term has been broadened to include volume as well as weight. The tabulation and plotting of results showed that when the rate of flow was large the current efficiency was low because of the large amount of chlorine dissolved in the brine, which on passing through the diaphragm with its equivalent amount of caustic and hydrogen re-forms salt and water with the liberation of heat. As the rate of flow diminished the amount of chlorine passing through the diaphragm diminished and the current efficiency rose to its maximum. As the rate of flow continued to diminish the current efficiency diminished and continued to diminish. I should like to be able to submit the original tables and charts illustrating this fact, but cannot do so, as they were destroyed by fire.

Table III, illustrated by Fig. 3, gives an idea of one form of rate of flow—viz., c.c. outflow caustic liquor per amp. hour per sq.ft. of diaphragm.

Table IV, Fig. 4, shows a chart of a cell in which the abscissæ represent consecutive days and the ordinates represent the per cent current efficiency, per cent decomposition efficiency, per cent power efficiency and the current in amperes and volts. It will be seen that a chart of this sort requires considerable study before much information is obtained.

TABLE III

Relation Between Rate of Flow in c.c. per Amp. Hour per Sq.Ft. of Diaphragm and Current Efficiency and Decomposition Efficiency

Rate of flow	1 3	1 2	1.1	1 0	0 9	0.8	0 7	0.6	0.5	0 4	0 3	0 2
Current eff	90 0	93 0	95 0	97 0	97 5	98 0	97 5	96 5	94.5	92 5	90 0	87 5
Decomp. eff.	22 5	23 5	25.0	26 5	28 0	32 0	34 5	40 0	47 0	55 5	67 5	77 5

Some of the facts shown in Table IV, illustrated by Fig. 4, are shown in Table III and Fig. 3.

It will be seen from the above that we get very regular curves from the apparently heterogeneous matter, as shown in Fig. 4.

Table V, Fig. 5, shows some of the lower ranges. This is only of academic interest, as cells are not supposed to run commercially in a manner to give such results. Of course the results as given in Table V were obtained solely to get some idea as to what effect the continued drop in rate of flow would have.

It will be noticed that Fig. 5 has different characteristics from Fig. 3. In Fig. 5 the cell was run on impure

TABLE IV

Days	Voltage	Current, Amp	Current, Eff	Decomp. Eff.	Power Eff.
1	3 44	1,332	95 0	23.0	63 6
2	3 39	1,298	94 5	24 6	64 1
3	3 37	1,282	96 5	30 5	65 8
4	3 39	1,307	93 7	30 1	63 6
5	3 38	1,285	100 0	32 8	68 1
6	3 24	1,036	94 8	30 5	69 4
7	3 34	1,128	99 3	36 9	68.4
8	3 43	1,266	95 1	39 1	63.8
9	3 44	1,346	93 9	40 1	62 8
10	3 47	1,350	95 2	41 3	63 1
11	3 44	1,233	96 3	41 8	64 4
12	3 44	1,164	99 0	43 2	66 2
13	3 48	1,225	92 0	46 6	60 8
14	3 55	1,3[illegible]8	91 5	49 7	59 2
15	3 52	1,282	94 4	48 5	61 8
16	3 55	1,305	93 6	49 1	60 6
17	3 57	1,319	93 1	48 9	59 2
18	3 32	1,282	94 7	49 6	65 6
19	3 58	1,326	93 3	50 8	58 3
20	3 59	1,335	94 9	49 8	60 8
21	3 59	1,301	92 7	49 8	59 4
22	3 55	1,275	94 3	49 8	61 2
23	3 58	1,300	93 1	50 6	59 8
24	3 59	1,321	92 4	50 6	59 2
25	3 59	1,316	96 0	49 5	61 5
26	3 56	1,309	93 1	53 9	60 2
27	3 71	1,531	93 5	54 8	58 0
28	3 61	1,535	90 0	53 4	57 3
29	3 63	1,351	94 0	51 9	59 5
30	3 59	1,309	93 5	50 2	60 0
31	3 16	1,328	93 6	47 0	59 5
32	3 57	1,351	91 1	50 6	58 7
33	3 70	1,320	94 0	52 5	59 0
34	3 76	1,330	93 5	53 2	57 2
35	3 79	1,309	89 4	55 2	54 3
36	3 82	1,307	90 6	54 9	54 5
37	3 80	1,319	89 1	54 1	54 0
38	3 81	1,315	91 1	54 9	55 0
39	3 84	1,296	89 1	54 5	53 4
40	3 86	1,328	90 1	55 9	53 8
41	3 85	1,316	90 1	54 9	53 8
42	3 89	1,306	93 0	56 4	55 0
43	3 82	1,152	97 3	55 2	58 6
44	3 95	1,275	88 7	63 4	51 7
45	3 95	1,197	88 7	58 5	51 8
46	4 01	1,420	90 3	54 9	51 9
47	4 31	1,568	91 4	57 2	48 8
48	4 29	1,634	90 4	66 6	48 5
49	4 29	1,350	90 2	59 0	48 2
50	4 19	1,349	93 1	60 3	51 1
51	4 27	1,509	91 6	62 8	49 3
52	4 40	1,812	90 8	62 5	42 5
53	4 51	1,854	92 9	62 6	47 4
54	4 49	1,765	91 8	61 8	47 0
55	4 53	1,724	91 3	63 8	46 1
56	4 63	1,791	92.1	65 4	45 7
57	4 57	1,842	93 0	62 6	46 8
58	4 64	1,860	95 0	58 0	47 0
59	4 68	1,848	96 6	60 3	47.5
60	4 52	1,598	94 8	58 9	48.2
61	4 50	1,428	90 7	60 5	46 3
62, 63	Cell down for washing diaphragm				
64	4 25	1,955	84 9	60 5	45 9
65	4 05	1,905	93 9	60 0	53.3
66	4 10	1,908	93 3	61 2	52 5
67	4 05	1,831	94 8	59 9	53 8
68	4 17	1,798	95 8	62 2	52 8
69	4 19	1,808	94 7	63 0	49 4
70	4 25	1,889	94 2	63 1	51 0
71	4 27	1,918	95.9	63 3	51.7
72	4 25	1,854	92 5	64 1	50 1
73	4 31	1,841	92 8	64 5	49.5
74	4 35	1,755	92 0	65 6	48 6
75	4 35	1,721	90 7	66 0	47 9
76	4 27	1,808	92 5	65 9	49 8
77	4 47	1,690	94 6	66 3	48 6
78	4 46	1,750	91 7	69 3	47 2
79	4.57	1,524	96 4	66 4	48 6
80	4 64	1,644	95 6	61 7	47 5
81	4 72	1,690	96 1	62 2	46 0
82	4 79	1,720	95 7	66 3	46 0
83	4 78	1,841	95 5	66 7	45 0
84	5 12	1,947	98 8	65 2	44 4
85	4 87	1,856	92 7	67.6	43 8
86	5.06	1,852	94 0	69 6	42 8
87	5 05	1,821	94 8	68 4	43 2
88	5 24	1,896	93 8	69 5	41 2
89	5 21	1,861	94 6	67 6	41 8
90	5 15	1,617	95 5	62 7	42 6

TABLE V

Rate of flow, c c	0 6	0 7	0 6	0 5	0 4	0 3	0 5
Per cent current eff	95 5	94 0	91 0	86 5	81 0	75 0	67.5
Per cent decomp eff.	26 5	30 0	35 0	41 0	50 0	60 0	74.[illegible]

TABLE VI

Rate of flow, c c	3 .0	30 0	27 5	25 0	22 5	20 0	18 0	16 0	14 0	12 0	10 0	9 0	8 0	7 0	6 0	5.0	4 [illegible]
Current eff per cent. .	91.5	94 5	96 5	97 5	98 0	98 0	97 5	96 5	95 5	93 5	97 0	91 0	90.0	88 5	87 5	86 5	85 [illegible]
Decomp eff, per cent	23 0	24 0	25 5	27 0	29 0	32 0	35 5	39.5	44 5	50 5	58 0	61 5	65 5	70 0	74 5	79 5	84 5

brine. It will be seen from the above that while the rate of flow chart is very valuable for comparative purposes when conditions are alike, care must be taken not to use the rate of flow chart determined under one set of conditions to interpret results of cells run under radically different conditions.

Of course neither these results nor the above are absolute, as they may vary within certain limits as will be seen later.

In the above it will be seen that I have given number of c.c. per amp. hour instead of lb. per amp. hour. This is more convenient, inasmuch as one can use a graduate instead of a set of scales.

The application of this kind of chart to the operation of a cell plant is a very simple matter. Suppose, for instance, you found you are going to have available in your cell plant 1,000 amp. and each cell has 20 sq.ft. of diaphragm and that you wished to run at 50 per cent decomposition efficiency. You would look up the rate of flow in c.c. per amp. hour per sq.ft. of diaphragm for 50 per cent decomposition efficiency, which according to Fig. 3 would be 0.46; multiply by 20 and 1,000 and you have 9,200, the number of c.c. per hour which must run through the cell to give you your desired results. If, however, all your cells had the same number of sq.ft. of diaphragm you could make a table like Table VI, illustrated by Fig. 6, and thus avoid the extra calculation.

Fig. 6 is based on a cell having 26.5 sq.ft. of diaphragm.

Suppose you had a cell plant each cell of which had 26.5 sq.ft. of diaphragm and you wished to run at 55 per cent decomposition efficiency with 1,200 amp. current; you would tell the operator to regulate the levels of the brine in the cells so that he would obtain a flow of 216 c.c. per minute—viz., rate of flow at 55 per cent decomp. — 10.8 c.c.

(10.8 × 1,200) : 60 (min. per hr.) =
216 c.c. per min.

At this decomposition efficiency the cell should have a current efficiency of 93 per cent. It will be seen from the above curves that a cell plant cannot be regulated by the amount of brine fed to the whole plant, for the cell which has too great a flow will have a low efficiency as well as the cell which has too small a rate of flow. To run a cell plant properly each cell should be regulated as to its rate of flow individually. In a commercial plant you have a mixture of cells whose ages since renewal of diaphragms, carbons, etc., may vary all the way from one day to 300 days. In our plant of 550 cells the ages vary from one day to 180 days.

Automatic Cooking Control for Chemical Pulp*

By C. H. Allen

SULPHITE pulp should be cooked automatically for three principal reasons, as follows: (1) Production will be increased; (2) quality will be improved; (3) the steam load on the boiler house will be more uniform.

The automatic control which I shall describe does for each charge of chips what a good cook tries to do but can never do, because, in the first place, the apparatus he is using places a practical limit on his control, and secondly, he cannot be everywhere at once and think of everything at the same time.

The Allen automatic cooking control system consists essentially of a power-driven steam valve electrically connected to a steam flow meter on the digester steam line, an automatic relief valve, and relief strainers that do not plug. It also includes the automatic separation of relief gas and liquor.

The steam apparatus can be set to maintain any constant or varying steam flow curve. Temperatures within the digester are proportional to the rate of steam input. The control apparatus therefore can be set to give any desired temperature curve.

Cooking automatically does not necessarily mean that all charges of chips will be steamed on the same steam curve. In practice, where the strength of the acid and quality of chips are reasonably constant the same steam flow curve should be used on all digester charges; but in cases where the strength of acid and quality of chips vary widely from cook to cook better results may be obtained by varying the form of the steam curve to suit changing conditions.

These changes in the steam flow curve are very readily and quickly made. The steam curve element of the control system is a small thin plate of copper having an insulated hole; it is slipped over the chart spindle of the steam flow meter clock. The periphery of this piece of copper at any point represents the rate of steam it is desired to carry at that particular instant.

Once the cook is started it needs no further attention until blowing time, and further, when a cook is started it is known beforehand when it is going to blow, within a few minutes. The reason for this is that it takes a certain and very definite quantity of steam to cook a cord of chips, and steam is metered into the digester at a predetermined rate. The cooking time may be shortened by steaming at predetermined higher rates, and lengthened by steaming at predetermined lower rates. It has been proved that other conditions such as will occur from day to day do not affect the cooking time except to a negligible degree. When the digesters of any one mill are steamed automatically, the proper spacing out of the blowing time follows as a natural and inevitable result. If as sometimes happens after blowing a digester a small amount of repairs are found necessary to the blow valve or piping, which delays the time of starting to cook the next charge of chips, the cooking operation can nevertheless be finished on schedule time by adjusting the control apparatus to maintain a higher steaming rate.

The automatic relief valve can be set to maintain any pressure it is desired to carry within the digester. The relief valve stem is operated by a diaphragm which carries digester pressure on one side and is counteracted by a spring on the other. The diaphragm and spring are made large so that the resistance due to the sticking of the valve stem in its packing is practically negligible in comparison with the forces which tend to actuate the valve. When cooking by hand a good cook tries to open his relief valve by very small amounts at each adjustment and just enough to hold the digester pressure against his steam valve opening. If he happens to open too wide the strainer plugs, it is then necessary to shut off steam, blow back the strainers and start over again. The automatic valve cracks open

*Read before the Technical Association of the Pulp and Paper Industry at the fall meeting in Saratoga Springs, N. Y., Sept. 1, 1920.

by exceedingly small increments. It is always open to the correct amount and instantly responds to changes in pressure too small for a cook to detect even if he happened to be trying to do so.

The strainers used in connection with the control apparatus are of two different designs, one being adapted for use under the cover and the other in the digester neck. The cover strainer, so called, is somewhat similar in appearance to other strainers in general use. It consists of a bronze internal framework and an outside covering of thin perforated lead. The neck strainer so called is made of perforated hard drawn lead. It is cylindrical in form and wide open at both ends. The outside diameter of this strainer is approximately 1½ in. less than the internal diameter of the digester neck. In short, the strainer is a perforated lead bushing fitting loosely in the digester neck. In operation the relief gas and liquor flow from within the strainer outwardly to the space between the bronze sleeve in the digester neck and the strainer, thence through the digester neck and through a pipe of suitable size to the automatic relief valve. This is a stationary strainer—i.e., it is not removed when the digester is being refilled.

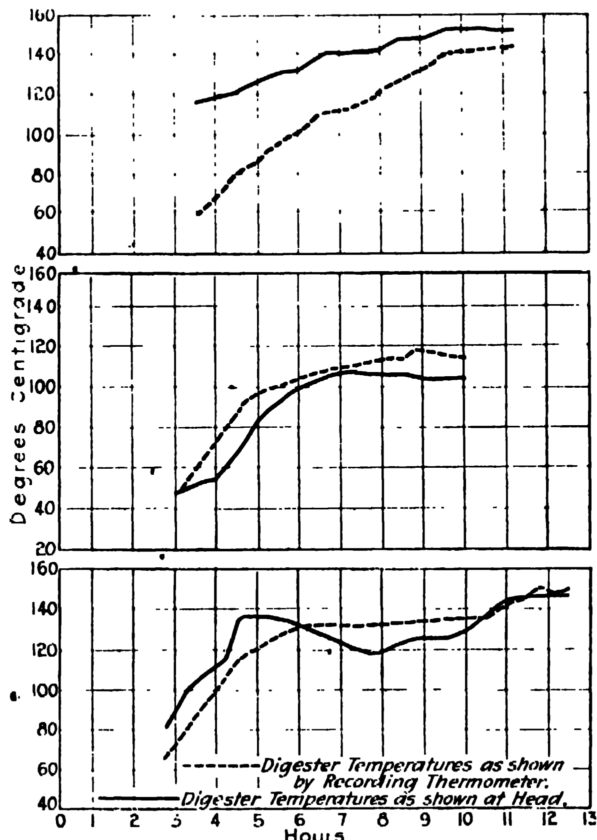


FIG. 1. DIGESTER TEMPERATURE RECORD

In the cooking of sulphite pulp many mill superintendents seek to have their cooks follow predetermined temperature curves. This practice represents an effort in the right direction and results in a somewhat greater uniformity of quality than is the case where steaming is left entirely in the hands of the attendant. Temperature recorders give only a rough indication of the steaming rate. It is easily possible to produce a very smooth temperature curve and a very erratic steam flow curve at the same time.

Temperature recorders are sluggish and slow to respond to the throttle valve. They do not indicate the rate of steam input at any instant. Changes in the quantity of steam pouring into the digester can be detected by means of the temperature recorder only after the lapse of considerable time.

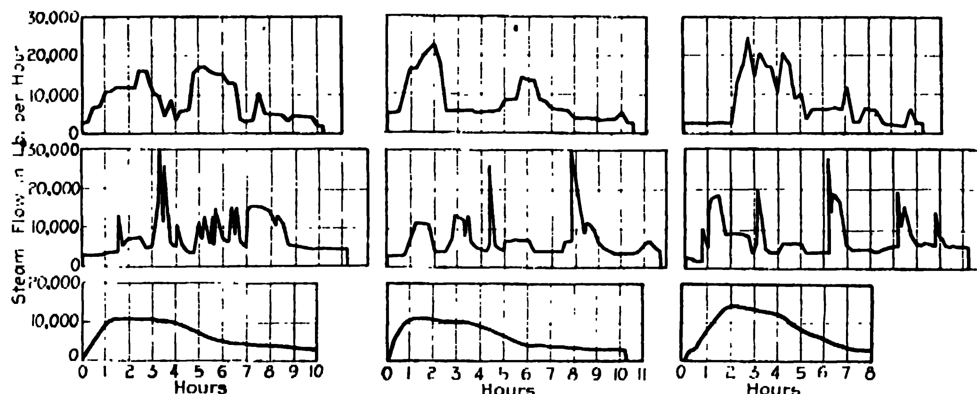


FIG. 2. STEAM FLOW TO DIGESTER METER RECORDS
Top—Hand control. Middle—With well-known regulator. Bottom—With Allen automatic control system.

Moreover, the temperatures at any two points within the digester are seldom the same. This fact is illustrated by the three sets of temperature records shown in Fig. 1. These are records of actual cooks. The dotted line in each case is the temperature in the side of the digester. The solid line is the temperature in the head.

Violent changes in the steam rate of short duration cause scarcely a ripple in the temperature curve; however, spasmodic and violent changes in the rate of steaming do cause non-uniformity of product. Spasmodic and violent changes in the rate of steaming also affect the economy of steam plant operation disastrously.

A sulphite cook, whose experience in cooking sulphite extends back over a period of seventeen years, once said to me: "I never steam two digesters alike, and no two cooks steam digesters alike." This man spoke the truth, as the evidence of the temperature records indicates.

In Fig. 2 the first three curves are the steam flow meter records of three cooks steamed by hand. The next three curves are the actual steam flow meter records of three cooks steamed with a well-known regulator; these are even worse than the records from hand control, though to be fair it should be said that this regulator produces a very smooth pressure curve. However, the degree of smoothness of the pressure curve is no indication of quality or the cooking time.

The last three curves are actual steam flow records taken from the same digester when steamed automatically. The first two curves were produced with the apparatus set for a 10¼-hr. cook, the last curve with the apparatus set for an 8¼-hr. cook. The quality of sulphite produced by these automatically maintained steaming rates was excellent.

In general it may be stated that the form of the steam curve determines quality, and the average rate of steaming determines the length of the cook.

Steel Rails From Sink-Head and Ordinary Rail Ingots—III

Various Physical Tests, Metallographic Examinations and Chemical Surveys, as Usually Performed, Were Made Upon All the Rails Under Examination—Comparison Rails Performed Much Better Under the Drop Test, and Service Tests Report Less Abrasion*

BY GEORGE K. BURGESS†

MECHANICAL TESTS

THE mechanical tests included the ordinary drop test made on the first 5-ft. piece below the top of the ingot showing physically sound steel. For the Hadfield rails this location was, in all but two cases, determined by the junction of sink-head with the ingot proper. The test was made in the usual way by dropping a 2,000-lb. tup from a height of 18 ft. upon the head of the rail, which was supported at two points 3 ft. apart. This test gives record of permanent set, elongation on the base and the number of blows required for the destruction of the rail.

The 6-in. test pieces (B, C, D, etc.—Figs. 1 and 2)[5], the drop test pieces and the specimens from the "M-A" position were examined for ultimate tensile strength, using a 2-in. test length, yield point, elongation, reduction of area, and hardness of Brinell and scleroscope. All specimens for the tension tests were cut longitudinally.

Method of Expressing the Results of Mechanical Tests. It is thought best to express measurements, such as yield point, ultimate tensile strength, elongation, etc., in terms of the average and average deviation from the mean.

The deviation of a single observation is the amount by which that observation departs from the mean or average value. By subtracting each observation from the mean without regard to sign, and averaging these, the average deviation from the mean is obtained.

When using the usual method of expressing results of this kind in terms of maximum and minimum values, undue emphasis is placed upon the occasional widely divergent figure, while the very close agreement that may exist is not brought to light.

Ultimate Strength and Yield Point. The ultimate strengths of the steel in rails from the H and M ingots are given in Table VIII[6] and are of the same order of magnitude—about 125,000 lb. per sq.in. For the thirty-five sink-head ingots the non-uniformity, expressed as the average deviation from the mean for values at the "A," "B," "C," "D" and "E" positions, is somewhat greater than for the comparison ingots, except for the "A" position, at which the results are erratic.

If we consider the ultimate strength throughout the length of the ingot, we note for the sink-head ingots there is practical uniformity down to the "E" position, while in the comparison ingots there is an abrupt increase in ultimate strength from the "A" to the "B" position and then a gradual falling off until the bottom of the ingot is reached, where at the "F" position the ultimate tensile strength is about 9,000 lb. per sq.in. less than the maximum at "B."

If the comparison ingots are studied by groups corresponding to heats, it may be shown that the ultimate strength of each group may be distinguished from the others. Thus groups M1 to M5 and M6 to M10 run closely parallel through the ingot, with M6 to M10 having slightly higher ultimate strength. Group M11 to M15 is characterized by the abnormally high value approximately (130,000 lb. per sq.in.) in the "A" and "B" positions.

The yield point shows, in general, characteristics similar to the ultimate strength; for the former, however, there is a somewhat greater uniformity throughout the ingot for all types, and for the ingots of a given group. The sink-head ingots have a slightly higher yield point (62,370 lb. per sq.in.) than the comparison ingots (61,370 lb. per sq.in.). For the three groups of the latter there is a falling off throughout the length of the ingot from approximately 64,000 lb. per sq.in. for B rail to 59,000 lb. per sq.in. for F rail (as for the ultimate strength), while for the sink-head ingots the yield point remains practically constant throughout.

Elongation and Reduction of Area. The distribution of ductility, as measured by elongation in tension test pieces from rails through the length of the sink-head ingots, is somewhat more uniform than for the comparison ingots. Elongation is practically the reciprocal of the tensile strength.

The average elongation of the rails from the sink-head ingots is 13.8 per cent, of the comparison ingots 13.6 per cent; the reduction of area for the former type of ingot is 24.38 per cent, for the latter type 25.78 per cent with a range of 21.73 per cent at "B" to 31.68 per cent at the "F" position. There are also considerable differences among the three groups of comparison ingots.

Hardness. The scleroscope hardness numbers do not appear to have any significance in defining any differences in qualities or properties in the steel of the several ingots. The material from the sink-head ingots has an average hardness of 31 while the steel from ingots cast in the usual manner has an average hardness of 32.

The Brinell numerals are, as would be expected, fairly closely proportional to the ultimate strengths and they appear to follow even more exactly the yield points. Whether or not there is any definite relation between carbon segregation and Brinell numerals appears difficult to say. The holes in drilling for the former are ½ in. in diameter and not always exactly coincident in location with the Brinell impression. In a general way one would expect the two to bear some relation to each other. The rails from the sink-head ingots had an average Brinell hardness of 260 (deviation ± 8) while the rails made from ingots cast with the small end uppermost without sink-heads had a Brinell hardness of 250 (deviation ± 6).

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*For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 19 and 20, Nov. 10 and 17, 1920, pp. 921 and 969.

†Chief division of metallurgy, Bureau of Standards.

[5]See pp. 921 and 924.

[6]See p. 971.

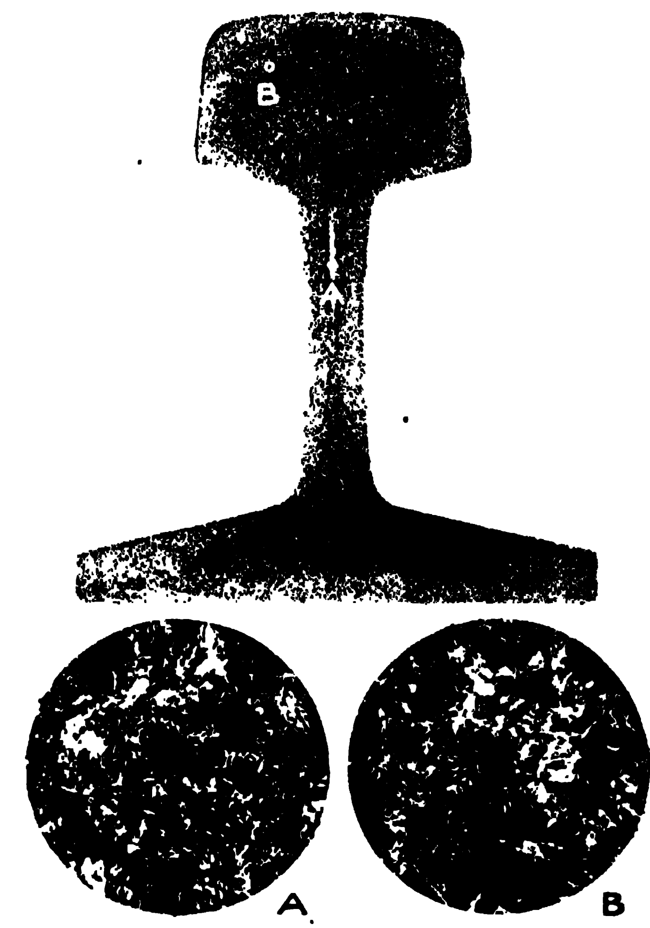


FIG. 7. RAIL H16-A

Sulphur print shows slight segregation in rail from upper part of ingot.

A Shows eutectoid structure of slightly segregated streak in web

B Average fine grained structure, pearlite with a very slight trace of ferrite.

Drop Tests. In the drop tests, blows were given on head of rail to destruction, the deflection was measured for each blow, the elongation for each inch over 6 in. and the total elongation noted.

The drop-test piece was taken from near the top of the ingot and in each case was the first 5-ft. length of rail immediately after reaching physically sound steel - i. e., free from pipe—and in the case of the rails from sink-head ingots also below the bottom of the sink-head. Of the fourteen comparison rails none broke under four or five blows (six rails were nicked and broken after the fourth or fifth blow), while for the thirty-five Hadfield rails the range was two to seven blows, there being nine of four blows, and four of three blows; only twenty-two, or 63 per cent, of the rails from sink-head ingots withstood four or more blows. The ductility as measured by the deflection and elongation is also somewhat greater and more uniform for the comparison rails.

Recalling the greater uniformity of the sink-head over the comparison ingots as shown in nearly all other mechanical tests, in less segregation, greater homogenity as shown by sulphur prints and etching, less amount and variability in discard to sound steel, the question of the significance and interpretation of the drop test may, it would seem, be raised with propriety. The greater ductility and more uniform behavior under the drop test of the steel from the comparison ingots would appear to be due more to the chemical composition and especially to the nickel and chromium content of this Mayari steel than to any factor traceable to manufacture, which in the case of the comparison ingots is seen to divide them sharply into three groups of very distinct physical characteristics—each a heat- - which fact the drop test is unable to reveal.

METALLOGRAPHIC TESTS

A sulphur print, light etching, and two photomicrographs at 100 diameters were taken of each test piece, examples of which are given in Figs. 3, 5, 6,[7] 7 and 8 (micrographs are here represented at 35 diameters).

Photomicrograph *A* was taken at upper part of web, *B* corresponds approximately with "O" position of Fig. 3. These tests were also made on sections of the 5-ft. pieces of the M-x, M-a and H-a rails to accompany the determinations of discard for chemical segregation.

The metallographic tests throw additional light on the question of segregation and soundness, and especially with reference to the presence of slag inclusions, streaks and seams. They also furnish evidence as to the uniformity of the operations in the rolling mill; although there appears also to be a distribution of structure for each ingot characteristic of its manufacturing processes preceding the rolling.

[7]See pp. 969 and 974.

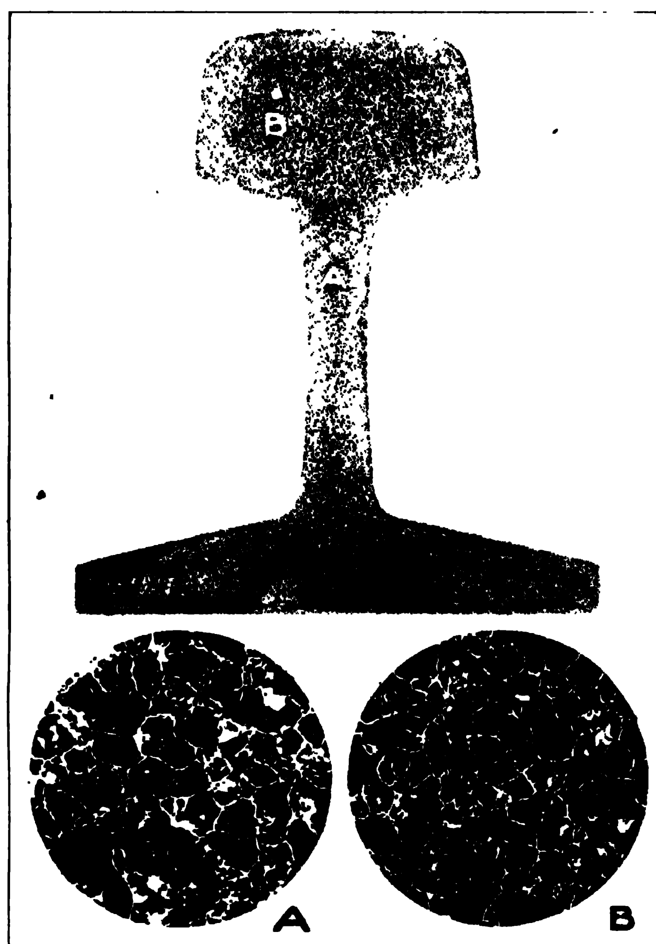


FIG. 8. RAIL H16-E

Homogeneous rail from bottom of same ingot yielding rail H16-A (Fig. 7).

A—Moderately fine grained structure, with a thick ferrite network.

B—Average fine grained structure, pearlite with a ferrite network.

The smoothness and evenness of tone of the sulphur prints of all rail sections from the Hadfield sink-head ingots, which are characteristic of the lot (Figs. 7 and 8), even from sections in the drop-test portion near the top of the ingot, is in striking contrast to the markedly irregular sulphur prints from comparison rails (Fig. 3)*, except for a few below the center of some of these ingots. Most of the rails from the Maryland ingots show very pronounced irregularities in terms of the sulphur prints, some of them from bottom of ingot showing well-defined pipes (Figs. 6 and 7).

As to the microstructure of the steel, here again the sink-head ingots show much the greater uniformity. This is especially true for the upper portions of the ingot, where differences would be expected.

The rails from the comparison ingots below the segregated area have about the same structural characteristics as the sink-head, except that for many of them the ferrite network is less pronounced and in some cases almost absent. The rolling and finishing temperatures of the ingots were not widely different and do not appear to play any considerable rôle in determining differences of structure. The manganese content, usually somewhat higher in the Hadfield ingots, apparently acts to accentuate the sharp, definite boundaries of ferrite surrounding the pearlite grains.

Sink-Head Ingot H37. Sink-head ingot H37 was cut in halves at Sheffield and Sir Robert Hadfield reports: "The whole of this ingot could be worked into rails after cutting off 10 per cent discard. The ingot is perfectly sound and represents the average quality of the whole of the thirty-six ingots sent to be rolled into rails.

"The capacity of the sink-head cavity of this ingot was 8,125 c.c., and the percentage of settling by weight in pounds—that is, of the total weight of the ingot was 2.58 per cent. The weight of the material which passed from the head portion into the ingot itself was about 130 lb. This ingot was selected because it showed the lowest cavity percentage—i.e., 2.58 per cent."

*See p. 969.

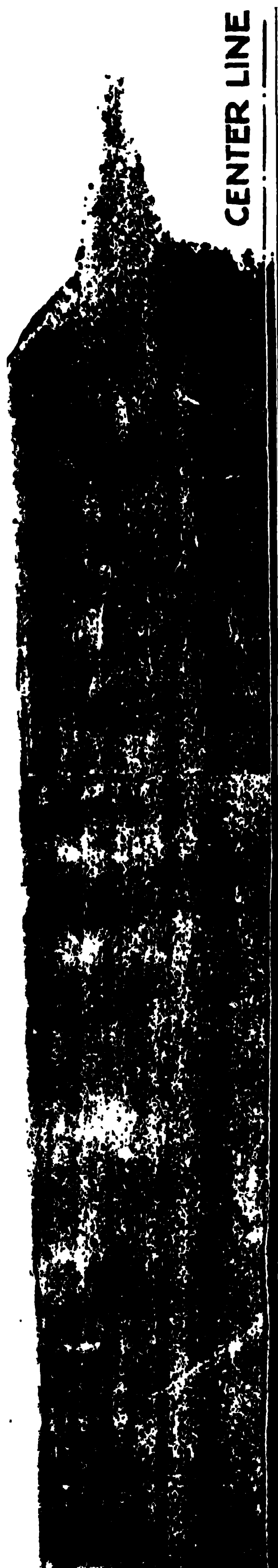


FIG. 9. Sulphur print of half-section of sink-head ingot H32.

Sink-Head Ingot H32. Sink-head ingot H32 was cut in halves at the Bureau of Standards. A photograph of a sulphur print of longitudinal half section of the ingot is shown in Fig. 9. Figs. 10 to 13 show the location of drill holes for chemical analyses of this ingot, as well as the results of the analyses. Only carbon, phosphorus, silicon and sulphur surveys were made, as the rail analyses indicated that there was no appreciable segregation of manganese in similar ingots. The results indicate that with about 9 per cent discard, steel free from piping and appreciable segregation is obtained.

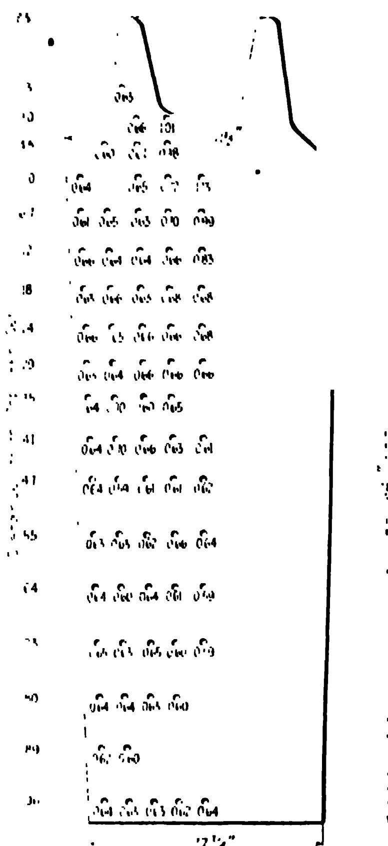


FIG. 10. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32

Showing percentage carbon of various ingot positions.

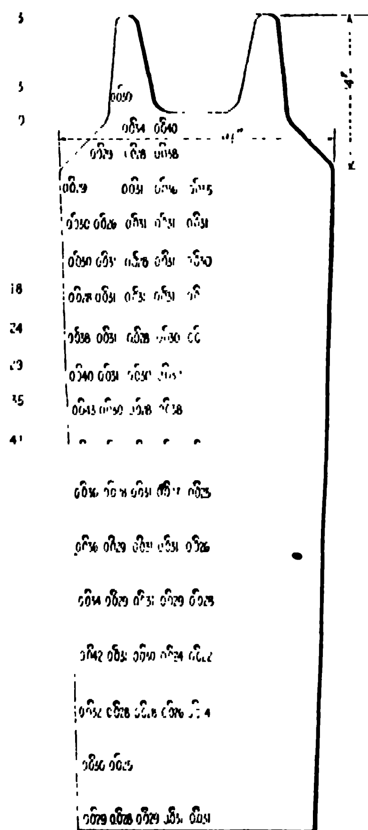


FIG. 11. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32

Showing percentage phosphorus of various ingot positions.

Carbon showed a high degree of segregation (0.68 to 1.13 per cent), but it will be noted that this is confined to extreme upper portion of the ingot. The high carbon content at this point is probably due to the fact that the steel in the top part of the ingot absorbed carbon from the charcoal used to keep the ingot hot on its upper surface while cooling.

Phosphorus, silicon, sulphur and manganese are remarkably uniform in this sink-head type of ingot.

Split Blooms. The top blooms from ingots H5 and M10 were split longitudinally at the Bureau of Standards and one half of each used for sulphur prints (Fig. 14) and the other half of each for a chemical survey of carbon, phosphorus, silicon and sulphur segregation.

As in the case of the sulphur prints from the rails, the sulphur print from the bloom of the sink-head ingot is of even tone, while the comparison bloom shows decided irregularities. In addition, the latter bloom has enclosed piping about 12 per cent below the top. The chemical survey shows the Hadfield bloom to be very uniform. The maximum carbon is 0.90 per cent, and this is only 4 per cent from the top of the ingot. The comparison bloom, according to chemical analyses, is also quite uniform except for the sulphur content, which is very irregular. This element attains a maximum of 0.166 per cent at 12 per cent from the top, while it is as high as 0.12 per cent at 21 per cent from the top.

A special sink-head ingot, of the same dimensions and type as the other sink-head ingots but containing chromium and nickel, was rolled into rails so as to permit more accurate comparison with the ingots cast in the ordinary manner. The latter naturally contains small amounts of nickel and chromium from the Mayari ore, from which the product was made.

The mechanical and chemical properties of the five

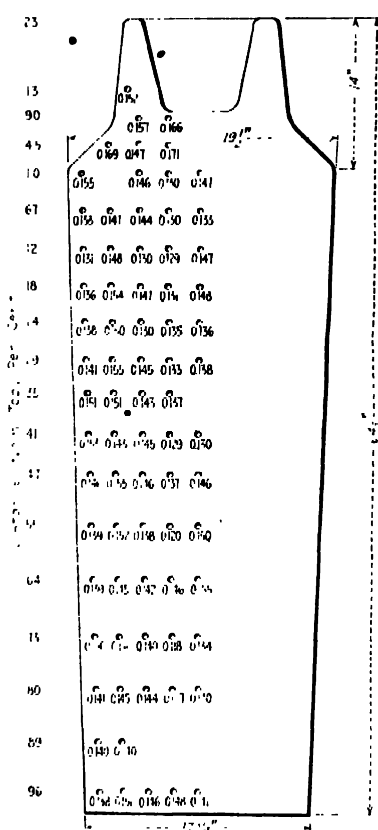


FIG. 12. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32
Showing percentage of silicon of various ingot positions.

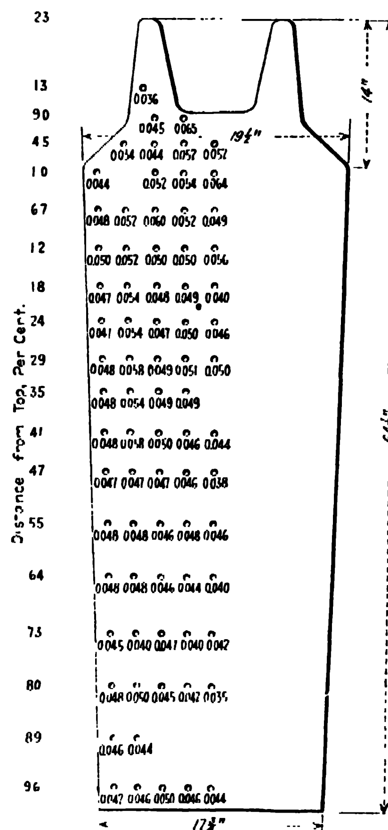


FIG. 13. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32
Showing percentage sulphur of various ingot positions.

rails from this special ingot (H38) are given in Table XIV. It will be observed that the yield point (70,791 lb. per sq.in.), the ultimate tensile strength (143,025 lb. per sq. in.) and the Brinell hardness (292) are greater, while the elongation (11.3 per cent) and reduction of area (19.06 per cent) are less than those of the average sink-head ingot. Under the drop test the rails from this ingot behave similarly to the comparison ingots.

From the standpoint of composition the steel from this ingot differs from that of the average sink-head ingot in that it is of higher carbon (0.73 per cent) and lower phosphorus (0.016 per cent) and sulphur (0.018 per cent); also in that it contains small amounts of nickel (0.19 per cent) and chromium (0.11 per cent).

It was necessary to discard 17.6 per cent of this ingot because of pipe, as against 9.1 per cent for the average sink-head ingot.

Service of Rails From This Investigation. The Pennsylvania Railroad, through A. W. Gibbs, reports as follows on the service of the rails from the earlier investigation[9] and from the present one:

"In January, 1915, the Maryland Steel Co. shipped free for test five No. 1, 33-ft. P. S. 100-lb. open-hearth steel rails rolled from ingots furnished by Sir Robert Hadfield to the Bureau of Standards. These rails were laid in the eastward freight track on Horseshoe Curve, Jan. 20, 1915, and were removed on May 15, 1915. The

[9]Hadfield and Burgess, *loc. cit.*



FIG. 14. SULPHUR PRINTS OF SPLIT BLOOMS (TOP)
Longer piece, top bloom from M10. Shorter piece, top bloom from H5.

average abrasion of the Hadfield rails was 1.16 sq.in. and that of the ordinary rail 0.78 sq.in. None of these rails failed.

"In September, 1915, the Maryland Steel Co. rolled forty-six No. 1 and sixty-one No. 2 P. S. 100-lb. rails (0.33 track-miles) from imported Hadfield sink-head ingots and at the same time rolled fifty-three No. 1 and four No. 2 P. S. 100-lb. rails (0.18 track-miles) from its own ingots for comparison. The forty-six No. 1 Hadfield and fifty-three No. 1 Maryland Special rails were laid on Nov. 26, 1915, in the eastward passenger and freight track on the 5 deg. 30 min. curves between Spruce Creek and Union Furnace, Middle Division, and removed on Oct. 23, 1916. The sixty-one No. 2 Hadfield and four No. 2 Maryland Special rails were laid on a 2 deg. curve in the eastwood low-grade track, Philadelphia Division, west of M. P. 69, and are still in track. The average abrasion of the No. 1 Hadfield rails was 0.42 sq.in.; that of the Maryland Special rails 0.37. The rail on low grade was still in track on Oct. 31, 1919; abrasion was then 16.1 per cent for Hadfield and 9.7 per cent for Maryland Special.

"There have been no failures of Hadfield rails or of the Maryland Specials.

"There is evidently no economy in the Hadfield process as regards wear, and it would require a much more extended trial to determine the relative freedom from failure."

The Maryland rails may owe their less abrasion to their content of nickel and chromium. It would appear to be unfair to draw any general conclusions as to performance in service from so few rails as this investigation furnished, although it would not be expected that the Hadfield type of sink-head ingots would furnish any rails showing structural defects.

The service results, showing no failures to date, in the few rails of this investigation cannot be considered conclusive one way or another.

It would be of the greatest practical importance in tracing statistically the origin of rail failures, if, in the reports to the rail committee of the American Railroad Engineering Association, they be grouped with reference to their position in the ingot, and in addition the steel manufacturing process be reported, at least briefly, by such notations as raising steel capped with plates; quiet steel deoxidized with x ounces of aluminum per ton; etc. If then it be found that for a given kind of steel there is a greater or less tendency for certain types of failure to predominate or to exist in certain definite regions in the ingot, corrections could be made intelligently in the manufacturing process. The present investigation indicates very strongly that one should expect the four types of steel and two types of ingot examined, in view of the sharply differing characteristics, to behave differently in service.

The results obtained indicate a decided superiority of the sink-head ingots over the comparison ingots as

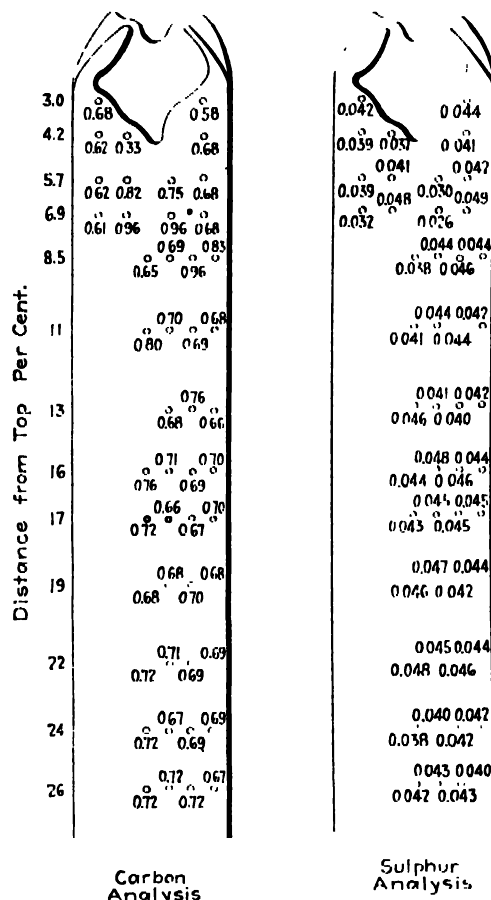


FIG. 15. CARBON AND SULPHUR SURVEY FROM TOP BLOOM H5

made of three grades of steel (Tables XI and XII)", although the sink-head ingots suffered from the disadvantage of having gone cold before rolling. The Hadfield type of ingot required a total discard of only 18.4 per cent on the average (13 per cent top discard to eliminate piping and segregation above 12 per cent), while the average ingot of the ordinary type for rails require a total discard of 43.9 per cent (26 per cent top discard), with great variations dependent upon the furnace and ingot practices. The comparison ingots

"See pp. 972 and 973

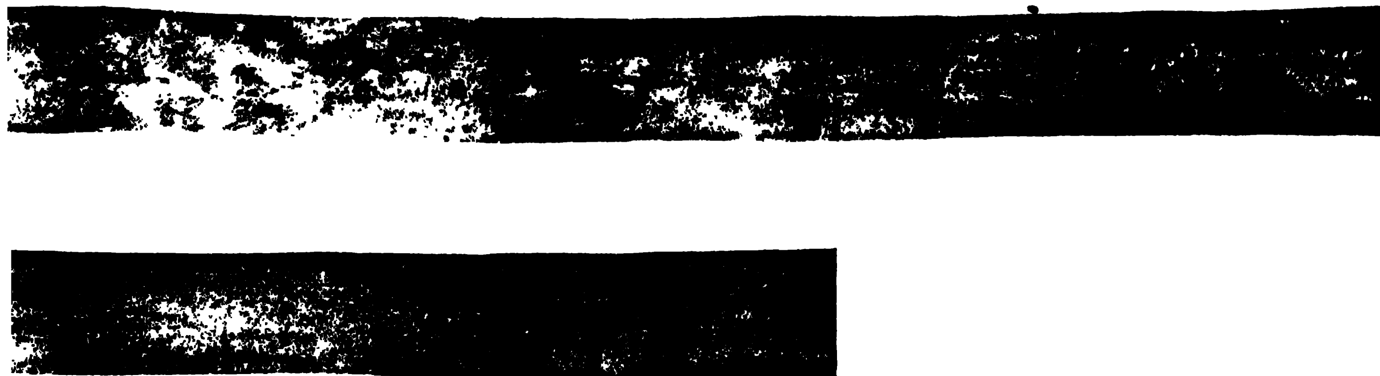


FIG. 14. SULPHUR PRINTS OF SPLIT BLOOMS (BASE)
Longer piece, top bloom from M10. Shorter piece, top bloom from

TABLE XIV. MECHANICAL AND CHEMICAL PROPERTIES OF THE SINK-HEAD SPECIAL (NICKEL AND CHROMIUM) INGOT

	Tension Tests				Hardness		Chemical Analysis at "O"								
							Per Cent								
Reel	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elong. Per Cent in 2 In.	Red. Area Per Cent	Brinell	Scleroscope	O	M	Seg.	Mn	P	Si	S	Ni	Cr
H38-A	70,030	142,725	12	18.79	274	33	0.741	0.741	0.0	0.91	0.024	0.179	0.018	0.19	0.10
H38-B	70,700	143,400	11	18.59	298	32	0.731	0.729	0.27	0.95	0.027	0.177	0.019	0.19	0.10
H38-C	70,950	143,450	12	18.54	318	29	0.728	0.735	0.96	0.93	0.026	0.179	0.018	0.19	0.12
H38-D	71,445	143,300	11.5	18.38	283	33	0.734	0.726	1.09	0.94	0.027	0.185	0.018	0.18	0.10
H38-E	70,830	142,250	10	21.00	287	31	0.731	0.730	0.14	0.96	0.025	0.180	0.019	0.19	0.11
Average	70,791	143,025	11.3	19.06	292	32	0.733	0.732	0.0	0.94	0.026	0.180	0.018	0.19	0.11

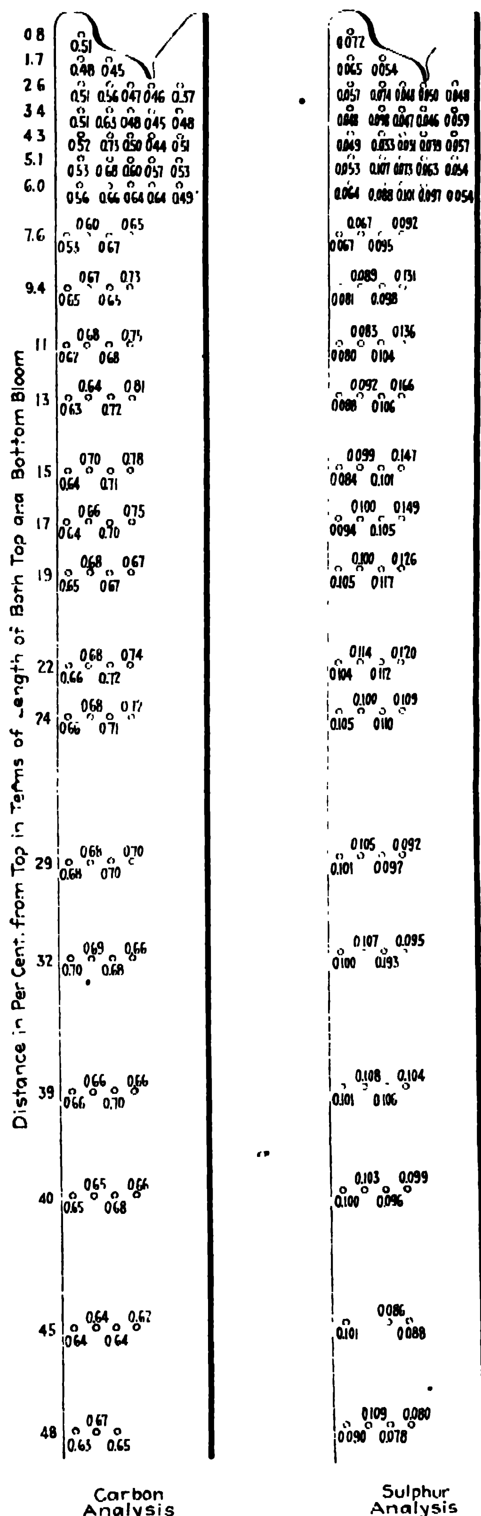


FIG. 16. CARBON AND SULPHUR SURVEY FROM TOP BLOOM H10

from heat M1 to M5 of non-deoxidized rising steel, chilled on top of ingot by cast-iron caps, required excessive discard to eliminate positive segregation at the top and negative segregation at the bottom of the ingot, the latter often accompanied by dangerous pipes.

The second heat (ingots M6 to M10) made of rising steel deoxidized with aluminum in the molds and the ingot tops of which were cooled with water, required the least total discard of the three heats. It was more subject to piping and less to segregation than the first heat of ingots made in the usual manner.

The third heat (ingots M11 to M15), made of quiet or "killed" steel, was not chilled on top with water or caps and was deoxidized with aluminum in the molds. The ingots of this heat required an intermediate amount of total discard when compared to the first and second heats; this heat was the only one for which a greater top discard was required to eliminate piping than to eliminate segregation above 12 per cent. One of the ingots of this third heat contained a small pipe at the bottom and all the rails from the middle and bottom of the ingots showed high negative segregation.

The distribution of physical properties throughout the length of each ingot is characteristic not only of the type of the ingot and the casting practice but also of the state of the steel when cast.

It has been established in the foregoing that after removal of the top discard of 13 per cent, the Hadfield type of sink-head ingot is free from piping and undue segregation. The ordinary type of ingot, cast small end up without sink-head as is usual for rail ingots, requires an average top discard of 26 per cent and the remainder of the ingot is liable to contain enclosed piping and excessive segregation. Defective rails, from the middle and bottom portion of the ingot, are not certainly detected by means of existing rail specifications, and as a result of this uncertainty rails containing pipes or excessive segregation may get into service with disastrous results.

The surface condition of the rails from the sink-head ingots was not as good for the ordinary ingots, but this is not considered an essential characteristic of rails from such ingots.

The markedly differing characteristics of the three heats of Maryland ingots leads one to raise the question whether or not it might be advisable to specify, at least in some degree, the methods of steel manufacture or of ingot practice for rails and similar products on which the safety of the traveling public depends.

While it is not claimed that the use of the sink-head process for the manufacture of ingots will solve all rail problems, it is maintained that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads. The necessary changes in mill operations, it is believed could be made without too great difficulties.

Tanks and Pipe Lines as Causes of Accidents*

A Study of the Hazards Involved in the Use of Storage Tanks and Pipe Line Distributing Systems in Chemical Plants — Safe Methods for the Construction, Cleaning and Repairing of Underground and Overhead Tanks and Pipe Lines

BY HOMER A. HOFFMAN†

PIPE lines and tanks are an important factor in the distribution and storage of liquids in a chemical factory and not infrequently we hear of an accident due to a break in the line, the overflowing of a tank, of persons becoming unconscious while in a tank, and even explosions as the result of directing a line into a tank other than the one intended. Although this is but one of the hazards of the chemical industry, it is one to which considerable attention may be given.

Our first consideration is the liquid to be handled, what are its reactions, its specific gravity and viscosity. In the selection of pipes and tanks it must be known in what way they will be affected by the liquid handled, what will be the probable life of the pipe or tank and will it in any way change the structure or give off impurities that will affect the liquid.

MATERIALS OF CONSTRUCTION

The field to select from is large and various, so that generally a choice can be made to fit the case. For instance, cast iron does very well for sulphuric, but not for tannins, which are best handled in copper- or brass-lined tanks and pipes. A few of the materials may be enumerated, such as stoneware, earthenware, monel metal, which satisfactorily resists acids and alkalis, aluminum for acetic acid, glass-coated or enameled cast iron, hard rubber and wood, all of which are used to meet certain conditions. The choice of woods are cypress, redwood and long-leafed pine.

For high-pressure pipe where the liquid necessitates costly material, cast iron or pipe of sufficient strength and lined with particular material is used. Connections on all high-pressure lines must be flanged, and valves are to be of a reinforced type. It will be found advantageous to use replaceable seats in such valves.

DISCUSSION LIMITED TO STORAGE TANKS AND DISTRIBUTION PIPING

Under location, it may be well to classify tanks for storage and piping for distribution. No attempt will be made to discuss the types engaged in processes.

Tanks used for the storage of flammable liquids should be placed so as to conform to the requirements of the National Fire Protection Association or other similar body. As these come under another subject, "Fire Explosions, etc.," they will not be given here. For non-flammable chemicals the tanks acting as distribution centers may be placed above ground or overhead and under ground.

CONSTRUCTION OF UNDERGROUND TANKS

Underground tanks may be set in vertically or horizontally, the latter being preferable for those of large capacity. A well or pit of concrete should act as a receptacle, the space between the pit walls and tank should be wide enough to allow the passage of a man at any point and the tank should be mounted about 15 in. above the pit bottom. This will allow for an easy inspection and room for workmen making repairs, and will provide proper ventilation about the tank. If the tank is in too close quarters the painting of it is often overlooked and its life will not be as long as expected.

The pit will withstand the action of fumes and acid far better if lined with asphalt, tar or one of the like preparations on the market. The latter as a rule contains a binder of asbestos or other material which prevents in cracking or scaling off. A stationary ladder should be at the pit opening so a person may emerge without delay. When a person is working in the pit a sign to that effect should be hung outside, or, better still, a man should be stationed above the pit.

Gratings are not suitable pit covers, as they allow water and dirt to accumulate in the pit, but if they are used, drainage should be provided for. Sliding covers or sectional lids are generally used for the purpose.

With a tank in a pit of this type a leak can easily be located and in case of a burst or overflow the contents can be recovered and repairs can be made without removing the tank. Tanks placed so should not exceed 10,000 gal. capacity and should be at least 2 ft. below the ground level or floor surface. All gages should be placed where they can be clearly read, and all control valves, cocks, etc., should be fitted with long stems that can be turned without entering the pit and have on them locks or warning signs if any danger exists or they are likely to be tampered with. Vent pipes should end in a receptacle for that purpose.

DISTRIBUTION FROM UNDERGROUND TANKS

Distribution from underground tanks necessitates pumps or compressed air, the latter being quite satisfactory for a good many liquids. Any difficulties in distribution are outweighed by the fact that there is no drip, splash or spray to contend with, material would not be lost in case of a burst, valves are above the tank, the tank is not easily reached by fire and in plants where space is limited it is out of the way.

LOCATION AND CONSTRUCTION OF OVERHEAD TANKS

Overhead tanks present more problems. The location is an important consideration. If placed over passageways, as is sometimes done, a drip pan of sufficient size, with a drain to a sewer or emergency tank, must be provided to carry off any liquid from a leak, overflow or burst. When placed in or on a building, it must be known that the floor, roof or building will not be overloaded when the tank is full.

*Delivered before the Chemical Section at the Ninth Annual Safety Congress of the National Safety Council, Milwaukee, Sept. 30, 1920.

†Safety Engineer, Monsanto Chemical Works, St. Louis, Mo.

Wood is used to a large extent for overhead tanks, and as the woods previously mentioned will resist the action of sulphuric and acetic acids of 20 deg. Bé., many of them, mostly of the open type, are found in chemical works. The failure of wooden tanks is often caused by the corrosion of flat hoops, the inner side of which cannot be seen and any defects noted. It is advisable therefore to use only round hoops, which can be gone over from time to time. Wooden tanks should not be allowed to dry out, but if such is the case the hoops may be tightened before being put into use again.

Dry rot is another cause of failures, so periodical inspections should be made. There must be as small a surface as possible in contact with other materials.

Pressure tanks should be tested over pressure before being put into use. Thus a tank car of liquid chlorine would be subjected to a pressure of about 300 lb. per sq.in. Such a tank will receive jolts, so it must be heavily insulated and the dome fittings incased in a hood. Switchings and siding from which such tanks are being loaded or unloaded should have a warning or lock on the switch.

In the case of all aboveground or overhead tanks a hoseline with a stream sufficient to drown a burst, and an emergency box containing gloves, goggles, safe clothing, etc., should be kept in the vicinity.

A runway or platform should be built over the tops of closed tanks so that valves and cocks can be reached from above or from one side. The chief advantage of the overhead tank is that distribution from it is by gravity.

Safe Methods for Cleaning and Repairing Tanks

Care in cleaning and repairing tanks is very important, and rules governing such operations should be strictly enforced. The importance of this may be illustrated by an occurrence at our plant which took place before the safety idea was recognized. The work on the particular tank was a welding job and before consulting the superintendent or chemist to ascertain if the tank had been properly ventilated, the welder injected his torch into the tank, causing an explosion which resulted in his death and injury to his helper, who had expected something of the sort and was making a getaway.

On another occasion a foreigner who was employed as a leadburner was found doing a job on a tank that had not been inspected. When asked how he knew it was safe to start, he replied: "He is all right. I try him first with my torch, he no blow up."

It is well to have steady crews to do such work as cleaning and repairing tanks. The accepted method of cleaning tank cars may well be applied to all other large closed tanks. The work of cleaning such tanks should be under the direction of a superintendent and as nearly as possible accomplished from the outside. This can be accomplished by removing the cleaning blank and opening all drains, after which a 2½-in. hose fitted with a curved 2-in. pipe which can direct a stream to any part of the car is used for washing. If the pressure is not strong enough to remove sediment or scale, a hoe fitted with a long flexible handle may be used to good advantage. If there is no bottom outlet, the tank should be filled enough to hold all the sediment in suspension when agitated, so that it may be pumped or siphoned out.

In cases where a workman must enter a tank it should be run full of water to exclude all gases, or a jet of fresh air run in for a sufficient length of time. A workman entering a tank must be supplied with an approved type of respirator and protective clothing, and if the entrance is through a manhole, he must wear a belt with slings under the arms attached to a flexible cable held at the other end by a man on the outside of the tank. A jet of fresh air from a compressor or some reliable source should be run into the tank as long as there is a man inside.

If an open light or flame is used inside of the tank, we use a helmet which has a hose supplying air from outside the tank or one with a compressed air tank fitted to the helmet, which supply will last for half an hour. Proper supervision is absolutely necessary.

Underground Pipe Lines

The same classification, overhead and underground, may be applied to pipe lines. Condition of climate enters as a factor, so that underground lines are preferable in colder climates when not housed or in heated buildings. For outside use where a number of lines are run parallel they should be set below the frost line in half round tile and cover, these acting as a conduit, with a break at intervals to serve as a drain in case of a leak or break. The tile cover not only prevents seepage but can easily be removed for making new installations or repairs.

Pipes, when set in this manner and given a coat of resisting paint, will last for a long while without showing any signs of external corrosion. An exhaust steam line may be run through the conduit to maintain an even temperature in winter months. For heavy pipe or pipe of large diameter such installation is costly and unnecessary.

With underground lines a burst can do little or no damage, there are no drips to contend with, all valves can be reached from above, the tripping hazard is eliminated, no installation is required, there is no freezing in the lines and no danger from falling material when the installation is made.

All valves, cutoffs, cocks, etc., must be clearly marked and open ends tagged to show what is being handled in the line. When compression is used to force the liquid through the lines, all connections should be flanged and the line tested before being put into use.

Overhead Pipe Lines

Overhead lines present quite a few hazards. In routing the lines care must be taken to see that those to contain toluene, benzene, alcohol, etc., are not run above or too near to open flames, boilers and switches, as a drip may become ignited.

Where it is required that acid, lye or other such lines cross passageways, they should be jacketed to prevent a drip or spray from falling on anyone beneath. The hangers supporting pipe should be strong enough to support the weight of a man in addition to the working load, as invariably you will find some person who will lean a ladder against, or stand on a pipe.

All overhead lines should be marked in some way to indicate their contents. The most desirable method is that of painting the lines of different colors, but where this cannot be carried out, all cocks, valves and lines should be marked in some way, and at open ends warning signs should be placed, stating what precaution should be taken or protection worn when handling the contents.

Difficulty sometimes arises due to an accumulation of sludge or the tendency of a liquid to crystallize in the pipe. The latter can in most cases be prevented by using a small steam coil about the pipe and covering with asbestos. Overlooking such a precaution was the cause of an accident at our plant. A length of 1½-in. steel pipe was carrying hot material which crystallized near the open end. In thawing out the pipe, the man used a blow torch, starting at the open end to allow the material to run out as it thawed, which it partly did. Some of it recrystallized, closing the pipe and building up pressure where the torch was being applied. This caused the pipe to blow out along the seam, driving the hot material with such force that it penetrated the man's clothing, burning his arms and chest.

Steady Crew Should Handle Inspection and Repair Work

A periodical inspection should be made of all lines and any faulty valves, leaking connections or corroded pipe be replaced and all lines no longer in use removed. Discarded lines should be allowed to drain, or, better still, be washed out, forcing water or air through them. Too often temporary lines are allowed to remain after having served their purpose. Work on lines should be done from a scaffold built on a level with the line, by persons wearing the proper safe clothing and goggles. Where a connection is to be broken, it should be covered with a shield or covered with a reasonable amount of sacking or rags to absorb drips and a warning sign should be hung below. In all cases the pipe should be supported so that it can be lowered to the ground and not left to fall.

It is very important to have a steady crew to do this work, men who know the rules and observe them, because it is through errors on their part that they or others are injured.

An Application of Super-Centrifugal Force

By Eugene E. Ayres, Jr.

THREE years ago the commercial centrifuge was unknown to the refiner of vegetable oils. Today the centrifuge is recovering about 225,000 lb. per day of edible oils. Each pound of edible oil recovered means the loss of only about one-half a pound of crude soap material. Each pound of oil recovered means from 6c. to 10c. net profit. For 1920 the collective profit to the refiners in the United States will amount to about $4,000,000.

The profitable quality of a technical process is not always a correct index of its value as an element of scientific progress, but this case is interesting in that an old familiar principle only modernly understood has accomplished what every refiner has wished to accomplish since the first kettle of cottonseed oil was agitated with lye.

This description is intended not for the vegetable oil specialist, who is already familiar with the process, but for the industrial chemist who may be confronted with similar problems.

An economist would express the refining problem as follows:

The oil expressed from cotton seed is crude oil, in the sense that it is unfit for food products or for the manufacture of fine soaps. Crude cottonseed oil is evaluated not on the basis of its value as crude but on the basis of the yield and quality of refined oil that may be obtained from the crude by acceptable refining methods. As for quality, the refined oil must have pleasant taste and odor or the absence of taste and odor, and a properly pale yellow color.

The refining is in three steps a caustic soda treatment to remove fatty acids and allied impurities, bleaching with fullers earth, and deodorization with steam, losses from these operations being in the order given. Losses from the caustic soda treatment are appreciable always and sometimes incredibly high. Research has not disclosed a suitable substitute for the caustic soda treatment. Other alkalis or the use of chemical substances (with few exceptions) in conjunction with caustic soda will produce oils that may not be properly deodorized and bleached.

Soapstock

The refiner's chief problem has been to secure a higher yield of refined oil without impairing the quality.

The byproduct from the refining is a mixture of soap, oil and impurities. This is called soapstock. The soapstock has a market value as a base for soap manufacture, but the value of soapstock (on the basis of fatty acid content) is from 6c. to 10c. less than the value of refined oil. The obvious thing to do is to conduct the refining in such a manner as to leave as little oil as possible in the byproduct soapstock. Failing this, the oil in the soapstock should be recovered as such.

Oil in Soapstock

The practical refiner would narrow the problem as follows:

Suppose a crude oil is composed of 97.5 per cent neutral oil and 2.5 per cent of free fatty acid and associated impurities. To remove the free fatty acid and impurities it is necessary to use an excess of caustic soda. The amount of excess reagent is the minimum that will yield a proper quality of refined oil. After separating the crude soap thus formed, from 100 lb. of crude oil 92.5 lb. of neutral refined oil will be normally recovered. Five pounds of oil that was present in the crude has been lost.

The loss may be fairly distributed between actual saponification by the excess alkali and mechanical association with the byproduct soapstock. The saponified oil cannot, of course, be reclaimed, though refining modifications have been suggested by which the extent of saponification of neutral oil may be reduced. But the oil in the soapstock (about 2.5 lb. in this case) should yield to some recovery procedure.

Nature of Mechanical Loss

From a chemist's viewpoint, the mechanical loss of oil occurs in the following manner:

When a volume of rancid oil is agitated with a smaller volume of caustic soda solution, a complex emulsion is produced. In this emulsion, oil is continuous. The suspended globules are not globules of soap water, but are globules of a secondary emulsion. This secondary emulsion is composed of continuous soap-water with very small globules of oil suspended. The oil in the refining kettle immediately after the addition of lye is, therefore, present in two phases—a primary continuous phase and a secondary dispersed phase.

After the break occurs the globules of the secondary

emulsion coalesce and sink, to form a compact layer. This is soapstock. The refined oil that is pumped out of the kettle is the oil that composed the primary continuous phase of the refining emulsion. The oil that was dispersed as globules in the secondary emulsion cannot be pumped out as free oil, for it is stubbornly enmeshed in the soapstock. This oil is enmeshed rather than suspended, because coincident with the "break" is a gelatinization of the strong soap-water, and as the jellied globules coalesce and sink, the tiny dispersed globules of oil are deformed and lie in irregular streaks and strata in the soapstock. The viscosity of the jel is too great to allow interfacial surface tension to act.

The principal emulsion problem of the cottonseed oil technologist has been naturally with reference to the refining emulsion- to insure a proper agglomeration and settling of the soapstock, and to secure conditions that will leave a minimum percentage of the oil as a secondary dispersed phase. Investigation of this point is difficult, because modifications in refining technique involve so many limiting factors, such as, for instance, color and taste.

The recovery of oil from soapstock, on the other hand, is not greatly complicated by questions of oil quality, for the reasons that the recovered oil can be so readily re-refined with caustic soda and the quantity of recovered oil is small compared with the output of the refinery. Such a recovery is a problem in subsidence.

Physically, soapstock is rather a nondescript mass of soap, water, oil, solids, salts and organic impurities. Although a little free oil will usually settle out of hot soapstock, it is not possible to separate even a trace of free oil when a hot soapstock is pumped through a most powerful centrifuge. This is easily accounted for by the fact that the recoverable oil is in an extremely unstable condition. The gelatinization of the soap solution while deforming the oil globules also causes considerable agglomeration of oil into strata, but if the viscous mixture is thoroughly agitated, the oil is again dispersed. With such an unstable condition, recovery is possible only when the mass can be undisturbed.

When soapstock is diluted with water to the point where it is no longer gelatinous it may be described as follows:

The continuous phase is water with a trace of inorganic matter dissolved and certain organic matters in colloidal dispersion.

Under a microscope of highest power, the continuous water phase of the soapstock is usually transparent, with a yellow color. In bulk the aqueous phase, when completely freed from oil (by filtration, for instance) is dark brown in color, but transparent, without the faintest trace of opalescence. Under the microscope the oil globules are without color and vary in size from 0.02 mm. down to 0.002 mm., or even smaller. When not prevented by viscosity, the smaller particles exhibit decided Brownian movement.

Use of Centrifugal Force

Centrifugal machines may be divided into two classes: (1) Those which induce filtration, such as the hydro-extractor; (2) those which induce subsidence. The latter type is applicable to emulsions.

Centrifugal force (like gravity) has two functions-- to move the globules down or up, depending upon relative specific gravities, and to cause adjacent globules to coalesce. Centrifugal force has been successfully utilized in the past for the separation of emulsions that yield both to subsidence and to coalescence. With one exception, emulsions whose globules will not coalesce under centrifugal force have never been resolved centrifugally on a commercial scale. The one exception is milk, oldest and best-known example of centrifugal separation. The cream separator, however, has always been a product of purely empirical design. The more modern centrifugals, adapted, for example, to the separation of water from petroleum, are designed with full scientific understanding of the emulsions for which they are intended.

The cream separator is a practical success only for milk. The subsidence-coalescence centrifugals are not successful with emulsions wherein coalescence will not take place. It has been necessary, therefore, to determine the fundamentals of the class of emulsions of which milk is a special case. This difficulty offers the best explanation of the fact that dilute soapstock emulsions were not satisfactorily centrifuged until recently.

Centrifugal Procedure in Oil Refineries

The soapstock must be diluted until it is no longer gelatinous. The thin emulsion is subjected to centrifugal force for a sufficient period to move to the surface all oil globules that do not exhibit Brownian movement. The emulsion is thus divided into two new emulsions, one saturated with oil, the other containing only the smallest globules. It is customary to refer to the one as the "light" emulsion, while the other has so few emulsion characteristics that it is termed the "heavy effluent."

The light emulsion on microscopical examination is found to possess a structure similar to that of the diluted soapstock, except that (1) the oil globules are nearly uniform in size, averaging 0.008 mm. in diameter, and (2) the oil globules are packed together very closely, touching each other in all directions.

The heavy effluent from cottonseed oil soapstock consists microscopically of a clear yellow phase containing a few scattered spherical oil globules averaging 0.002 mm. in diameter.

To obtain continuous oil from the light emulsion it is convenient to add salt water and recentrifuge. The salt wholly or partly precipitates the soap from solution and in this way tends to reverse the form of the emulsion—to make oil continuous and water globularly suspended. Emulsions of this type are easily separated by centrifugal force. Preparatory to recentrifuging, other chemical methods of breaking down emulsion stability are satisfactory, but salt is economical and efficient.

Under correct operating conditions, the centrifugal process appears to recover about 60 per cent of the neutral oil present in the soapstock. Yields have been reported as high as 78 per cent and as low as 40 per cent.

It is not to be supposed that any plant now in operation is operating at maximum efficiency. The soapstocks produced at the various refineries are different in many respects. For example, in one refinery it was found that the centrifugal recovery yields were very low because of the fact that the water used for the dilution of the soapstock had been softened. Soft water is not as good as hard water when emulsion stability is to be reduced. Maximum efficiency will come, of course, only as the conditions at each recovery plant are more and more thoroughly understood, and when suitable operating modifications are adopted.

Philadelphia, Pa.

The Separation of Mineral Matter From Natural Flake Graphite

By W. C. Ratliff and Joseph D. Davis

AMERICAN flake graphites, as they are put on the market, contain rather large percentages of ash. The ash content of Alabama graphite, for sample, ranges from 9 to 15 per cent, and the figures for Pennsylvania graphite are about the same. The dust or fines resulting from the refining or grading of the flake are much higher in ash. No. 1 dust from Alabama flake[1] graphite contains about 55 per cent ash, while the ash content of No. 2 dust will run as high as 70 per cent.

The Bureau of Mines has been conducting investigations looking toward the better utilization of American graphites, and this paper represents a part of the investigation.

There may be some question as to the economy of further purification of the coarser flakes, particularly when they are intended for use in crucible making, but the dusts as they come from the refinery are not readily marketable, and it is believed that if they were free from mineral matter they would be in demand for such purposes as the manufacture of stove polishes, graphite paints and lubricants, and particularly for the manufacture of graphite electrodes. It was for the purpose of developing a method for the purification of dusts that the experimental work which follows was undertaken.

Method Adopted for Purification

The method used in this experimental work was that devised by Lieutenant Walter E. Trent primarily for the purpose of removing mineral matter from coal. The method is essentially as follows:

The coal to be treated is finely pulverized and thoroughly wetted with water, the weight of water added being at least twice the weight of the coal. Enough oil is then added to saturate the coal (usually about 1 part oil to 2 parts coal), and the mixture is thoroughly agitated with some efficient type of mechanical agitator. The effect of the agitation is to cause the coal and oil to be agglomerate, leaving the mineral matter suspended in the water, with which it can be poured off from the coal-oil mixture. By repeatedly agitating the coal-oil mixture with fresh portions of water and pouring off the wash water, a large part of the extraneous mineral matter can be removed. Most of the water held mechanically by the pasty mass of oil and coal can now be removed by squeezing as butter is worked.

Preliminary Experimental Work

A 100-g. sample of Alabama flake graphite was thoroughly agitated in a small hand churn with 100 c.c. of topped crude oil of paraffine base and 0.87 specific gravity, and about 200 c.c. of water. The graphite and oil agglomerated with a fairly good separation of the water. The water, however, carried only a small amount of mineral matter from the graphite, and the sample was known to contain over 12 per cent ash.

It was now decided to investigate the effect of fineness of grinding. Accordingly, a fairly large sample of the Alabama flake graphite was ground in water for about eight hours in a ball mill, and then filtered and dried for one hour at 105 deg. C., to remove all the moisture. On visual inspection, the size of the flakes seemed to have been considerably reduced. On close examination, however, under the microscope, Dr. Reinhardt Thiessen of this bureau found that the area of the flakes had not been greatly reduced, but that they had been reduced in thickness. The thin laminæ of which the flakes are made up had been separated, leaving the mineral matter held between the laminæ exposed. A 60-g. sample of this ground graphite was agitated with 60 c.c. of topped crude oil and 120 c.c. of water. The water decanted from the agglomerated mass of graphite and oil carried with it quite a large amount of mineral matter resembling clay. Fresh water was added and the mixture was again thoroughly agitated, after which the water was poured off from the graphite and oil, containing apparently as much sediment as that from the first treatment.

The washing with water was repeated until the water came off clear, six washings being required in all. All the washings were then collected and filtered, and the residue was ignited in a muffle furnace for one hour, after which it was cooled and weighed. The weight of the residue so obtained amounted to 10.16 per cent of the weight of the sample treated. A portion of the graphite-oil mixture was now extracted with benzene to remove the oil, the benzene was driven off and the amount of ash in the residue was determined. It was found to contain 3 per cent ash, whereas the original graphite sample contained 13 per cent ash.

Another test was made wherein only half as much oil was used as in the test just described, but this amount of oil failed to effect good agglomeration. About equal portions of oil and graphite gave the best results. The amount of water required was approximately twice that of the graphite. Further additions of water had no effect on the agglomeration, but aided in keeping the mineral matter in suspension so that it could be more readily removed from the oil and graphite.

Comparative Efficiency of Different Agglomerating Liquids

Having found that heavy oil gave fairly good results as an agglomerant, it was decided to try the agglomerating effects of lighter and more volatile liquids, the idea being to find a liquid that would do the work as well as the oil and at the same time be more readily recovered by volatilization. No doubt the surface tension and viscosity of the liquid used have an important bearing on its behavior, but these are matters which require more extended study than this paper contemplates. The known requirement of a liquid agglomerant is that it must be immiscible with water. Benzene, toluene and carbon tetrachloride answer this requirement and were selected for comparative test with oil. All these liquids gave good agglomeration when churned up with the graphite and water, but the carbon tetrachloride apparently gave the cleanest separation of the water and agglomerated mass. The comparative washing efficiencies of the liquids were now determined quantitatively.

For the determination, large samples (approximately 2 lb.) of Alabama and Pennsylvania graphites were ground in a ball mill with water for about eight hours. The samples were then dried at 105 deg. C. until all the moisture was removed. Fifty-gram samples of the ground graphites were thoroughly agitated with 50-c.c. portions of the different liquids, about 200 c.c. of water being added in each case.

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[1]Downs, F. G., "Grading of Graphite in Alabama," *Eng. and Min. J.*, Feb. 9, 1918, pp. 282-283.

The agglomerated residues were now washed until the decanted water was clear. This required from five to eight washings with 200 c.c. portions of water. The benzene, toluene and carbon tetrachloride, being readily volatile, were easily driven out of the graphite by heating, and the oil was extracted from the oil-graphite residue with benzene. After thoroughly drying all the samples, duplicate samples of each were weighed out and ashed to constant weight in a muffle furnace at about 800 deg. C. Table I gives the results of the washing tests.

It will be noted that the efficiencies of benzene, toluene and carbon tetrachloride are very nearly the same, whereas that of oil is different and not so good. In the case of the Alabama graphite the amount of mineral matter removed by the lighter liquids averages 72.7 per cent of the total mineral matter contained, while that removed by the oil is 63.3 per cent of the total. In the case of the Pennsylvania graphite, the light liquids removed 44.1 per cent of the total mineral matter and the oil removed 35.8 per cent of it. The greater efficiency of the treatments in removing ash from the Alabama graphite may be accounted for by the fact that the Alabama flake was finer than that from Pennsylvania. This is shown in Table III, which gives the size tests on all samples used.

TABLE I

Per Cent Ash in Alabama and Pennsylvania Graphites Before and After Treatment With Topped Crude Oi[illegible] Tetrachlorid[illegible]

Kind of Graphite	Untreated	Treated With Oil	Benzene	Toluene	Carbon Tetrachloride
Alabama	11 68	4 28	3 44	3 41	3 30
Pennsylvania	10 03	6 43	5 54	5 71	5 55

Although the efficiencies of benzene, toluene and carbon tetrachloride are about the same, carbon tetrachloride was used in making further tests, since it gave the best agglomeration and the cleaner cut separation of the agglomerate from water.

Effect of Size of Graphite Particles

Fairly large samples (approximately 100 g.) of the Alabama and Pennsylvania graphites were ground in the ball mills for eight hours and then treated with carbon tetrachloride and washed to free them from suspended mineral matter. The samples were then dried at 105 deg. C. to remove all the carbon tetrachloride and moisture. Small samples of the residues were reserved for determination of ash and the remainders were again ground wet in the ball mills, this time for twelve hours. They were then treated with carbon tetrachloride and separated mineral matter was removed by washing as before. The resulting agglomerates were now dried and ash determinations were made on the dried final product. The results of the tests, as shown by the ash determinations, are given in Table II.

TABLE II

Per Cent Ash Remaining in Alabama and Pennsylvania Graphites After Eight and Twenty Hours Grinding, and Treatment With Carbon Tetrachloride

Kind of Graphite	Per Cent Ash Ground 8 Hr.	Ground 20 Hr.
Alabama	3 51	1.56
Pennsylvania	5 65	1.75

In order to get the relation between the fineness of the graphites and the amount of ash removed in each case, size tests were made on all samples treated, and the results of the tests are given in Table III.

TABLE III

Results of Size Tests on Alabama and Pennsylvania Graphites

	Alabama Graphite Unground	Ground 8 Hr.	Ground 20 Hr.	Pennsylvania Graphite Unground	Ground 8 Hr.	Ground 20 Hr.
	Per Cent			Per Cent		
On 48 mesh	11 7	9 5	1 5	74 4	80 6	10 3
Through 48, on 100 mesh	82 2	70 0	32 9	25.0	15 4	32 7
Through 100, on 200 mesh	5 2	12 7	31 1	0 1	1 7	28 2
Through 200 mesh	0 9	7 8	43 5	0 5	2 3	28.8

These size tests give only an approximation of the actual sizes of the graphite flakes, since in every case the flakes were somewhat broken up in going through the screens. Particles that should have been retained on the screens passed through before constant weight on the amount retained could be secured. This is true of the unground sample of Pennsylvania graphite, where a smaller quantity was retained on the 48-mesh screen than that retained on the same screen after eight hours' grinding. However, in general, the size tests do show a reduction in size by grinding. Microscopic examination showed that the thickness of the flakes had been greatly reduced, but that the area had not been reduced so much. By picking apart the flakes with a needle, particles of clay could be dislodged from the laminæ. The main effect, then, of grinding the flake graphite was to break apart the laminæ and expose the mineral matter, which was then easily removed by treatment with carbon tetrachloride with subsequent washing.

Treatment of Other Graphite Samples

A sample of Alabama flake dust, containing 37.63 per cent ash and of such fineness that 52 per cent of it passed 200 mesh and the remainder passed 100 mesh, was treated with carbon tetrachloride and washed in the usual manner. After treatment, the ash remaining in the graphite amounted to 22.59 per cent. This residue was now ground wet in a ball mill for seven hours, and, after washing, the amount of ash still held by the graphite was 7.87 per cent.

A very finely pulverized sample (100 per cent passed 200 mesh) of amorphous Mexican graphite was treated with carbon tetrachloride and washed free from separated mineral matter in the usual manner. The ash content of the original sample was 15 per cent and the amount remaining after washing was 7.5 per cent. It was shown that the ash content of the sample could be further reduced by grinding, but quantitative reduction tests were not made.

Conclusion

From the results of the experimental work just described, the following conclusions may be drawn:

1. Graphite, both flake and amorphous, may be cleaned by agitating with oil and water.

2. Light volatile liquids, benzene, toluene and carbon tetrachloride, are better adapted to the cleaning of graphite than oil. It is probable that this is due mainly to their lower viscosity. It was noted that with the lighter liquids the agglomerates formed were much less viscous and that mineral matter separated with much less agitation than in the cases where heavy oil was used.

3. The extent of the cleaning effected by this method depends indirectly on the fineness of the graphite treated. The value of grinding is not so much due to actual size reduction thereby as to a separation of the mineral matter from inclosing carbon.

Molybdenum During 1917-1919*

By Frank L. Hess

THE molybdenite deposits of the United States are legion. This mineral has probably been found, at least in small quantity, in every state in which there are any considerable outcrops of granite. In the Rocky Mountain and other Western States individual occurrences are too numerous to record. Like gold leaf, molybdenite is apt to be spread so thinly and to make so great a show compared with its real bulk that a much exaggerated impression of its quantity is had unless dependence is placed on assays alone. Molybdenite [the sulphide of molybdenum (MoS_2) and by far the commonest molybdenum mineral] is so attractive when seen in the white quartz in which it is commonly found and so deceptive in its appearance of quantity, and so many stories of its great usefulness and value have been current, all with a touch of the mystery connected with supposed secret uses, that many persons have been induced to invest much more labor and money in molybdenum mining enterprises than careful investigation would warrant.

In 1918 the United States retained its lead as the greatest producer of molybdenum by an output of 431 short tons of metal in 2,280 tons of ore and concentrates valued at $1,253,700.

In 1918 the center of production moved from Arizona to Colorado. The dumps of the old Mammoth gold mine, from which a large part of Arizona's production had come, had yielded their crop of wulfenite, though the mine is still productive; but the great size of the Colorado deposits and the large mills give an output which is far greater than that of any other state.

Disposition of Molybdenum in 1917

The Atlantic Metal & Alloys Co., Boonton, N. J.; the Arizona Rare Metals Co., Tucson, Ariz.; the Primos Chemical Co., Primos, Pa.; and the Rose Chemical Co., Los Angeles, Cal., made ferromolybdenum during 1917. The Atlantic Metal & Alloys Co. went out of business during that year, and the Tungsten Products Co., of Boulder, Col., took over its slag on hand and produced ferromolybdenum from it.

So far as is known, except for a small quantity used experimentally and another small quantity used by one firm in tool steels, all the ferromolybdenum made in 1917 was exported, most, if not all, going to France, and most of the concentrates produced in this country that were not reduced to ferromolybdenum were also exported to France. Small quantities were used for the production of molybdic oxide, molybdic acid and ammonium molybdate. The molybdic oxide and molybdic acid were used either to make ammonium molybdate or molybdenum (metal).

Consumption in 1918

In 1917 and in the earlier part of 1918 there was a good foreign demand for molybdenum ores and ferromolybdenum, and considerable quantities were used by the Ford Motor Co. and the Carbon Steel Co. in the United States, but the domestic market was very restricted and was supplied during the first part of the year mostly by the Climax Molybdenum Co. and the Primos Chemical Co.

The Ford Motor Co. had a contract to supply crank shafts and connecting rods for Liberty aircraft engines to the Government, and in these 0.35 to 0.50 per cent of molybdenum was used, with more chromium and nickel. A crank-shaft forging weighed 196 lb. and an extra shaft was shipped with every twenty-five Liberty engines. The yield of forging bars was about 60 per cent per heat in the electric furnace, and about 90 per cent of good shafts were obtained from the bars. The connecting-rod forgings weighed about 62 lb. per engine, and each electric furnace heat also gave about 60 per cent of good forging bars but only about 80 per cent of finished forgings from the bars. About 100 crank shafts was the maximum daily output, with presumably an equal number of connecting rods.

During the summer small plates of similar steel exhibited had shown great resistance to light projectiles, and it was proposed to make all armor for tanks and airplanes of similar steel.

The Government did not itself buy any molybdenum ores for the work, but gave its assistance to the companies which were to make the steel in their efforts to obtain ferromolybdenum quickly and guaranteed their contracts. Before the steel was made the company that had advised the use of molybdenum steel announced that it had obtained better results with steel carrying a very small percentage of zirconium, and the company was told to go ahead with zirconium steel if that would afford the best possible protection. Baddeleyite (zirconium oxide) was therefore ordered from Brazil, but before either steel was actually used the armistice was signed and all contracts were nullified.

Market Conditions in 1919

The reaction in the molybdenum market caused by the cessation of hostilities and the withdrawal of the European demand for molybdenum ores and ferromolybdenum probably reached a maximum during the year 1919.[1] The development of new properties and the production of increased quantities of ore, stimulated by the active demand, more especially during 1917, naturally resulted in overproduction as soon as the war demand ceased. The largest single consumer, the Ministry of Munitions in London, announced early in the year that accumulated stocks in the United Kingdom were large enough to meet all demands for at least eighteen months. Most of the production within the British Empire was under contract at a fixed rate. Arrangements were therefore made to reduce drastically all shipments from outlying points to allow existing stocks to be realized and to permit the world's market to settle down to a normal working condition as soon as possible. The Ministry of Munitions therefore terminated the existing purchasing arrangements and no deliveries of molybdenite loaded on ocean steamers from British overseas ports after April 30, 1919, were to be accepted. The Ministry of Munitions also recommended that empire producers, in their own interests, should take immediate steps to reduce the production of these ores.

The agents of the Federal Government of Australia continued purchasing supplies of tungsten and molybdenum ores at the scheduled prices to Dec. 31, under the contracts previously made by the Commonwealth Government with the Imperial Government. During the negotiations the Imperial Government advised the

*Advance sheets, Mineral Resources of the U. S., 1917, 1918.

[1]The three following paragraphs are by Alfred W. G. Wilson, Department of Mines, Ottawa, Canada, in "The Mineral Industry During 1919."

WORLD'S OUTPUT OF MOLYBDENUM CONCENTRATES IN TERMS OF THE CONTAINED MOLYBDENUM

(M = molybdenite; W = wulfenite.)

Country	Ore Mineral	1915 Quantity (Metric Tons)	1915 Value	1916 Quantity (Metric Tons)	1916 Value	1917 Quantity (Metric Tons)	1917 Value	1918 Quantity (Metric Tons)	1918 Value
Australia	M	71.9	$377,700	70.39	$314,800	102.05	$456,273	111.8	$500,000
Austria	W	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Bolivia	M	6.5	5,475	5.17	7,663	(a)	(a)	(a)	(a)
Canada	M	.	......	42.5	156,461	78.5	288,705	102.8	434,528
Chile	M	.	. .	0.8		20.1	9,836	.. .	.. ....
China	M	(a)	(a)	0.3	1,409	1.6	1,700	1.08	3,689
Chosen	M	.	..	3.2	12,463	59.2	19,034	10.7	25,884
Germany	M	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
India	M		. ..	0.4	983	0.7	3,050	0.09	551
Italy	M	. . .	.	.		0.2	(a)		.
Japan	M		..	18.3	31,177	12.06	30,124	(b) 70.3	12,746
Norway	M	72.3	(a)	73.1	(a)	82.1	533,333	84.9	1,248,804
Peru	M	1.3	6,990	3.08	14,120	3.8	20,970	1.3	7,445
Spain	W	1.8	1,861	.....	. . . .	... ..	....		
United States	M, W	82.4	114,866	93.8	205,000	158.8	495,350	390.8	1,253,700

(a) Figures not available. (b) 66.3 tons coarse ore of low grade.

Commonwealth Government that the estimated stock of tungsten and molybdenum minerals in Great Britain at the end of 1919 would be sufficient to meet the requirements of the home and export trade of the United Kingdom for at least two years. It was expected that these stocks would have to be realized by the Imperial Government at prices below the fixed standard at which they had been purchased.

Overproduction, beyond the ability of the market to absorb, quickly resulted either in the accumulation of stocks at some of the mines or in the cessation of mining. Production had stopped at nearly all the mines early in the year, and some new properties that were ready to produce concentrates found themselves without a market.

Colorado Deposits

The greatest single feature of 1918 in the mining of molybdenum was the building of expensive and elaborate mills by the Climax Molybdenum Co. and the Molybdenum Products Corporation and the development of their holdings on the great deposit on the west side of Bartlett Mountain, at Climax, Summit County, fifteen miles north of Leadville, Col. The Climax Molybdenum Co. had its mill sufficiently finished to carry on experimental work in the latter part of February and in March. In April the mill was running regularly.[3]

The Molybdenum Products Corporation has a patented claim 150 by 1,500 ft. located on the same ore body, and had the ore on at least three sides of its claim. It got to work later than the Climax Molybdenum Co. and was not so fortunate in disposing of its product, so that it operated only a short time. So far as it is already explored the deposit can probably supply 100,000 tons of elemental molybdenum. Both companies are ready for operation at any time that a demand sufficient to warrant operation arises.

World's Production

The United States and Canada apparently have the largest known molybdenum supplies. It is believed that the United States has the greatest individual deposits and the greatest quantity of available ore, but neither Canadian nor American Government geologists have examined deposits in both countries, and private opinions differ. The United States has for some years been the largest producer of molybdenum ore and is in a position to increase production greatly whenever the market warrants.

The accompanying table shows the world's production of molybdenum contained in ore, so far as the data are at hand, for the years 1914 to 1918, inclusive. No facts are now known that indicate a greatly different distribution in the near future. It is known that some molybdenite has been produced in Germany and some wulfenite in Austria, but the quantities are unknown.

[3]See CHEM. & MET. ENG., vol. 19, p. 651, Nov. 1, 1918.

Legal Notes

BY WELLINGTON GUSTIN

Hair-Line Cracks on Ingot Steel Not Breach of Warranty Against Serious Surface Defects

In the case of the Clark Equipment Co. against the John A. Crowley Co., judgment for the former being recently affirmed in the United States Circuit Court of Appeals, the controversy involved hair-line cracks on the surface of steel ingots, rendering them unfit for gun forgings.

The Crowley company sought to defeat payment for the ingots, claiming the plaintiff had breached its warranty in forging the ingots. The warranty insisted on is found in the order for manufacture given by the Clark company to the Crowley company and in a nearly contemporaneous letter explaining what was wanted. The order was prepared by the buyer and tells the forge company that its acceptance "constitutes a guaranty that all steel furnished [under the order] will be free from all physical defects." The letter charges the forge company that its "responsibility consists" in furnishing steel "free from surface defects and an unusual amount of pipe"; wherefore [wrote the buyer] "please use care; . . . serious surface defects will be cause for rejection of the entire ingot."

Now it was laid down that where the warranty on a sale of goods was contained in the order and letter, both of which were prepared by the buyer, any doubt as to construction of these writings will be resolved against the buyer. The above warranty is one as to quality; the rule applicable being that there must be a substantial compliance, and substantial failure being a breach.

The forge company or seller admitted the existence of "hair-line" cracks on the ingot surface, but averred that it had "chipped out" the same so that the ingot was either "perfect" on delivery, or was made so thereafter, at its expense. There was evidence that such cracks were a necessary result of cooling of metal, and

their removal produced perfection, and also that steel of the composition and ingot size contracted for could not resist without cracking the method of forging adopted by the purchaser. On the other hand, the purchaser gave evidence that "fine cracks" discoverable by "a more or less careful scrutiny" existed before forging, and under "the hammering process . . . they became larger."

The only point properly before the court was whether what the seller called "hair-line cracks," removed by chipping, constituted "serious surface defects." It was held that hair-line cracks chipped out before delivery and serious surface defects are not convertible terms, and the jury having found as a fact that the ingots delivered did conform to the terms of the contract, the judgment for the seller was affirmed.

Plant Must Be Operated Not to Interfere With Health of Neighboring Residents

The rules governing liability for maintaining an industrial plant as a nuisance are laid down in the decision of the Supreme Court of Minnesota in two actions brought by Alice Millett against the Minnesota Crushed Stone Co.

Millett brought suit to recover damages extending over a period of six years from the operation of a quarry, crushing plant and grinding mill near her home. It was claimed that because of noise and jar of blasting, the noise and danger of falling rocks, the noise of steam drills and of a steam shovel, and because of smoke and dust, the plant was a nuisance. On trial the jury found against the company and it appealed.

The Supreme Court stated the rules in effect to be that a land owner who has a deposit of limestone or other product on his land may not quarry as he chooses, but he may be liable for maintaining a nuisance in the operation of a quarry and other incidental industries, even though the odors, noise, dust and the like complained of are ordinary incidents of such a business conducted without negligence; that the rights of inhabitants are superior to the rights of trade, and that, whenever they conflict, the rights of trade must yield, that such a business must be conducted in such a manner as not to offend or interfere materially with the health or ordinary physical comfort of people living in the neighborhood.

Two questions were presented for determination by the Supreme Court: First, whether the home owner was entitled to recover for the diminution of the value of the use of the property. Second, whether recovery for personal discomfort, inconvenience and ill health is an additional element of damage.

Answering the first proposition it was said that a property owner whose property is injured by a nuisance may recover for the property damage sustained. This is generally the diminished rental value, if the property be rented, or the diminished value of the use, if the property be used by the owner (2 Sup. Court, 719). This element of damage is recoverable only by the owner (Jefferson Fertilizer Co. vs. Rich, 62 So., 40).

Answering the second proposition, the court said the rule was now well settled that in an action for damages for maintaining a nuisance recovery may be had for inconvenience, physical discomfort and illness to the occupant of the property resulting from the nuisance. This element of damage is something additional to the element of diminished rental value.

In an action for a private nuisance, affecting injuriously the health and comfort of the occupants of the homestead, the husband and father of the family, if he be the owner, may recover for any discomfort, annoyance or illness suffered by himself or any member of his family resulting from the nuisance. And it is not permitted to each member of the family to maintain separate actions to recover these elements of injury. This rule is laid down to avoid a multiplicity of law suits.

Company Has Right to Replace Old System to Preserve Investments

An attempt to enlarge profits in salt manufacture got the Buckley & Douglas Lumber Co. into the courts through a controversy among its directors. In an earlier case brought by the State of Michigan against it, the company was permitted to manufacture salt as an incident to the manufacture of lumber, and as the salt business was extended of late years, the quantity of logs sawed has diminished.

The increasing manufacture of salt brought about an increasing problem of fuel. Coal burned by the company in plant 1 amounted in 1915 to $45,435; in 1917, $86,468; and in 1918, $153,575. The value of the salt block and equipment in 1910 was about $225,000, and in 1918 about $350,000.

In 1918 a contract was entered into with the Manistee Iron Works Co. for the installation in plant 1 of new pans and a new system of applying steam thereto whereby it was claimed the same quantity of salt could be produced by the use of one-fourth the amount of fuel. The purchase price of the new equipment was $238,650, and the cost of installation would make the total cost thereof about $300,000.

The complaining directors, who voted against this transaction, brought suit against the companies and majority directors, contending the contract was unlawful, and asked that the court declare said contract *ultra vires* and void, and that defendants be restrained from doing any act under it, holding the individual defendants personally liable.

The questions presented were: First, had the board of directors the power to enter into the contract to replace with the iron company? Second, if they had such power, was the making of such contract a legal fraud upon the rights of the minority stockholders?

The court said the board had the same right as a copartnership or an individual would have to enter into any contract reasonably adapted to further the business of the corporation, if within the powers conferred by its charter. They may generally do whatever an individual, acting intelligently and honestly, would do under similar circumstances.

Plant 1 included a warehouse with a capacity of from 350,000 to 400,000 bbl., five salt wells about 2,000 ft. deep, railroad tracks, docks and shipping facilities, besides apparatus for manufacture of salt. Its total cost has been about $350,000. The board was found to be justified in preserving this investment in the manner it followed, by replacing worn-out salt-manufacturing apparatus with a new system which allows greater salt production with less fuel. And the directors had the power to contract in good faith to replace worn-out apparatus for its incidental salt manufacturing, and such was not a fraud on minority stockholders. Such was the judgment of the Supreme Court of Michigan.

Notes on Pulp and Paper*

THERE are four general processes of reducing wood to a pulp condition—namley, the ground wood, sulphite, sulphate and soda processes of pulping.

The Ground Wood Process

The ground wood process of pulping is used mainly for the reduction of non-resinous, long-fibered wood, such as spruce and balsam. The barked wood in 2-ft. lengths is ground on a grindstone, the surface of which has been sharpened to produce a cutting action. The yield of pulp is approximately 90 per cent of the weight of the raw wood. The pulp is inferior in quality and is used only to mix with longer- and stronger-fibered stock such as unbleached sulphite pulp—in the manufacture of paper in which permanency is not required, as in news-print, cheap catalog, magazine and certain other papers. It is also used to a large extent in the manufacture of wall board.

The Sulphite Process

The sulphite process is used chiefly for the reduction of long-fibered, non-resinous, coniferous woods, such as spruce, balsam and hemlock, giving a yield of less than 45 per cent based on the weight of the original wood used. This pulp can be bleached to a high degree of white and is largely used both unbleached and bleached in the manufacture of books, news-print, wrapping, bond and tissue papers.

The Sulphate Process

The sulphate or kraft process of pulping is used for the reduction of any long-fibered wood and yields approximately 45 per cent. This is an alkaline process and can be used for the reduction of both resinous and non-resinous woods, such as the pines, spruces, hemlocks, firs, etc. Kraft pulp is normally not bleached but on account of its strength it is used for the manufacture of kraft wrapping paper and high-test container board.

The Soda Process

The soda process is restricted in use to the short-fibered deciduous woods, such as aspen, cottonwood, willow, gum woods, etc., yielding less than 45 per cent. The resulting pulp is invariably bleached to a high degree of white, and after admixture with a longer- and stronger-fibered stock, such as spruce sulphite, is used for the manufacture of book, lithograph, envelope papers, etc.

Cost of a Pulp and Paper Mill

No accurate figures are available as to the cost of a pulp and paper mill, but it is the opinion of the laboratory that under present conditions a balanced pulp and paper mill cannot be erected at a cost of less than $45,000 or $50,000 per ton capacity of finished paper per day. It is not feasible, except under abnormal conditions, to erect a pulp plant of less than twenty-five tons capacity, requiring approximately sixty cords of wood a day. Before proceeding with the erection of a pulp and paper mill a competent engineer who has specialized in this field should make a very careful survey of the economic conditions, such as labor, markets, living conditions, cost of fuel and power, as such factors are of decided importance in determining whether or not the enterprise will be a financial success.

American conditions are deemed unsuitable for plant fiber paper. General investigations have shown that fibers such as sugar cane bagasse, corn stalks and various straws offer the following difficulties in handling:

Difficulties in Using Plant Fibers

1. Plant stalks, straws, grasses, etc., usually contain a large percentage of pith, giving pulps low in fiber content and requiring high chemical consumption.

2. Material of this type represents seasonal crops, so that facilities must be provided for the storage of a large volume of the stalk in order to permit the paper mill to operate throughout the year. The susceptibility of such material to decay adds greatly to the costs and difficulties of storage.

3. Due to the bulkiness of these materials the digester charge is reduced, thereby reducing the yield and increasing overhead costs proportionately.

Some of these fibers, such as straws, are being pulped at the present time for use in the manufacture of corrugated board and cheaper board products. Pulp of this nature, however, does not compare with a refined pulp such as sulphite or rag stock; it can be used only for special purposes and not in the manufacture of news-print or high-grade paper. Plant fibers of this nature are being reduced commercially in Europe where economic conditions and the scarcity of wood permit their utilization.

Availability of Southern Woods

There has been considerable inquiry concerning the suitability of Southern woods for paper manufacture. While these have a good fiber length, on account of their pitch content they cannot be reduced by either the sulphite or the ground wood process to compete commercially with pulp made from Northern coniferous woods, such as spruce, balsam or hemlock.

Southern Pines

The various species of Southern pines can best be reduced by the sulphate, or kraft, process of pulping, and the resulting pulp utilized for the manufacture of kraft wrapping paper or high-test container board. These pines can also be reduced by the soda process and the resulting pulp utilized in the manufacture of grades of paper in which sulphate pulp is ordinarily used. It is possible that further work will demonstrate the feasibility of pulping these pines by the sulphate process, bleaching the pulp to a satisfactory degree of white and mixing it with short-fibered sulphate or soda pulp made from other Southern woods, such as the gum woods, for the production of magazine, book, envelope or lithograph papers. The yield of pulp by the soda and sulphate processes is less than 45 per cent.

Southern Hardwoods

The large stands of hardwoods occurring in the South consist in part of the various species of gum wood, cottonwood, sycamore, basswood, magnolia, willow, etc. All of these woods are short-fibered and, according to laboratory experience, can be most satisfactorily reduced by the soda and sulphate processes of pulping. This pulp after admixture with a longer- and stronger-fibered stock, such as bleached spruce sulphite or pine sulphate pulp, can be used for the production of book, envelope or lithograph paper.

*Abstracts from the Forest Products Laboratory *Technical Notes*.

Producer Gas-Fired Boiler Installation in France

A Description of the Installation and Operation of a Producer Gas-Fired Boiler Plant at the Montrambert, Loire, Coal Mines, Using Coked Slack and Mine Waste for the Production of the Gas

BY JOHN H. BARTLETT, JR.

ENGINEERS and works' managers are frequently heard to express certain doubts as to the possibility of obtaining complete combustion with gas of very low calorific value without the use of supplementary heat furnished by pre-heating the air destined to support this combustion.

Difficulties in lighting and in maintaining a stable combustion are feared and it is commonly considered to be of prime necessity to provide for an excess of air in order to insure the gas being completely burned. For the most part, these ideas are traceable to the fact that the designs and equipment used have almost always been more or less defective, and it is thought that in this connection a short description of the tests recently made on firing a water tube boiler with lean producer gas at Montrambert (Loire) may be of some interest.

Some readers may be already familiar with the studies and experiments carried on during latter years by the Société des Houillères de Montrambert et de la Béraudière of St. Etienne (France) with the aim of utilizing in the most economical and rational way the slack from its mines and its low-grade coals. In order to pursue these studies this company built a complete test works of 500 kw. capacity which is operating regularly at present, furnishing the power used in the exploitation of the shafts at Montrambert and producing a surplus which is turned on to the distribution system of the Cie. Electrique de la Loire et du Centre, with which this installation is connected. A few words will perhaps be necessary to describe hastily this installation and to explain the connection between these projects and the tests recently made upon the use of producer gas for boiler firing.



FIG. 1. THE BUTTNER BOILER WITH GAS BURNER INSTALLED

In order to utilize this slack and mine waste, which is a coking fuel containing 42 to 45 per cent of moderately fusible ash and 18 to 20 per cent of volatile matter, the Société des Mines de Montrambert has had recourse to gasification, dividing the operation into two parts. The coal is first charged into coke ovens, the byproducts being recuperated and the waste heat employed for steam generation; the coke thus formed is next utilized in gas producers and the gas produced is employed in two internal combustion engines for generation of electrical power.

By this method are avoided the difficulties resulting from a direct treatment in producers of a coking coal, rich in viscous tar and which produces continuously, through agglomeration, compact masses of clinker in the producer and gives off a gas whose purification is extremely difficult. These low grades of coal can be handled very well in coke ovens and the use of coke in the producers permits an exact regulation of the latter, making it possible to produce a gas which is practically constant in composition and calorific value.



FIG. GENERAL VIEW OF PRODUCER INSTALLATION

Since this gas is to be used in internal combustion engines its purification is necessary; but the Société des Mines de Montrambert considers that even if the gas were destined for industrial furnaces or boilers it would be worth while in most cases to purify it to a certain extent and to recover, as far as possible, the condensable byproducts and the sensible heat carried by it.

Its installation of two 10-ft. rotating grate producers is therefore completed by purifying and cooling apparatus which insures the deposit of the dust and tar contained by the gas, and which cools and so dries it, pre-heating the air blast for the producers at the same time. In this same apparatus the hot air is saturated with water and the proportion between the weights of water vapor and air furnished to the producer is easily controlled by regulating the temperature of the air.

The gas after its passage through this apparatus is discharged by an extractor into a series of purifying cases and finally passes to a holder from which it is drawn by the suction of the gas engines.

A supplementary installation is added to the equipment mentioned above for the recuperation of the nitrogen content in the coke, of which about 70 per cent is

recovered in the form of ammonia salts. The further recovery of sulphur compounds and other products is being studied.

The works has been in normal operation for about two years, furnishing a monthly production of 200,000 kw.-hr. which is utilized by the Société des Mines de Montrambert or discharged upon the system of the local electric company. Its operation has been so successful that the Société de Montrambert is at present considering the construction of a large works comprising coke ovens and producers capable of handling all the low-grade coal and non-salable waste produced by its various mines. It was as part of this project that this company decided in 1919 to experiment upon the use of the available producer gas for the firing of boilers in order to determine whether this gas was suitable under practical conditions for such an application and also to find out what efficiency could be expected of a boiler so fired and whether it would be advantageous to provide batteries of boilers supplying turbo-generator groups instead of internal combustion motors.



FIG. GAS HOLDER

For this test the company chose the boiler installed near the battery of coke ovens and which is normally heated by waste gases from the latter. This boiler (Fig. 1) is of the Büttner type (water tube) having a heating surface of 80 sq.m. (about 860 sq.ft.) and is installed in the open air without economizer or feed water heater. It had been in operation for about ten years and the tubes were fouled by the tar and the lamp black deposited by the waste gases coming from the coke ovens. Prior to the test the interior of the tubes was cleaned, but it was impossible to reach the exteriors in order to remove scale and soot, which fact probably reduced the boiler efficiency to some extent. The brick setting was in rather poor condition.

For the firing of this boiler the principle of "surface combustion" was used, employing the patented process and equipment of an American firm, the Surface Combustion Co. of New York. This process consists in mixing intimately the gas with the air necessary for its combustion in their exact chemical combining proportions (without excess of either air or of gas) and in projecting this mixture into a porous bed of refractory material at a speed sufficient to avoid any possibility of back firing. Almost instantaneous combustion takes place in contact with the hot surfaces of the refractory pieces composing this bed, which is rapidly brought to incandescence and serves as a source and reservoir of radiant heat.

It is in this form that heat is most penetrant and the most rapidly absorbed by the object to be heated, although this factor has been frequently lost sight of in the application of gas burners to the firing of boilers.

In the usual boiler practice with the solid fuel firebox not only is the boiler heated by absorption from the hot products of combustion, but also to a very considerable extent by radiation from the surface of the fuel bed. Efficiency is lost, however, in the use of solid fuel owing to the large excess of air required for complete combustion, with its consequent lowering of the flame temperature.

In the usual methods of firing boilers with gas the reverse is true and a more or less high flame temperature is obtained, but this flame is practically non-radiant. Contact of the hot gases or of the flame itself with the tubes is therefore relied upon for heating the boiler, which thus becomes to all intents and purposes practically a waste heat boiler.

If, therefore, we can utilize the efficiency of generation obtained by perfect control of a gas mixture with consequent high flame temperature, and at the same time present an efficient radiant surface to the boiler, we shall realize the combined advantages of firing with gaseous and solid fuels. This was the object in view.

Fig. 4 represents a longitudinal section of the boiler firebox transformed for the use of gas. The gas was drawn from the holder by a Roots blower, which raised it to a pressure of 12 to 16 in. of water and transmitted it through an overhead pipe line to the boiler. This pressure is employed in the inspirator A, consisting of a gas nozzle and Venturi throat, to inspirate from the atmosphere the full quantity of air necessary for the complete combustion of the gas. The high velocity of the gas and air passing through the throat completes their intimate mixture and this mixture is delivered, under pressure, to the cast-iron burner B, which discharges it at a suitable velocity into the refractory bed C. This burner is designed to present the minimum of metallic surface to the radiation from the furnace and its cross-section is sufficiently great to insure the rapid conduction of any heat absorbed to the exterior, where this heat is dissipated to the air by means of cooling fins cast integral with the body of the burner.

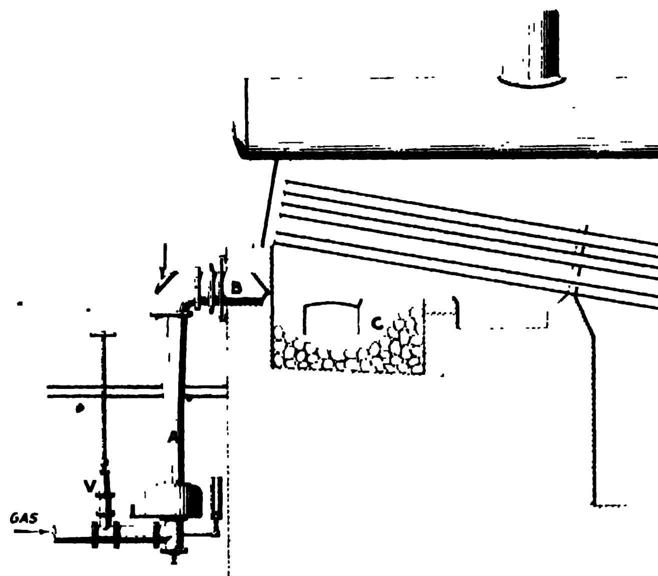


FIG. 4. LONGITUDINAL SECTION OF BOILER WITH GAS BURNER

A feature to be noted is that the inspirator *A* maintains automatically constant the proportions of air and gas furnished to the burner without the need for any attention on the part of the operator. The gas consumption and therefore the rate of evaporation of the boiler may thus be regulated by the operation of a single valve *V* in the gas supply line as long as the quality of the gas remains approximately constant. By this means combustion under the most efficient conditions is assured—i.e., without excess of air or of gas and at the highest possible temperature.

Since a draught is not necessary for the proper operation of this system, but on the contrary is rather harmful, the boiler was isolated from its stack and a small brick flue was built against the rear of the setting, mounting to the same height as the latter, and into the bottom of this flue the waste gases were discharged from the breeching. A small damper in the flue permitted the control of the pressure in the boiler setting.

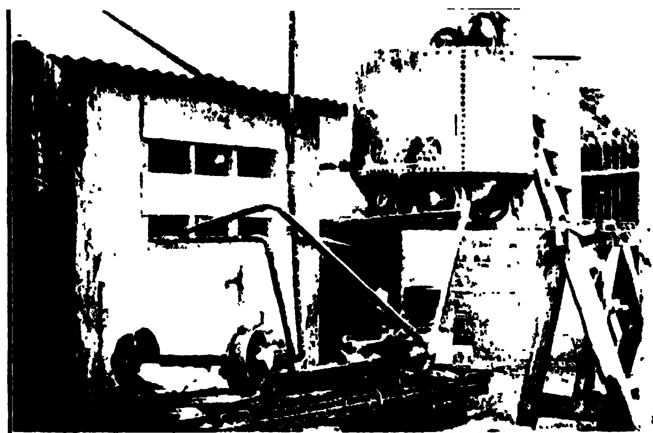


FIG. 5. EXTRA PUMP AND RESERVOIR INSTALLED TO MEET INCREASED EVAPORATION UNDER GAS FIRING

During the period of installation of the gas-burning equipment the boiler was shut down. It was therefore entirely cold when first started up and contained water up to the normal operating level. The burner was lit quite easily by means of a small torch of oily waste. At the end of forty minutes of heating the boiler was in full operation at 120-lb. pressure as was indicated by steam escaping from the safety valve. This speed of heating demonstrates the extreme flexibility in responding to variation of load which a battery of boilers fired with gas by the surface combustion system would have.

A continuous test of the boiler at normal pressure (6.5 kilos = 93 lb.) was next attempted, but at the end of a short time it was discovered that the injector and the feed pump with which the boiler was equipped taken together were of a capacity insufficient to supply its demand when in full operation with gas firing. A second and more powerful pump was installed and a new pipe line was run doubling the capacity of the water feed. Even with these arrangements the factor limiting the production of steam was still the feed water equipment and not the boiler itself, and it was impossible to allow it to operate continuously at its maximum evaporative capacity. This latter is apparently in the neighborhood of 30 kilos of steam per hr. per sq.m. of heating surface (6.15 lb. per sq.ft.). A 24-hr. test was, however, obtained during which the average rate was 23.75 kilos per sq.m. (4.9 lb. per sq.ft.), which is about double the normal steam production for this type of boiler. The water feed was measured by a meter known to be correct and the gas by observations made upon the gas holder, which during this test was used to supply only the boiler. The boiler was connected in upon a steam line at 6½ kilos and the pressure during the test was therefore maintained at this figure.

The average production of steam was found to be 1,900 kilos per hr. (4,200 lb.) with a gas consumption of 2,485 cu.m. (87,800 cu.ft.) per hr. measured at the holder and of 1,990 cu.m. (70,300 cu.ft.) per hr. measured by the nozzle in the inspirator. Since the temperature at the holder averaged 49 deg. C. and the gas was saturated with water vapor at this temperature, the consumption calculated by the holder was corrected for the normal pressure and temperature at the works laboratory, account being taken of the volume of water vapor contained. The above figure then becomes 1,970 cu.m. per hr. (69,600 cu.ft.) at 718 mm. and 15 deg. C., which checks quite well with the consumption calculated from the pressure at the inspirator nozzle, or, correcting to 0 deg. C. and 760 mm., 1,765 cu.m. (62,-300 cu.ft.) per hr. In round figures, therefore, 1 cu.m. of gas produced 1 kg. of steam (16 cu.ft. of gas produced 1 lb. of steam). The calorific value of the gas was controlled by a Junkers calorimeter and varied during the test from 813 (minimum) to 902 (maximum) calories per cu.m. (91.3 to 101 B.t.u. per cu.ft.) —average 856 at 15 deg. C. and 718 mm. (96.3 B.t.u.). From these figures the over-all thermal efficiency of the boiler is figured as equal to 73.3 per cent. This efficiency could without doubt be improved appreciably with a clean boiler well constructed with a view to economy. The coke consumption of the producer averaged 450 kilos (1,000 lb.) per hr., 45 per cent ash content, calorific value not over 4,000 calories per kilo (7,200 B.t.u. per lb.).

The pressure and temperature of the flue gases were measured; near the bridge wall a pressure of 5 mm. water was found and immediately before the damper in the small chimney there was a suction of 5 mm. At the same place the temperature of the gases was 344 deg. C. on Dec. 20 and 354 deg. C. on Dec. 21.

Frequent flue gas analyses were made—the average of these was 17.9 per cent CO_2 with sometimes several tenths per cent CO and at other times a slight percentage of oxygen according as the gas varied in quality.

The samples taken at the bridge wall checked well with those at the breeching, showing that combustion was complete in the firebox before contact of the gas with the tubes.

In view of the satisfactory results which these first tests have given, the Société des Houillères de Montrambert et de la Béraudière is considering at present the use of producer gas for firing an important battery of boilers as a part of a large project for the utilization of its waste coal.

The installation was made by the Cie. Générale de Construction de Fours of Paris, employing the patented process and equipment of the Surface Combustion Co. of New York.

The writer wishes to acknowledge his indebtedness to M. Blache of the Société de Montrambert for much of the information above, and for the many courtesies extended to him during the tests.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cellulose Esters.—Cellulose esters are prepared by subjecting to the usual process of esterification a cellulose derivative obtained on treating cellulose with nitric acid in the presence of nitrobenzene. In an example, cotton is treated with a mixture of nitric acid and nitrobenzene, and the product, after washing and drying, is warmed with a mixture of glacial acetic acid, acetic anhydride and bromine or other catalyst, as indicated in the parent specification; the acetate is separated in the usual manner by dilution with water, and may be hydrolyzed before or after separation. Specification 1,156—1914 is referred to. (Br. Pat. 145,524—1919. AKT. GES. FÜR ANILIN FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Dust Removal From Gases and Vapors.—Dust is removed from gases and vapors by means of a rotary electric field between a number of stationary electrodes. These may be arranged about the axis of a casing, in number dependent on the kind of the field used; preferably the number of electrodes is a multiple of the number of phases of the alternating supply system, so that the field is multipolar. The electrodes may be arranged longitudinally with reference to the casing. They may be surrounded with insulating material. In the center of the rotating field there may be arranged either a rod having a higher dielectric constant than the gases, or a conductive rod connected to the neutral point of the polyphase supply system. Alternatively, a combination of these devices may be employed, in the form of a conductor surrounded by a glass cylinder, or of a stream of water. Reference is made to an arrangement having electrodes rotated by means of a rotary electro-magnetic field. (Br. Pat. 145,585 1919. W. NORTH, Hanover, Germany, Sept. 1, 1920.)

Cellulose Acetate Compositions.—A composition for use as a coating material, or in the manufacture of artificial silk or films, or as a varnish, and which can be cast or molded, consists of cellulose acetate and the aggregate of fatty acids extracted from coconut oil. A volatile solvent such as chloroform, acetone, acetylene tetrachloride, or chloroform and alcohol, is used in the manufacture of the composition; and the proportions of solvent and of fatty acid are varied according to the purpose for which the composition is to be employed. (Br. Pat. 146,212- 1919. BRITISH CELLULOSE & CHEMICAL MANUFACTURING CO., London, Sept. 8, 1920.)

Obtaining Copper and Nickel Electrolytically.—In treating copper-nickel alloys or concentrates in chloride solutions, an oxidizing agent such as chlorine is introduced at intervals or continuously, so that the copper deposited at the cathode is equal in amount to that dissolved from the alloy constituting the anode. The solution may contain hydrochloric acid or a chloride such as common salt. Initially, for instance, it may be a solution of 135 g. crystallized cupric chloride per liter of 25 per cent hydrochloric acid. At a low electric pressure, copper and nickel dissolve from the anode as sub-chlorides, no copper being deposited until a large part of the cupric chloride is reduced. No chlorine is added until deposition has brought down the proportion of copper in solution to about 4 per cent. The anode may contain 30 per cent of copper. When the solution is sufficiently rich in nickel, it is treated for the recovery of this metal by known means. (Br. Pat. 145,600—1919. P. GOLDBERG, Treptow, Berlin, Sept. 1, 1920.)

Aminophenol Derivatives.—*N*-dioxypropyl-*p*-aminophenol and its alkyl ethers are obtained by the reaction of *p*-aminophenol or its alkyl ethers with α-monochlorhydrin or glycide; the process may be effected in the presence of a neutral solvent or substances binding hydrochloric acid. Examples are given of the preparation of *n*-dioxypropyl-*p*-aminophenol, *n*-dioxypropyl-*p*-anisidine, and *n*-dioxypropyl-*p*-phenetidine; *n*-dioxypropyl-*p*-aminophenol may be used as a photographic developer, and *n*-dioxypropyl-*p*-phenetidine has therapeutic properties. Instead of α-monochlorhydrin, epichlorhydrin may be used, the resulting chloro compound being saponified by alcoholic potash. (Br. Pat. 145,614—1919. E. KOLSHORN, Dahlem, Berlin, Sept. 1, 1920.)

Isolation of the Alkaloids of Lobelia Inflata.—Three alkaloids, termed α-, β-, and γ-lobeline, are isolated from the crude alkaloid of *Lobelia inflata* by dissolving the crude product in hydrochloric acid, crystallizing out the difficultly-soluble hydrochloride of β-lobeline, and extracting the hydrochloride of α-lobeline from the mother liquor by means of chloroform. The chloroform solution is mixed with soda solution, the chloroform evaporated off, and the α-lobeline crystallized out; it is formulated as $C_{11}H_{23}O_2N$. The β- and γ-lobeline are not crystalline. The crude alkaloid employed may be obtained by extracting the drug by alcohol, distilling off the alcohol, dissolving the bases in dilute acid, neutralizing the acid solutions by alkali and extracting with ether; or the first extract may be made with ether or benzene. This process may be modified by using carbon tetrachloride, trichlorethylene, acetylene tetrachloride, etc., instead of chloroform for extracting α-lobeline hydrochloride from the mother liquor from which β-lobeline hydrochloride has been crystallized out. (Br. Pat. 145,621 and 145,622—1919. C. H. BOEHRINGER SOHN, Ingelheim-on-Rhine, Germany, Sept. 1, 1920.)

Dyeing With Vat Dyes.—In dyeing animal fibers or mixed goods with vat dyes, the products of alkali hydrolyses of vegetable or animal albumins similar to protalbinic or lysalbinic acids, or their alkali salts, are added to the dye vats; brighter shades are thereby obtained and the fibers become more soft, elastic and glossy. The vats may be made neutral or slightly acid. In an example, a vat contains indigo MLB, sodium hydrosulphite, and hydrolyzed glue or casein, and is neutralized by formic acid. (Br. Pat. 145,674—1919. C. BENNERT, Grunau, near Berlin, Sept. 1, 1920.)

Artificial Threads, Ribbons, Films and Sheets.—In the manufacture of artificial threads and of ribbons, films or sheets from viscose, the solution is introduced through suitably shaped apertures into a precipitating bath consisting of waste sulphite-cellulose lye to which has been added a mineral acid or an acid salt—for example, sulphuric acid, sulphurous acid or hydrochloric acid. The waste lye obtained in the manufacture of

"sulphite ethers" may also be used. It is preferred to use a waste lye which is free from lime—for example, a sodium sulphite lye obtained when the wood is boiled with sodium bisulphite, or "by conversion of sodium salts from the waste lye of lime"; and the lye should be concentrated before use. Hardening agents such as formaldehyde or sulphate of alumina, and glue, seaweed mucilages, etc., may be added to the precipitating bath; by such additions the sensitiveness of the threads, etc., to water and their capacity for dyeing can be favorably affected. (Br. Pat. 145,627—1919. M. MUELLER, Finkenwalde, near Stettin, Sept. 1, 1920.)

Tanning.—Hides and skins are stated to be tanned by the application of constituents extracted from vegetable substances such as wood, straw and the like by means of alkaline liquids; or by formaldehyde or the salts of heavy metals such as chromium and iron, in the presence of such constituents. In an example, an extract obtained by boiling straw in soda-lye is mixed with iron-alum, in which case a yellow deposit is slowly brought down. This suspended agent is used for tanning. (Br. Pat. 145,742—1919. H. BREUER, Bonn-on-Rhine, Sept. 1, 1920.)

Refining Tin and Antimony.—Crude tin is refined by treating with dry chlorine which may be obtained by vaporizing liquid chlorine, filtering the liquid product, treating with water to decompose the chlorides of antimony, arsenic and sulphur, filtering again, and recovering tin from the pure solution of stannic chloride, for instance, by reduction to stannous chloride and electrolysis. To separate the antimony, the process is modified by heating the reaction vessel to 115-120 deg. when the antimony pentachloride is decomposed into chlorine and solid trichloride, which is therefore removed in the first filtration. In a similar manner antimony is separated from metals such as lead, and is obtained as pentachloride alone when tin does not occur among the impurities. (Br. Pat. 145,789—1919. G. BONNARD, Plombière-St. Marcel, Savoie, France, Sept. 1, 1920.)

Gallolactates, Tannolactates. — Gallolactates and tannolactates of the alkaline-earth metals, magnesium or aluminum are obtained by heating normal lactates with gallic, tannic or gallotannic acid, or basic tannates or gallates with lactic acid, in dilute alcohol, dilute acetone or mixtures thereof. Examples are given of the preparation of calcium tannolactate, calcium gallolactate, barium tannolactate, strontium tannolactate, aluminum tannolactate and magnesium tannolactate. The products are practically insoluble in water and alcohol, are slowly decomposed by dilute acids, and have therapeutic properties. (Br. Pat. 146,234—1919. E. KOLSHORN, Dahlem, Berlin, Sept. 8, 1920.)

Acyl Cyanamides. — Cyanamides of α-halogenfatty acids are obtained by reaction of halides of α-halogenfatty acids with metal cyanamides in aqueous solution or suspension. An example is given of the preparation of diethylbromacetyl cyanamide from diethylbromacetyl chloride or bromide and sodium cyanamide; α-bromisovaleryl cyanamide is also specified. Instead of sodium cyanamide, the cyanamides of calcium, silver, copper, lead, etc., may be employed. (Br. Pat. 146,289—1919. FARBENFABRIKEN VORM. F. BAYER & CO., Leverkusen, near Cologne, Sept. 15, 1920.)

Separating Mixtures of Gases.—To separate into its constituents the gas obtained in the dry distillation of fuel, the gas is first freed from tar, ammonia and benzene, and then passed over substances having a large superficial area—for example, absorbent carbon—in which the constituents are selectively absorbed; this selective absorption is facilitated by passing the gas over a plurality of absorbent masses at different temperatures. The process is particularly applicable to the separation of ethylene, in which case it is preferred to cool the absorbent mass to a temperature between 0 and 20 deg. C.; the fraction enriched with respect to ethylene is if necessary expelled, collected and reabsorbed as before to obtain a further enrichment, and this process may be repeated. (Br. Pat. 146,332—1919. GOLDSCHMIDT AKT. GES., Essen, Sept. 15, 1920.)

Linoleum.—A composition for making linoleum consists of cellulose treated with alkaline lyes and vapor of carbon bisulphide, a rubber-like product obtained by heating glue or carbohydrates with glycerine and saponified resin. These ingredients are mixed, heated, treated with hardening agents, such as formaldehyde, chrome salts, alum, tannin, etc., and kneaded and rolled up with cork meal, sawdust or other finely powdered cellulose and coloring matter. The mass can be applied to a backing of paper or not, as desired. (Br. Pat. 146,367—1919. PHENOLEUM GES., Berlin, Sept. 15, 1920.)

Pigments.—Ultramarines and lakes are made by liberating, in a mass of china clay, alumina and/or silica; and, in the case of ultramarines, heating the product with a polysulphide of sodium; in the case of lakes, combining it with acid or basic aniline coloring matters, according as alumina or silica predominates. After treatment with acid sulphate of soda solution, sodium carbonate solution is added to precipitate alumina. The paste is filtered and the residue, after washing, is treated with sulphides of sodium and air-calcined to produce ultramarine or heated to boiling point with a solution of coloring matter to produce lakes. To obtain siliceous blues the product of the acid sulphate reaction is extracted with water to remove the aluminum sulphate and the residue treated with carbonate as before. According as acid or basic colors are employed for producing lakes, the china clay is treated to liberate alumina or silica respectively as described above. (Br. Pat. 146,402—1919. R. D. LANCE, Paris, Sept. 15, 1920.)

Zinc Sulphide; Lithopone. — Pure zinc sulphide is prepared from a soluble zinc salt, by passing sulphuretted hydrogen into the solution after the addition of such quantity of oxide or carbonate of the alkali or alkaline earth metals that the final solution when all the zinc sulphide has been precipitated remains slightly acid. The zinc solution employed may be prepared from any zinc-bearing materials, but when obtained by acting on zinc blende with hydrochloric acid and eliminating impurities, the sulphuretted hydrogen evolved during the solution of the ore may be used subsequently to precipitate the zinc sulphide. The most suitable oxide or carbonate to employ is magnesia or magnesium carbonate, since hydrochloric acid and magnesia may be regenerated, by heating with steam, from the magnesium oxychloride obtained by the addition of magnesia to the magnesium chloride solution left after the separation of the zinc sulphide. The latter is calcined at a high temperature, washed and ground, and by incorporating with barium sulphate yields lithopone. (Br. Pat. 146,410—1919. C. CLERC, Paris, and A. NIHOUL, Villexneuve le Roi, Sept. 15, 1920.)

Program American Institute of Chemical Engineers

THE thirteenth winter meeting of the A.I.C.E. will be held at New Orleans, La., Dec. 5 to 8, after which the salt, sugar, molasses and sulphur industries in the immediate district will be visited. Reservations on train 137 leaving the Pennsylvania station, New York, at 3:40 p.m., Friday, Dec. 3, should be made with F. E. Dodge, Room 1430, The Barrett Company, 17 Battery Place, New York City. The local committees, composed of Lezin A. Becnel, Charles E. Coates, William C. Ermon and Charles S. Williamson, Jr., have arranged a little Mardi Gras of intellection which will begin with a parade through the streets of the city as follows:

SUNDAY, DECEMBER 5

2:30 P.M. Automobile ride seeing New Orleans.

MONDAY, DECEMBER 6

Meeting at the Cabildo.

9 A.M. Business session. Canvass of ballots for officers. Reports of officers and council. Reports of committees.

10 A.M. Reading of papers:

"Recent Advances in the American Sulphur Industry," Dr. R. F. Bacon.

"The Conservation of Heat Losses as Applied to Power and Heating Systems," E. R. Weidlein.

"The Sulphuric Acid Fume Problem," James R. Withrow and F. C. Vilbrandt.

"Costs—A Study of Factory Economics," A. G. Peterkin.

"Operating Variations in Sugar Production as Indicated by Some Plantation Data," Lezin A. Becnel.

2 P.M. Alternate excursions: Visit to plant of Southern Cotton Oil Co. and Sugar Refinery, or Visit to Water Filtration Plant of New Orleans.

8 P.M. Meeting at the Cabildo.

"Resources of the State of Louisiana," N. L. Alexander, Chief of Conservation Commission.

"Sewage, Water Purification and Drainage in New Orleans," George G. Earle, Chief Engineer and Superintendent, Sewerage and Water Board.

Smoker.

TUESDAY, DECEMBER 7

Meeting at the Cabildo.

9 A.M. Business session.

10 A.M. Reading of Papers:

"Lubrication of Concrete," Maximilian Toch.

"The Treatment of Sewage by Aëration in the Presence of Activated Sludge," E. Bartow.

"The Federated American Engineering Societies and the Institute," James R. Withrow.

"The Salvaging of Sag Paste," C. B. Morey.

"Studies in Evaporator Design -IV. Some Data From the Horizontal Tube Evaporator," W. L. Badger.

1:30 P.M. River trip and inspection of port facilities—tendered by the Board of Commissioners of the Port of New Orleans. The plant of the U. S. Industrial Alcohol Co. and of Penick & Ford, largest molasses canners in the world, will be visited.

7 P.M. Subscription Dinner at Antoines.

11 P.M. Leave New Orleans for visit to salt and sulphur mines.

WEDNESDAY, DECEMBER 8

7:08 A.M. Arrive at Lake Charles. Breakfast and auto ride to sulphur mines--tendered by the Chamber of Commerce of Lake Charles.

11:20 A.M. Leave Lake Charles for New Iberia.

2 P.M. Arrive at New Iberia.

Visit to salt mines during afternoon and returning to New Iberia at 6 P.M.

THURSDAY, DECEMBER 9

1:59 A.M. Leave New Iberia.

2:42 A.M. Arrive at Franklin. Visit to sugar factory and sugar plantation during the forenoon.

12:36 P.M. Leave Franklin.

5:50 P.M. Arrive at New Orleans.

7:40 P.M. Leave New Orleans.

FRIDAY, DECEMBER 10

11:10 A.M. Arrive at Chattanooga, Tenn. Alternate excursions: Auto trip to Lookout Mountain and nearby points of historic interest, or excursion to byproduct coke plant.

7:50 P.M. Leave Chattanooga.

SATURDAY, DECEMBER 11

9:30 A.M. Arrive Roanoke. Visit to blast furnaces of the Virginia Iron, Coal & Coke Co.

12:50 P.M. Leave Roanoke.

5:45 P.M. Arrive at Luray. Visit to the famous Caverns of Luray.

11:30 P.M. Leave Luray for Philadelphia and New York.

Ladies' Program

SUNDAY, DECEMBER 5

2:30 P.M. Automobile ride seeing New Orleans.

MONDAY, DECEMBER 6

2:30 P.M. Visit to State Museum and Vieux Carré, the old French quarter of New Orleans.

8:15 P.M. Theater party.

TUESDAY, DECEMBER 7

1:30 P. M. River trip with inspection of port facilities—tendered by Board of Commissioners of the port of New Orleans.

5:30 P.M. Return.

7 P.M. Subscription Dinner at Antoines.

11 P.M. Leave New Orleans for visit to salt and sulphur mines.

The remainder of the meeting– same program as for the men.

New Selling Method in Brick Industry Proposed

A new card of price extras has been adopted by a number of the leading producers of fireclay and silica brick. The plan used follows very closely the percentage method used by plate-steel manufacturers.

Shapes are classified according to cost of manufacture and each class takes a percentage extra over the base price. Thus the extra or up charge on any class of shapes automatically changes with any change in the base price.

A large number of the shapes in common use have been classified according to the costs of production, and it is expected that as further cost figures are obtained a complete list of all shapes in general use can be prepared. This is the first general change in firebrick extras since brick were selling for $18 to $20 in 1912 and 1913.

As labor costs represent the larger part of extra costs on special shapes, the increases in wages during the past few years made a change in extras necessary. The classification, while based on recent cost figures, follows quite closely the same percentage of the 9-in. base price as the extras in use when brick sold at $20.

Loans Dye Collection to University

Dr. Charles E. Munroe, a widely known high explosives specialist, has loaned his collection of dyestuffs to the new chemical laboratory of the George Washington University. The collection is particularly complete.

Current Events
in the Chemical and Metallurgical Industries

Notes on European Chemical Industry

Dr. James F. Norris of the Massachusetts Institute of Technology presented a very interesting and instructive address on "Conditions of European Chemical Plants" at a joint meeting of the Western New York Section of the American Chemical Society and the Niagara Falls Section of the American Electrochemical Socciety held in Niagara Falls, Nov. 16.

Dr. Norris was a Colonel in the gas service of the United States Army during the war. In the summer of 1918, the gas chemists of the United States Army discovered and developed a new gas which was much more deadly than any gas which had ever been used in warfare. Owing to the possibility of a courier carrying written information falling into the hands of the enemy, Colonel Norris, who was familiar with all the details of manufacture, was intrusted with the personal delivery of these important discoveries to the Allied Commission, and at the same time was to obtain information for the Chemical Warfare Service regarding new discoveries made abroad.

The speaker first discussed the conditions of the chemical industries as he found them in England. Much praise was given the high standard and excellent quality of work produced by the individual unit both in research and in production of important chemicals essential to munitions. The lack of organization, however, was one outstanding feature which was in direct contrast to the way in which the same operations were carried on in America. There were no centralized laboratories, and the small individual laboratories, although under the direction of a capable head, were handicapped by the lack of a sufficient number of assistants and adequate equipment to undertake the problems which arose.

Dr. Norris further stated that some of the English industrial chemical plants which were constructed during the war were the most wonderful he had ever seen. An instance was given where he made a visit to one of the largest contact sulphuric acid plants at the noon hour and the factory was so spotlessly clean and orderly that the women employees ate their lunches and enjoyed their noonday rest seated around an acid tower. This particular plant was operated entirely by women, there being only one man in the entire plant organization.

After the armistice the speaker was privileged to visit German chemical plants in the British, American and French occupied zones. Many instances were cited of the ingenuity of the German chemists in meeting the problems brought about by the war and in developing new processes to use available crude materials in place of common ingredients which could not be obtained.

In one plant near Cologne, where vast quantities of sulphuric acid were made, the supply of pyrites became exhausted. An ample supply of gypsum was available, and the plant chemists stepped to the front and developed a commercial process for making sulphuric acid from gypsum, unheard of previously. Calcium sulphate and silica sand, with a little clay added for a flux, were heated in a rotary cement kiln to bring about the necessary reaction. The gases drawn off were treated and made available for conversion into the acid, and a good grade of cement was obtained as a byproduct from the slag which came from the kilns.

All of the plants in the occupied territory were in a very orderly condition and in the best of repair. At the cessation of hostilities the plants ceased to produce, and the workmen were given employment in cleaning up and putting the plants in good order. The men in charge showed a willingness to describe in detail the processes which they used in their plant in the manufacture of gases up to the point of naming the catalyzers which were used. With German thoroughness all records of research laboratories and plant operation, as well as all the catalytic agents, were removed from the plants and sent to Berlin before the Allies reached the chemical plants along the Rhine.

The speaker gave a brief description of the process and apparatus used and some of the difficulties encountered in the German plants which manufactured ammonia by the Haber process. He corrected the erroneous report which has been in circulation to the effect that the contact towers used were buried in the ground and stated that the apparatus was all situated above ground, and that the contact towers, which were about 35 ft. high and 3 ft. in diameter, had walls 9 in. thick, in order to withstand the working pressure of hot hydrogen at 200 atmospheres.

In one of the plants visited, the manufacture of synthetic rubber in large quantities was noted. This material was stated to be superior in some respects to the natural product, especially in the manufacture of hard rubber articles.

The close connection between the dye industry and the manufacture of gases and chemicals essential to modern warfare was impressed upon the audience, as well as the future commercial possibilities of some of the hitherto obscure chemicals whose commercial production was highly developed during the war.

Dr. Norris closed his lecture with a number of slides depicting devastated France and showing the deliberate systematic destruction of the French chemical plants by the German forces as they were compelled to retreat during the closing days of the war.

Colloidality and Olfactometry

At the New York Section meeting of the American Chemical Society, Nov. 19, Reston Stevenson presented a preliminary paper on the Maximum Zones of Colloidality by Jerome Alexander, following which Ellwood Hendrick entertained the audience by an appreciation on the nose. Olfactometry has both a humorous and a serious aspect which the chemist should study in conjunction with the psychologist. It is undoubtedly of scientific and industrial importance. The value of foods and many commodities are dependent on odor and taste, which are related. The subject should not be neglected.

Calcium Arsenate Conference Is Called

That manufacturers of calcium arsenate may be more familiar with the methods used in applying this poison to the cotton plant, a conference has been called at the Chemists' Club, in New York, Dec. 6 and 7. At that meeting, which is under the auspices of the Plant Protection Institute, specialists of the Department of Agriculture will explain certain phases of the problem with which it is believed the manufacturers have not a clear understanding.

The Department of Agriculture, in its laboratory at Tallulah, La., developed the most effective method of controlling the boll weevil yet devised. It was found that the boll weevil relied upon the dew on the plant for its liquid. By dusting the leaves of the cotton plant early in the morning with calcium arsenate, it was discovered that the dew could be poisoned sufficiently to kill a large proportion of the weevils. The discovery of this method of boll weevil control led to a very rapid expansion in the demand for calcium arsenate. While the product now has been standardized so as to meet the requirements for cotton dusting, there are still a number of matters which it is believed advisable to talk over with the manufacturers.

Rochester Section, A.C.S., Holds 112th Meeting

The Rochester Section of the American Chemical Society held its 112th meeting Monday evening, Nov. 8, in the Eastman Building, University of Rochester.

Chairman Woodland announced the personnel of the various committees which will have charge of the Spring Meeting of the American Chemical Society, which is to be held in Rochester during the week of April 25, as follows:

Executive Committee: J. Ernest Woodland, Hans T. Clarke, Victor J. Chambers, Harry A. Carpenter, Harry LeB. Gray, Erle M. Billings, Florus Baxter, Herbert Eisenhart, Ivar N. Hultman, Charles F. Hutchison, William Earle, Charles W. Markus, John Howe, Benjamin V. Bush.

Entertainment Committee: Charles F. Hutchison, chairman; Otto I. Chorman.

Transportation Committee: Charles W. Markus, chairman.

Excursion Committee: William Earle, chairman.

Program Committee: Erle M. Billings, chairman; Wilbur Miller, Arthur J. Herty, Felix Elliott, John I. Crabtree, Robert Salter.

Finance Committee: Herbert Eisenhart, chairman; Frank W. Lovejoy.

Publicity Committee: Benjamin V. Bush, chairman.

Hotels Committee: Harry LeB. Gray, chairman; Lincoln Burrows.

Registration and Information: Harry A. Carpenter, chairman; William Line, Otto Cook, Florus Baxter, Mrs. Richard Kruger, Miss Gertrude Reissman, Edward Pickard.

Women's Entertainment Committee: Miss Jane P. Hannock.

Rochester Section Chemical Industrial Show: Ivar N. Hultman, chairman; M. J. Kolb, Mr. Nausman, Mr. Viergiver, Mr. Will, Mr. Story, Mr. Prince, Mr. Leary, Mr. Tucker.

Due to the increased number of National Society members from the Rochester Section, another councilship is allotted to the Section from next Jan. 1. Dr. Hans T. Clarke was unanimously elected to fill this office. Dr. Clarke is widely known among the chemists of America. He is director of the synthetic-organic chemistry department of the Eastman Kodak Co.'s Research Laboratory. Dr. Clarke is also secretary of the Organic Division of the American Chemical Society. He is the author of many textbooks and papers dealing with organic chemistry.

Dr. John R. Murlin, director of the department of vital economics and chairman of the committee on food and nutrition, National Research Council, delivered an address before a large assembly of chemists, on "Energy and Metabolism." In this lecture the way the human body derives its energy from various classes of foods was clearly brought out by illustrations and demonstrations.

A Research Information Bureau

The National Research Council has established a research information service as a general clearing house and informational bureau for scientific and industrial research. This "service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the *Bulletin* or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council.

Requests for information should be addressed to Research Information Service, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Engineer Needed for Non-Metals Work in the Bureau of Mines

R. B. Moore, chief chemist of the Bureau of Mines, is having considerable difficulty in locating a mining engineer with experience in non-metals work. He has been authorized to place two non-metals men at the new Tuscaloosa Experiment Station. He has found it difficult, however, to locate men with the required experience and has about reached the conclusion that it will be necessary to employ a mining engineer with good basic training who has not heretofore specialized in non-metals work.

Dr. Moore also is looking for a chemist with training in radio-activity. A chemist with such qualifications is desired to assist Dr. S. C. Lind in his radium work at the experiment station at Reno, Nev.

A.C.S. Advisory Sub-Committee Chairmen on Chemical Warfare Service Named

Chairmen have been selected for the four subdivisions of the American Chemical Society's advisory committee on Chemical Warfare Service matters. Wilder D. Bancroft, of Cornell University, will be chairman of the Research subdivision. W. K. Lewis, of the Massachusetts Institute of Technology, will head the Development subdivision. C. L. Reese, of the du Pont company, has been selected as chairman of the Production advisers, while A. S. Loevenhart, of the University of Wisconsin, will head the Physiological Investigation subdivision.

More Care Needed in the Handling of Chemicals

The Bureau of Explosives of New York City reports that during the three months ended Sept. 30, 1920, there were 624 fires or explosions on common carriers, resulting in property damage of $222,575.22 and injury to seventeen persons.

The following is a summary of accidents causing fires, personal injuries and property loss during transportation:

Article	No.	Injuries	Property Loss
Acid, sulphuric (oil of vitriol)	170	1	$9,444 77
Acid, hydrochloric (muriatic)	75		5,746 46
Acid, n. o. s	70	3	2,479 78
Gasoline	52	6	78,867 21
Acid, nitric	48		12,503 20
Gas, compressed carbonic acid	38	*1	175 90
Alcohol	29	2	9,770 18
Charcoal	23		10,982 58
Matches, strike anywhere	20		5,656 47
Electrolyte	17		668 23
Carbon bisulphide	8	2	7,664 95
Varnish	8		617 75
Batteries, storage (charged with acid)	7		2,235 09
Acid acetic	6		392 82
Oil, crude petroleum	5	1	70,505 10
Benzene	4		161 33
Gas, compressed sulphur dioxide	4		41 00
Acid, hydrofluoric	3		83 00
Cement, rubber	3		26 18
Lacquer	3		493 08
Liquefied petroleum gas	3		†
Rubber (reclaimed and ground scrap)	3		950 00
Acid, nitrating (mixed)	2	1	70 51
Bromine	2		201 25
Cologne spirits	2		269 37
Driers, paint and Japan	2		13 36
Naphtha distillate	2		17 50
Tin, bichloride of	2		561 79
Acetone, methyl	1		93 98
Chloride of sulphur	1		15 00
Coal tar oil	1		33 20
Ether	1		7 40
Gas, compressed oxygen	1		286 00
Matches, strike on box	1		†
Oil, gas	1		81 36
Paint, liquid	1		64 00
Phosphorus, amorphous (red)	1		†
Polish, furniture (liquid)	1		10 00
Rags, oily	1		1,228 00
Shellac, varnish	1		56 25
Toluene	1		1 17
Totals	624	17	$222,575 22

*Also one death. † Not yet reported.

Methanol Plant for British Columbia

The Acetate Products, Ltd., has completed the purchase of the old Liverpool Cannery plant at South Westminster, B. C., and will commence the installation of an up-to-date methanol (wood alcohol) plant at once. The company has obtained a concession for the cutting of alder over a considerable area along the Fraser and Pitt rivers, and, besides methanol, will make acetate of lime, charcoal and several wood-tar products. This is the first methanol plant to be erected on the Canadian Pacific coast; there are to be two plants of a similar nature in eastern Canada, one in Ontario and the other in Quebec.

Fish and vegetables formerly were canned at the Liverpool Cannery, but the plant has been idle for more than two years. The Acetate Products, Ltd., has announced that it will purchase as much machinery as possible locally, but a considerable proportion will have to be purchased in the East, as it is not manufactured on the coast.

Wood Preservatives Must Be Water Soluble*

Effectiveness of substances in preserving wood is dependent on their solubility in water, at least to the extent of producing a toxic water solution. It would seem reasonable to expect that any material which is poisonous enough to kill an organism of any kind must necessarily be soluble in the body fluids of that organism; and the chief body fluid of timber-destroying fungi and wood borers is water. With very poisonous materials this solubility need not be great; in fact, 1 part in 1,000,000 may be sufficient if the material is poisonous enough.

Wood preservatives now in use are of two distinct types—inorganic salts, such as zinc chloride, which are very soluble in water; and oils, such as the creosotes, which are generally considered to be insoluble. The solubility of creosote is usually considered so slight as to be neglected, but experiments indicate that certain constituents of creosote are sufficiently soluble in water to render it toxic, the others insoluble in water and hence not toxic. The non-toxic oils act as a reservoir for the toxic oils and feed them slowly to the moisture in the wood.

The difference between oil preservatives and inorganic salt preservatives, as far as this theory is concerned, is in their method of retaining the reserve supply of poison. Zinc chloride has no reserve supply, all the material being soluble in the usual amount of moisture present in air-dry wood. Sodium fluoride may have a reserve supply in the form of solid crystals, if applied in a saturated solution. Creosote oil may have a considerable reserve supply stored in the oil itself, this supply being fed to the wood as needed.

*From *Technical Notes*, Forest Products Laboratory.

Standard Packages for Reagents

The Committee on Guaranteed Reagents of the American Chemical Society is recommending standard packages for reagents in the metric units. The effort is to eliminate wide varieties of packages so that purchases will be made for any particular material in only two or three standard size units which will be 500 grams instead of a pound; 200 grams instead of a half pound, 25 grams instead of the ounce. The chairman of the committee says: "I am hoping that enough orders will be placed in metric units within the next six months to change the basis of purchase within that time. It can be done if all those who have expressed themselves as preferring the metric units will use them in this connection."

Recommended lists are being submitted by the committee for the guidance of purchasers and it hopes that after some experience on this basis satisfactory agreement can be reached that will permit much greater uniformity than has previously prevailed.

Washington Section, A.C.S., Holds Meeting

"The Chemistry of Vitamines" was the subject of the presidential address by Dr. Atherton Seidell before the Chemical Society of Washington, D. C., Nov. 11. Dr. Seidell gave the history of efforts to isolate pure vitamines and described the present status of our knowledge of these substances. He pointed out that at present it appears more likely that vitamines are in nature fairly similar to enzymes rather than that they are pure chemical compounds in the usual sense.

Officers of the Chemical Society of Washington (local section of the American Chemical Society) were elected at this meeting, as follows:

President, William Blum, Bureau of Standards; secretary, J. B. Reed, Bureau of Chemistry; treasurer, F. P. Dewey, Bureau of the Mint, and councillors to the A.C.S., R. B. Sosman, W. D. Collins, W. M. Clark, F. W. Smither and A. Seidell.

Relativity and Life

On Thursday evening, Nov. 18, members and guests of the Philadelphia Section of the American Chemical Society filled the auditorium of the Engineers' Club to hear Ellwood Hendrick, president of the Chemists' Club, New York, and consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, speak on "Relativity and Life."

In spite of the fact that not more than a dozen men can follow the mathematical paths by which Albert Einstein arrived at his theory of relativity, the principle itself is most simple and is capable of universal application. Mr. Hendrick developed in some detail the thought that this doctrine should not be confined to the realm of cosmic physics, but should be made a controlling factor in our daily lives. The concept that everything is relative—that nothing is absolute that our every thought and deed is influenced by our relations with others—leads to a system of ethics which the speaker showed could be applied to politics, religion, business and law with benefit to all concerned. Carrying the idea further, it is possible to determine the dimensions of many of the factors involved in our social relations, and we thus have a means of measuring these in an approximately quantitative manner at least. It has often been remarked that scientists and engineers seem reluctant to take part in public affairs. Perhaps they have felt that the gulf between was too wide for them to span. If so, it seems that we have in Einstein's theory of relativity the bridge which wil unite the fields of science, engineering and politics.

Book Reviews

CHEMICAL REACTIONS. By *K. G. Falk*. xiv + 211 pp. New York: D. Van Nostrand Co., 1920. Price $3.

Contrary to the expectation produced by the title, one does not find the law of mass action, the theorem of Le Chatelier, the principle of maximum work or the phase rule. The effect of the intensity factors of energy in the displacement and determination of equilibrium is not considered. The intensity factor of chemical energy (affinity) is mentioned in the first few pages and its importance stated, but throughout the book the capacity factor (valence) is used instead. This, however, criticises merely the outside of the book and classifies the inside. The subject treated is the application of the J. J. Thomson electron theory of valence to E. C. C. Baly's addition theory of chemical reaction.

The author is particularly qualified by his publications and researches to present the electron theory of valence. He develops and applies this theory admirably. With electronic structural formulæ, reactions are pictured as they would occur when the first step in a reaction is the union of the reacting substances. The addition compound is generally instable and temporary and a rearrangement gives one or more of several possible resultants. The methods of determining electronic formulæ, their significance and the chemical considerations determining the resulting rearrangement are fully discussed. Electrochemical reactions are omitted. Some inorganic reactions are presented but the book will be valuable chiefly to the organic chemist. Reaction is represented as electronic rather than ionic. A distinct contribution to the ionic theory is made by the explanation of the importance of the solvent.

Every modern organic chemist should read this book as an application of modern physical chemistry to organic chemistry. It is ingenious and profound and an amazing wealth of modern research has been digested and incorporated. The author's style is that of a verbal discussion such as a professor's lecture to advanced students. Many readers will regret that the exposition is not more gradual and that postulates, theories and experimental evidence are not more obviously classified. On page 43, line 4 is one of the rare typographical errors and on page 133, line 21, hydroxyl should be written instead of hydrogen. The book is printed in large type and the elaborate formulæ are distinct.

RESTON STEVENSON.

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SELLING YOUR SERVICES. By *George Conover Pearson*. 238 pp. New York: Jordan-Goodwin Corporation; 1920. Price, $2.

In scarcely any field of human activity is the engineer less proficient, on the average, than in selling his services, and in scarcely any other would he find, on the average, greater financial profit through effort expended to increase his proficiency. If what he needs is impetus, inspiration, or in the language of the day "some pep," he will find Mr. Pearson's little book valuable, but if he goes about it after the fashion of any other engineering problem, analyzing it into its component factors, and getting a firm grasp on the fundamental principles, the style and presentation of the subject matter is not unlikely to be unattractive to him. The author principally has in his mind the securing of a position as an executive in general business, and not only does not recognize that positions of a different character call for variations of method, but says plainly that the same method can be applied to any kind of position. Perhaps this is a natural error on the part of the author because of the tendency on the part of industry to attempt to standardize human beings, undeterred by the fact that it is a quite impossible task. Just at present the executive type of mind is the fashion and the technical expert is only considered to have exhibited the full measure of his powers when he has demonstrated his executive ability. Too many scientific men have demonstrated their value to society without possessing executive ability to render assent possible to such a view. However, from reading the book, the technical man may gather useful suggestions as to the most effective procedure in selling his services when the need for doing so may arise.

T. T. READ.

Personal

DR. ERNEST ANDERSON, for the past three years professor of agricultural chemistry in Transvaal University College, Pretoria, has been appointed professor of general chemistry in the University of Nebraska, Lincoln, Neb.

DR. W. R. BLOW, professor of biochemistry at the University of California, addressed the California Section of the A.C.S. recently on the subject of "Fat Metabolism."

R. T. CHAMBERLAIN, professor of geology at the University of Chicago, who has recently returned from a trip in the South Seas, spoke before the Chicago Chemists' Club recently on "The Coral Reefs at Samoa."

GEORGE P. GRAY has resigned his position as assistant professor of entomology and chemistry at the University of California, to become chief of the division of chemistry of the newly established Department of Agriculture of the State of California, Sacramento, Cal.

DR. L. O. GRONDAHL has resigned as professor of physics at Carnegie Institute of Technology, Pittsburgh, Pa., to become director of research with the Union Switch & Signal Co., Swissvale, Pa.

NORMAN C. HILL, who for almost five years was superintendent of acid plants at the Naval Proving Ground, Indian Head, Md., resigned that position on Oct. 4 to become superintendent of acid production with the Monsanto Chemical Works at East St. Louis, Ill. He will have direct charge of contact and chamber plants, muriatic, chlorsulphonic acid, nitric acid and zinc chloride manufacture.

L. E. JACKSON has resigned as chemist and chemical en-engineer with the Empire Gas & Fuel Co., Bartlesville, Okla., to accept a fellowship at the Mellon Institute.

VICTOR KADISH has resigned the position of superintend-

ent of the Milwaukee Patent Leather Co. to open an office as consulting chemist in the Trust Building, Milwaukee, Wis. He will specialize on leather problems.

GEORGE H. KIMBER has left the United States Color & Chemical Co., Ashland, Mass., and is now with the Semet-Solvay Co., Syracuse, N. Y.

CLIFFORD S. LEONARD, who received the degree of Ph.D. from the University of Wisconsin in June, has accepted one of the traveling fellowships of the American Scandinavian Foundation, and has sailed for Sweden. He will study chemistry at the Karolin Institute, Stockholm.

Colonel C. W. OTWELL, recently transferred from the Corps of Engineers to the Chemical Warfare Service, is to take command of the proving ground at Lakehurst, N. J.

S. W. PARR, professor of applied chemistry at Illinois University, delivered a talk before the Western Society of Engineers, Chicago, Wednesday, Nov. 10, on "Fuels of the Future."

CHARLES L. PARSONS, secretary of the American Chemical Society, was in Chicago recently.

WILLIAM N. PRITCHARD, formerly with the Calco Co., Bound Brook, N. J., and Harold Hurst, formerly with the LeDoux Co., are now on the staff of the department of chemistry, Cooper Union, New York.

SAUVEUR & BOYLSTON, metallurgical engineers, Abbott Bldg., Harvard Sq., Cambridge, Mass., announce the appointment of H. M. Boylston to the chair of metallurgy in charge of the mining engineering department, Case School of Applied Science, Cleveland, Ohio, where he will be available for consultation. The firm will continue its laboratories and offices in Cambridge under the supervision of Prof. Albert Sauveur.

O. R. SWEENEY has changed his position from professor of chemical engineering and head of the department of chemical engineering at the University of Cincinnati, to professor of chemical engineering and head of the department of chemical engineering at Iowa State College, Ames, Iowa.

L. J. WALDBAUER has left the Redpath Laboratory of E. I. du Pont de Nemours & Co., to be instructor in chemistry at the University of Maine, Oronto, Me.

T. K. WEBSTER, vice-president of the Fansteel Products Co., Chicago, has recently returned from a month's sojourn in England.

JOHN A. WILSON has been retained by the Milwaukee Sewage Commission to direct investigations on the dehydration of sludge.

ROBERT F. WOOD has severed his connection with the Sandusky Foundry & Machine Co., and is now with the Monel Metal Products Corp., Bayonne, N. J., as metallurgist.

R. ZELLER has resigned his position as vice-president, secretary and plant manager of the Egyptian Lacquer Mfg. Co., New York City, and is now with the Zeller Lacquer Mfg. Co., Inc.

The following gentlemen have just been elected directors of the Research Corporation: Dr. A. A. Hamerschlag, president of the Carnegie Institute of Technology, Pittsburgh; John C. Pennie, patent attorney, 35 Nassau St., New York, and Ellwood Hendrick, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING. The other directors are: E. H. Hooker, of the Hooker Electrochemical Co., Niagara Falls, N. Y.; Benjamin B. Lawrence, consulting mining engineer, New York City; Charles A. Stone, president of the American International Corp., New York City; Arthur D. Little, of Arthur D. Little, Inc., Cambridge, Mass.; T. Coleman du Pont, of New York City; Frederick A. Goetze, treasurer of Columbia University, New York City; John B. Pine, attorney, New York City; Charles D. Wolcott, secretary of the Smithsonian Institution, Washington, D. C.; George F. Kunz, Tiffany & Co., New York City; Otto H. Kahn, banker, New York City; John J. Carty, of the American Telephone & Telegraph Co., New York City, and Howard Poillon, mining engineer, New York City. E. H. Hooker is president of the Research Corporation and Benjamin B. Lawrence is treasurer.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Nov. 22, 1920.

Continued slackening of industrial wheels at various points throughout the country has been greatly reflected in the consuming demand during the past week. Irregular trading of a small character is reported and buying power is not specially emphasized in any important direction. Large holders are granting concessions on some items in order to stimulate business, while others are cutting prices in a spirit of competition. In some instances dealers have declared intentions of keeping out of the market until signs of a more stable market present themselves. In short, the spot market is purely a buyers' affair. Smaller chemicals have shown greater weakness than the larger, and it is asserted that the rapidity of declines in several directions speaks well for the establishment of a permanent trading basis in the near future.

Caustic soda was rather quiet during the week and the market weakened on the arrival of large quantities from leading New England mills. Spot prices ranged from \$4@\$4.15 per 100 lb. *Bichromate soda* touched a new low level for the year when sales were made at 9c. per lb. Buyers showed no inclination even at these prices to buy freely. *Prussiate of soda* suffered another sharp decline owing to strong selling competition and reached its lowest price of the year. Trading did not assume active dimensions and holders were eager to do business ranging from 19@20c. per lb. *Heavy calcined magnesia* is bringing 8@8½c. per lb., the inside figure being the lowest on record for the year. The technical variety is moving quietly at 11c. per lb. *Formaldehyde* buyers showed no disposition to operate in a large way, regardless of the acute price concessions. Prices last heard ranged from 18@19c. per lb. *White arsenic* sales were reported in larger volume than any on the list. In one quarter a sale was consummated for 50 long tons November-December shipment at 11¼c. per lb. This figure was the cheapest heard in the past few months and could not be judged as the prevailing market price.

COAL-TAR PRODUCTS

The market for the crude products has reflected a steady tendency during the past week, with reports from leading producers showing their output scarcely above the consuming demand. Prospects of any further declines seem to have disappeared and the present market is toward firmness. *C.P. benzene* in some quarters is available in tank cars at 33c. per gal., and in drums at 36c. The 90 per cent is 28c. in tank cars and 30c. in drums. *Toluene* is heard at 26@34c. per gal. *Solvent naphtha* retains its steady tendency at 30@35c. per gal. *Cresylic acid* is easy and available at 95c.@\$1.15 per gal., depending on grade.

Intermediates suffered some sharp declines owing to persistent reports that tanneries and textile mills have accumulated large supplies of colors and dyes. Dealers have thrown goods on the market at new low levels with only little response from leading consumers. *Beta naphthol* technical reached its lowest price of the year when sales were recorded at 40c. per lb. Supplies of *dimethylaniline* are easy and not much interest is shown even with offerings at 72@75c. per lb. Demand for *paranitraniline* is quiet, with reports current of low stocks on spot. Prices ranged from \$1.10@\$1.15 per lb. *Diethylaniline* supplies are reported in fair accumulation with the demand small and the market holding steady at prices between \$1.50 and \$1.60 per lb. *Monochlorbenzene* tone is easy and sellers quote 14@16c. per lb. The demand is limited to small lots.

CRUDE RUBBER

The market for crude rubber continues to present a quiet and dull appearance. Leading consumers are still out of the market and factors report only small lot sales. Heavy

liquidations have been reported around town and there seems to be little hope for an immediate improvement in the situation. Prices continue mostly nominal. Offerings of *ribbed smoked sheets* on spot are noted at 18¾c. per lb. and it is intimated that firm bids of 18½c. per lb. would probably be accepted. December prices are quoted at 18¾c. per lb. Deliveries over next year remain unchanged and featureless at 21c. per lb. for January-March, 23c. for April-June and 25½c. for July-December.

PHILIP S. TILDEN SAYS:

The following extract is an expression of the present chemical market delivered recently before the members of the Philadelphia Chemical Club, by Philip S. Tilden, sales director of the heavy chemical and acid department of E. I. du Pont de Nemours & Co.:

"As to the future of the chemical business, God knows. If I knew, I would go out and play golf and come back and reap the benefits at the proper time; but again there should be no cause for pessimism. You cannot take care of 111,000,000 people which make up the United States without an expansion in the chemical business. We do not often realize that everything we have on has been treated in some way by chemicals, and without chemicals we could not exist. Therefore, we must forget the temporary dullness and work for the future. Again this is no time for contraction. I do not mean that we should needlessly expand, but we should be ready for what we know is in store for us in the line of increased demands for the articles which we represent. I think less profiteering was seen in the chemical market than in other lines of industry. The bichromates, prussiates and cyanides have, however, given us many sleepless nights since the war began, and we must now bring ourselves to realize that we must again come down to earth and continue in the chemical business along lines in which it is ordinarily conducted. If the buyers realize that we are again on a permanent basis, it appears to me that buying would be resumed in this business as well as in others."

It is evident, from these remarks, that leaders in the chemical industry believe that the time is already past when ruthless profiteers would again try to domineer the chemical market with exorbitant prices. American producers must now look forward to our domestic consumers for the preservation of the chemical industry. There must be more stability and normality in the present market to tempt buyers into active trading. It is to be hoped that stability will be a reality in the near future.

The Baltimore Market

Baltimore, Md., Nov. 20, 1920.

The local market on fertilizer raw materials continues dull, with buyers showing little interest in offerings. About the only sales that are being effected are in distressed lots which can be secured at prices below the nominal market.

The spring prices for bagged goods have finally been approved at Washington as follows: $5 per unit of ammonia; 80c. per unit available phosphoric acid; $2.25 per unit of potash.

The fertilizer manufacturers are sending their salesmen out this week to begin campaigning for spring business; their success in securing orders will be the controlling factor in the resumption of movement of raw materials.

ACID PHOSPHATE

The market on this commodity may be quoted nominally at $17.50 per ton, basis 16 per cent, bulk run-of-pile. A firm offering, however, has been reported this week at $17 on the basis mentioned above. It is thought by many that the acid phosphate market will show a slight improvement shortly.

POTASH

Shipments of foreign potash continue to arrive intermittently. Contracts for Alsatian salts for forward delivery are now being booked. Arrival of the full quota, however, is uncertain at this time. German potash is coming in more slowly, although arrivals of cargoes are being noted from time to time at the various ports. A good portion of these German salts are being shipped by the merchants in the United Kingdom. Up to this time we have had no report that Nebraska producers have booked contracts for future delivery. The market on the various potash salts may be quoted nominally: muriate $2.10 per unit, manure salts and kainit at $1.90 per unit, all c.i.f. Atlantic ports. A sale was reported this week, at a Southern point, of a round lot of manure salts at $1.95 per unit c.i.f. Southern port.

NITRATE OF SODA

This commodity is quoted nominally at $3 per 100 lb., ex vessel Northern and Southern Atlantic ports. It is quite possible that the importers would entertain a bid somewhat lower than this price on a round tonnage for delivery prior to Jan. 1. A number of fertilizer manufacturers secured their requirements for the spring during last summer at a price averaging $3.70 per 100 lb.

SULPHATE OF AMMONIA

The last price noted on this material was a resale at $4.50 per 100 lb., bulk basis 25 per cent, f.o.b. shipping point. A comparatively small tonnage of this material is to be had on the open market.

FISH SCRAP

Many of the factories on the Chesapeake Bay have discontinued fishing for the year owing to the recent light catch on the approach of cold weather. Due to indifference on the part of buyers machine-dried, unground fish scrap has again declined and may be quoted today nominally at $4 per unit of ammonia and 10c. per unit b.p.l. delivered Baltimore, in buyers' bags, for prompt shipment. There is a rather heavy accumulated stock of menhaden fish oil at this time, and the market on this commodity has also dropped and is today offered nominally at 40c. per gallon in tierces.

The Iron and Steel Market

Pittsburgh, Pa., Nov. 19, 1920.

Steel production by the independents is decreasing at a decidedly rapid rate, as many are not operating at over 50 or 60 per cent of capacity. In occasional instances the production of ingots is extremely light, but with finishing mills operating at a moderate rate on semi-finished steel accumulated during the period of car shortage. The Steel Corporation's operations are well maintained and are probably at a higher rate than that of last August and September, when there was considerable restriction on account of fuel shortage.

There is a fresh run of cancellations of finished steel contracts and of instructions to suspend or postpone contract shipments. Possibly on this account, or possibly because so little business is offered as an incentive, the independent mills as a class show little disposition to reduce their prices. Bars, shapes and plates are regarded as being on the basis of 3c. in the independent market, when the Steel Corporation prices are 2.35c., 2.45c. and 2.65c. respectively. Even sheets, which were declining continuously and rapidly for weeks, have shown little recession in the past week. Tubular goods remain very strong.

STEEL AND OTHER INDUSTRIES

Opinions in the steel trade as to the future of the market have been undergoing a rapid change of late, in the direction of expectations that the readjustment and depression will last longer than was expected. The opinions commonly expressed a few weeks ago were based upon what was observed in the steel industry rather than upon what was occurring in industry and finance generally. It was noted that the consumptive demand for steel kept up rather well, and it was inferred that with a little readjustment in prices and perhaps a period of a few weeks of slack operation the market would be found adjusted and buyers would begin taking hold again. Predictions were quite common, though by no means universal, that the decline in pig iron and steel prices would have run its course by March or April, with a buying movement and a stiffening in prices immediately following.

No such view is now entertained. It is now recognized that the reason the manufacture and consumption of steel continued heavy long after many industries had become almost idle was not because the industry was entitled to continued exemption but because its momentum had carried it for a longer period of time. The force had been spent more slowly because there had been the succession of restrictive influences to production—the steel strike that began Sept. 22, 1919, then the coal strike and then the railroad strikes. The present view is that the iron and steel trade will have to undergo readjustment the same as other industries, and that it cannot become really active again until other industries are active. It is possible, but improbable, that the iron and steel industry could readjust so rapidly as to be ready for business on the new basis within a very few months, but even if so it would have to wait until industrial and financial conditions generally are readjusted, and the process will admittedly take quite a while.

The present view as to the iron and steel future is that through a large part of next year there will be more or less industrial depression, with a real revival in iron and steel buying being early if it occurs in the fall of the year. The present stagnation in buying cannot of course continue for any length of time. There is always consumption, but just after a period of high pressure almost all buyers are able to refrain from making any fresh commitments for a time. Such buying will be from hand to mouth and will not be broad enough to cause prices to advance or stiffen from whatever level they may have declined to.

Pig Iron Prices

Despite the firmer attitude the merchant furnaces recently suggested they intended to display, waiting for actual inquiries of importance before making further cuts in prices, the pig iron market has slid off again, bessemer being off $2 and basic and foundry $1, making the market now quotable as follows: bessemer, $40; basic, $37.50; foundry, $39 f.o.b. valley furnaces, freight to Pittsburgh being $1.96. The declines occurred with little incentive being presented by way of inquiry. There was hardly any bessemer sold and little basic, while the $39 price on foundry iron was developed by a sale of 500 tons, for delivery through the remainder of the year to the Standard Sanitary Manufacturing Co.

Declines from the top points reached last August are now $8.50 in bessemer and $11 each in basic and foundry. Predictions common only a few weeks ago that the bottom would be reached at between $30 and $35 have disappeared. The debate now is as to whether or not the market will break through the Industrial Board prices. Those prices were $25.75 for basic, $26.75 for foundry and $27.95 for bessemer. The furnacemen grudgingly adopted them when promulgated March 21, 1919, and adhered to them for more than six months. It is quite impossible now to make any appraisal as to where the pig iron market can go, because the coke market has refused to give an idea as to where it will go, Connellsville furnace coke for spot shipment being scarcely down to $8, while in April, 1919, it sold at $3.60 and in May, 1915, at $1.50.

Steel Prices

It is now not entirely improbable that eventually, and before there is any general upward swing, even the United States Steel Corporation's steel prices will decline. For a long time the trade generally held to the view that whenever a readjustment in steel prices should come it would consist simply in independent prices declining to the Steel Corporation or Industrial Board level. The independents are holding their prices above the Steel Corporation level so well that it seems improbable they will decline to the corporation level until conditions require that all prices should decline. The corporation would have no occasion to reduce its prices for a long time. Even though its order books shuld not permit it to operate full, it would be operating at much higher rates than the independents, nor would the corporation be much disposed to reduce its prices without a reduction in costs, but the general readjustment in the country is so extensive that reductions in costs are not improbable eventually.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0 65 - $0.75
Acetone	lb.	$0 15½-$0 16½	.16½- 17
Acid, acetic, 28 per cent	100 lbs	3 50 - 3.75	4 00 - 4 50
Acetic, 56 per cent	100 lbs	7 50 - 8 00	8 50 - 9 50
Acetic, glacial, 99½ per cent, carboy	100 lbs	11 50 12 00	12 50
Boric, crystals	lb.	.15½ 16	.16½- .19
Boric, powder	lb	15½ .16½	.17 - .20
Citric	lb.		.52 .54
Hydrochloric (nominal)	100 lb	1.85 - 2 25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	16½- .18
Lactic, 44 per cent tech	lb	10 .11½	12 - .16
Lactic, 22 per cent tech	lb	04½ .05½	.06 .07
Molybdic, C. P.	lb	4.00 4 50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg	lb	.07 07½	08 - 08½
Nitric, 42 deg	lb.	.07½ 08	08½ .09½
Oxalic, crystals	lb	.0 20½	21 21½
Phosphoric, Ortho, 50 per cent solution	lb.	19 - 20	21 - .22
Picric	lb.	28 - .35	.40 - 50
Pyrogallic, resublimed	lb	2 30 2 55	2 60 2 65
Sulphuric, 60 deg., tank cars	ton	11 00 12 00	
Sulphuric, 60 deg., drums	ton		
Sulphuric, 66 deg., tank cars	ton	18 00 19 00	
Sulphuric, 66 deg., drums	ton	21 00 -22.00	22 50 - 23 00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27 00 30 00	37 00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28 00 30 00	38 00 42 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32 00 35 00	40 00
Tannic, U. S. P.	lb	1 45 1 50	1.55 - 1 65
Tannic (tech.)	lb	.60 - 70	.80 - .90
Tartaric, crystals	lb		49 - .52
Tungstic, per lb. of WO	lb		1 20 1 40
Alcohol, Ethyl (nominal)	gal		5 75 6.25
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof (nominal)	gal		82 85
Alcohol, denatured, 190 proof (nominal)	gal		.88 .90
Alum, ammonia lump	lb	04½ 04½	05 .05½
Alum, potash lump	lb	05½- 06	06½ 07
Alum, chrome lump	lb	14½- 15	16 .17
Aluminum sulphate, commercial	lb	03½- .03½	.04 - 04½
Aluminum sulphate, iron free	lb	04 04½	04 - 05½
Aqua ammonia, 26 deg., drums (750 lb.)	lb	08½- .09½	09½ 10½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb	33 .35	36 .38
Ammonium carbonate, powder	lb	14 14½	14½ 15
Ammonium chloride, granular (white salammoniac) (nominal)	lb	13½- 13½	14 14½
Ammonium chloride, granular (gray salammoniac)	lb	11 12	12½ 13
Ammonium nitrate	lb	10	11 14
Ammonium sulphate	lb	04½ 04	05 .05½
Amyl acetate	gal		4 50 5.00
Amylacetate tech	gal		4 00 - 4 20
Arsenic, oxide, lumps (white arsenic)	lb	13 - 13½	13½ 14
Arsenic, sulphide, powdered (red arsenic)	lb	16 - 16½	16½- .17½
Barium chloride	ton	90 00 95 00	100.00 - 105 00
Barium dioxide (peroxide)	lb	24 - 25	25 - .27
Barium nitrate	lb	.12 12½	13 13½
Barium sulphate (precip.) (blanc fixe)	lb	04½ 05	05½ .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Brimstone (see sulphur, roll)			
Bromine		.70 80	85 - .90
Calcium acetate	100 lb.	3 50 3 55	
		05½ 06	06½ 06½
Calcium chloride, fused, lump	ton	30 00 32 00	33 00 35 00
Calcium chloride, granulated	lb	02 02½	03 - 03½
Calcium hypochlorite (bleaching powder)	lb	05½ 05½	06½ 06½
Calcium peroxide	lb		1 50 1 70
Calcium phosphate, monobasic	lb		75 .80
Calcium sulphate, pure	lb		25 30
Camphor	lb		1 05 1 10
Carbon bisulphide	lb	08 09	10 11
Carbon tetrachloride, drums	lb	13 13½	14 - 14½
Carbonyl chloride (phosgene)	lb		1 25 1 50
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	09 .09½	10 .10½
Chloroform	lb		43 - .50
Cobalt oxide	lb		3 90 4 00
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb	.27 28	29 31
Copper cyanide	lb		65 70
Copper sulphate, crystals	lb	.07½ - 08	08½ 09
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal		1 05 - 1.10
Ethy Acetate pure (acetic ether 98% to 100%)			
Formaldehyde, 40 per cent (nominal)	lb	18 18½	19 - .20
Fusel oil, ref	gal.		4 25 4.50
Fusel oil, crude (nominal)	gal		3 25 3 50
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra	lb		23 24
Iodine, resublimed	lb		4 30 - 4 40
Iron oxide, red	lb		15 - .25
Iron sulphate (copperas)	100 lbs	2 25 - 2 50	2 75 3 00
Lead acetate, normal	lb.		12½ 16
Lead arsenate (paste)	lb.	13 14	14½ 15
Lead nitrate, crystals	lb.		90 1 00
Litharge	lb.	12 - .12½	13 - .13½
Lithium carbonate	lb.		1 50 -
Magnesium carbonate, technical	lb.	11½- 12	12½- .13
Magnesium sulphate, U. S. P.	100 lb.	3 00 - 3 25	
Magnesium sulphate, commercial	100 lb.		3 50 - 3 60
Methanol, 95%	gal		1 85 - 1 90
Methanol, pure	gal		2 30 2 35
Nickel salt, double	lb.		12 - .12½
Nickel salt, single	lb		.13 - .13½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	50 - 55	60 .65
Phosphorus, yellow	lb.		.35 - .37
Potassium bichromate	lb.	.22 - .22½	.23½- .23½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb	$0.45 - $0.47	$0.48 - $0.49
Potassium bromide, granular	lb.	... - ...	45 - .50
Potassium carbonate, U. S. P.	lb	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.13½ - .14	.14½ - .15
Potassium chlorate, crystals	lb.	.18 - .18½	19 - .20
Potassium hydroxide (caustic potash)	lb.	.16½ - 16¾	.17 - 17½
Potassium iodide	lb.	... ...	3.20 - 3.30
Potassium nitrate	lb	14 .16	.16½ - .17
Potassium permanganate	lb	.60 - .63	.65 - .70
Potassium prussiate, red	lb.	.73 - .75	.78 - 80
Potassium prussiate, yellow	lb	.34 - .35	.35½ - .36
Potassium sulphate (powdered)	ton	$240.00 - 255 00	......-.......
Rochelle salts (see sodium potas. tartrate)		......-......	......-.......
Salammoniac (see ammonium chloride)		......-......	......-.......
Sal soda (see sodium carbonate)		....-.	....
Salt cake	ton	... - ...	52.00 - 55 00
Silver cyanide (nominal)	oz.	... - ...	1.25 -.......
Silver nitrate (nominal)	oz	-......	.60 - .62
Soda ash, light	100 lb	2 05 - 2.10	2.20 - 2.40
Soda ash, dense	100 lb	2 50 - 2 75	3.00 - 3.25
Sodium acetate	lb.	08 - 08½	08½ - .09
Sodium bicarbonate	100 lb	2.90 - 3 00	3.25 - 3.50
Sodium bichromate	lb	.09 - 09½	.09½ - .10
Sodium bisulphate (nitre cake)	ton	7 00 - 7.50	8 00 - 11.00
Sodium bisulphite powdered, U S P.	lb.	06½ - .07	07½ - .08
Sodium borate (borax)	lb.	.08½ - .08½	.09 - 09½
Sodium carbonate (sal soda)	100 lb	1 85 - 2.00	2.15 - 2.25
Sodium chlorate	lb	.14½ - .15	.15½ .16½
Sodium cyanide, 96-98 per cent.	lb.	.26 - .27	.28 .30
Sodium fluoride	lb.	.20 - 20½	.21 - .22
Sodium hydroxide (caustic soda)	100 lb.	4 00 - 4.10	4 30 - 4 50
Sodium hyposulphite	lb.		.04 .04½
Sodium molybdate	lb	2.50	3.25 - ...
Sodium nitrate	100 lb	3 00 .. .	3 75 - ......
Sodium nitrite	lb.	.07½ - 08	.08½ - .08½
Sodium peroxide, powdered	lb	.35 - 40	.42 - .45
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.33 - .35
Sodium prussiate, yellow	lb	.19 - .20	.20½ - .21
Sodium silicate, solution (40 deg)	lb.	01½ - .01¾	.02 .02½
Sodium silicate, solution (60 deg)	lb.	.02½ - 03	.03½ - .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	2 15 - 2.50	2 60 2 75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb	07 .07½	.07½ - .08
Sodium sulphite, crystals	lb	.04 .04½	04½ - .05
Strontium nitrate, powdered	lb	.20 - .20½	.21 - .22
Sulphur chloride red	lb	.08 - 09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	.. -.....
Sulphur dioxide, liquid, cylinders	lb.	.09 - ..	.10 - .12
Sulphur (sublimed), flour	100 lb.	....-	3.70 - 4.35
Sulphur, roll (brimstone)	100 lb	- .	3.40 3.90
Tin bichloride, 50 per cent	lb	.18 - .19	- ...
Tin oxide	lb.	......-......	50 - .51
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb	12 - 13	.13½ - .14
Zinc cyanide	lb	45 .49	.50 - .60
Zinc dust	lb	.12 13	.13 - .14
Zinc oxide, XX	lb	.10 .10½	11 - 11½
Zinc sulphate	lb.	.03½ 03¾	.04 - .06

Coal-Tar Products

NOTE The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.10	— $1.15
Alpha naphthol, refined	lb	1 45	— 1.50
Alpha naphthylamine	lb	.44	— .46
Aniline oil, drums extra	lb.	.26	— .27
Aniline salts	lb.	.32	— .33
Anthracene, 80% in drums (100 lb)	lb.	.90	— 1.00
Benzaldehyde (f f c)	lb.	2.00	— 2.10
Benzidine, base	lb	1.15	-- 1.20
Benzidine sulphate	lb.	1.10	-- 1.15
Benzoic acid, U S P	lb.	.80	- .85
Benzoate of soda, U S P.	lb	80	— .90
Benzene, pure, water-white, in drums (100 gal)	gal	.35	— .40½
Benzene, 90%, in drums (100 gal)	gal	.33	— .38½
Benzyl chloride, 95-97%, refined	lb.	.35	— .40
Benzyl chloride, tech	lb	.25	- .35
Beta-naphthol benzoate (nominal)	lb	3.50	- 4.00
Beta-naphthol, sublimed (nominal)	lb.	.75	— .80
Beta-naphthol, tech (nominal)	lb.	.40	— .45
Beta-naphthylamine, sublimed	lb.	2.25	— 2.40
Cresol, U. S P, in drums (100 lb)	lb.	.18	— .19
Ortho-cresol, in drums (100 lb)	lb	.23	— .25
Cresylic acid, 97-99%, straw color, in drums	gal	1 10	-- 1.15
Cresylic acid, 95-97%, dark, in drums	gal	1.05	-- 1.10
Cresylic acid, 50%, first quality, drums	gal	.65	- .75
Dichlorbenzene	lb.	.07	— .10
Diethylaniline	lb.	1 45	— 1.50
Dimethylaniline	lb.	.75	— .80
Dinitrobenzene	lb.	.30	— .37
Dinitroclorbenzene	lb	.27	— .32
Dinitronaphthalene	lb.	.42	— .45
Dinitrophenol	lb.	.40	.45
Dinitrotoluene	lb.	38	- .40
Dip oil, 25%, tar acids, car lots, in drums	gal	.38	— .40
Diphenylamine (nominal)	lb.	.80	— .85
H-acid (nominal)	lb.	1.65	— 1.70
Meta-phenylenediamine	lb.	1.25	- 1.30
Monochlorbenzene	lb	.18	. .20
Monoethylaniline	lb.	1.75	2.25
Naphthalene crushed, in bbls. (250 lb)	lb.	.09	— .09½
Naphthalene, flake	lb.	.09	— .09½
Naphthalene, balls	lb.	.09½	— .10
Naphthionic acid, crude	lb.	.70	— .75
Nitrobenzene	lb	.12	-- .15
Nitro-naphthalene	lb.	.40	-- .50
Nitro-toluene	lb.	.18	-- .25
Ortho-amidophenol	lb.	3.20	-- 3.75
Ortho-dichlor-benzene	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.75	— .80
Ortho-nitro-toluene	lb.	.25	— .40
Ortho-toluidine	lb.	.32	— .35
Para-amidophenol, base	lb.	2.35	-- 2.40
Para-amidophenol, HCl	lb.	2.25	— 2.30
Para-dichlorbenzene	lb.	.10	— .15
Paranitroaniline	lb.	1.10	— 1.15
Para-nitrotoluene	lb.	1.25	-- 1.40
Para-phenylenediamine	lb.	2.50	— 2.65
Para-toluidine	lb.	1.85	-- 2.00
Phthalic anhydride	lb.	.60	— .70
Phenol, U. S. P., drums (dest), (240 lb.)	lb.	.10	— .12
Pyridine	gal	2.00	— 3.50
Resorcinol, technical	lb.	2.90	— 3.00
Resorcinol, pure	lb	3 75	— 4.15
Salicylic acid, tech, in bbls (110 lb)	lb	.35	-- .38
Salicylic acid, U. S. P.	lb	.40	— .45
Salol	lb.	.85	— .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	30	— 35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	— .22
Sulphanilic acid, crude	lb.	.32	— .35
Tolidine	lb.	1.75	— 1.80
Toluidine, mixed	lb.	45	-- .55
Toluene, in tank cars	gal	.35	— ...
Toluene, in drums	gal	41	— .42
Xylidines, drums, 100 gal.	lb	.50	— .65
Xylene, pure, in drums	gal	.45	— .47
Xylene, pure, in tank cars	gal	45	— ...
Xylene, commercial, in drums, 100 gal	gal.	.37	— .38
Xylene, commercial, in tank cars	gal	30	—

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.31	— $0.33
Beeswax, refined, light	lb.	34	— .37
Beeswax, white pure	lb.	.55	— 60
Carnauba, No. 1. (nominal)	lb.	.80	— .90
Carnauba, No. 2, regular (nominal)	lb.	70	— .80
Carnauba, No. 3, North Country	lb	25	-- .26
Japan	lb	.19	— .20
Montan, crude	lb.	12	— .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.08	— .08½
Paraffine waxes, crude, scale 124-126 m.p.	lb	08	— 08½
Paraffine waxes, refined, 118-120 m p.	lb	.09	— .09½
Paraffine waxes, refined, 125 m p	lb.	09½	— .09½
Paraffine waxes, refined, 128-130 m p	lb	.10½	— .11
Paraffine waxes, refined, 133-135 m p.	lb	.13½	- .14½
Paraffine waxes, refined, 135-137 m p.	lb.	.14½	15½
Stearic acid, single pressed.	lb	.17½	.17½
Stearic acid, double pressed	lb	18½	- .19
Stearic acid, triple pressed	lb	22½	-- .23

Flotation Oils

All prices are f o b New York, unless otherwise stated, and are based on carload lots The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist, sp gr, 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref, sp gr 1 025-1 035.	gal	.48
Pine tar oil, crude, sp gr. 1 025-1.035 tank cars f o b Jacksonville, Fla	gal.	.35
Pine tar oil, double ref, sp gr. 0.965-0.990.	gal	.75
Pine tar, ref, thin, sp gr, 1 080-1.960.	gal.	.36
Turpentine, crude, sp gr, 0.900-0.970	gal	1.25
Hardwood oil, f o b. Mich, sp gr., 0.960-0.990.	gal	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B D, bbl	280 lb.	$11.75	.
Rosin E-I	280 lb.	11.75	- ...
Rosin K-N	280 lb	11.75	-- . .
Rosin W. G.-W. W	280 lb.	12.00	-- 12.25
Wood rosin, bbl.	280 lb.	11.00	—
Spirits of turpentine	gal.	1.10	— . .
Wood turpentine, steam dist.	gal.	1.08	— .
Wood turpentine, dest. dist.	gal.	1.02	— .
Pine tar pitch, bbl.	200 lb.	.. ..	— 8 50
Tar, kiln burned, bbl. (500 lb)	bbl.	.	— 15.00
Retort tar, bbl.	500 lb.	15.00	- 15 50
Rosin oil, first run	gal.	.70	- . .
Rosin oil, second run	gal.	.73	—
Rosin oil, third run	gal.	.90	— .

Solvents

73-76 deg, steel bbls. (85 lb)	gal.	$0.41
70-72 deg, steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb)	gal	.38
V. M and P naphtha, steel bbls. (85 lb.)	gal	.30

Crude Rubber

Para—Upriver fine (nominal)	lb	$0.22	—$0.23
Upriver coarse (nominal)	lb.	15	— .16
Upriver caucho ball (nominal)	lb.	.16½	— .17½
Plantation—First latex crepe	lb	.19	— ...
Ribbed smoked sheets	lb.	.18	— . ...
Brown crepe, thin, clean	lb.	.16	— .
Amber crepe No 1	lb.	.17	-- .

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.14½	— $0.15
Castor oil, AA, in bbls	lb.	.15½	-- .16½
China wood oil, in bbls. (f o.b. Pac. coast)	lb.	.13½	— .14
Cocoanut oil, Ceylon grade, in bbls	lb.	.14	-- .14½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.15½	-- .16½
Corn oil, crude, in bbls	lb.	.11	— .11½
Cottonseed oil, crude (f.o.b. mill)	lb.	.08	— .08½
Cottonseed oil, summer yellow	lb.	.10½	— .11
Cottonseed oil, winter yellow	lb.	.13½	-- .14
Linseed oil, raw, car lots (domestic)	gal	.85	— ....
Linseed oil, raw, tank cars (domestic)	gal.	.80	— . ..
Linseed oil, boiled, car lots (domestic)	gal.	.87	-- . .

Item	Unit	Price	
Olive oil, commercial	gal.	2.75	— 3 00
Palm, Lagos	lb.	07½	— 09¼
Palm, Niger	lb.	.09	— .09¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	08½	— .09
Peanut oil, refined, in bbls	lb	.15	— .15½
Rapeseed oil, refined in bbls	gal	1.15	— 1 20
Rapeseed oil, blown, in bbls	gal	1 25	— 1.35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	11	— 11½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb	08½	— .08¾

FISH

Item	Unit	Price	
Light pressed Menhaden	gal.	$0.65	— $0.70
Yellow bleached Menhaden	gal.	.67	— .70
White bleached Menhaden	gal.	.72	— .75
Blown Menhaden	gal.	1.05	— 1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Item	Unit	Price	
Barytes, ground, white, f.o b. Kings Creek, S. C.	net ton	$24.00	—$30 00
Barytes, ground, off color, f o.b. Kings Creek	net ton	22.00	— 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	— 12.00
Barytes, floated, f o b St. Louis	net ton	26 50	— 28.00
Barytes, crude, first grade, Missouri	net ton	10.00	— .
Blanc fixe, dry	lb.	.05	— .05½
Blanc fixe, pulp	net ton	60 00	— 65.00
Caseine	lb	.14	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb	04½	.05
China clay, (Kaolin) crude, f o b mines, Georgia	net ton	9 00	12 00
China clay (Kaolin) washed, f o b. Georgia	net ton	12 00	- 15 00
China clay (Kaolin) powdered, f o b. Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f o b Virginia points	net ton	8 00	- - 12.00
China clay (Kaolin) ground, f o b. Virginia points.	net ton	15.00	— 40 00
China clay (Kaolin), imported, lump	net ton	25 00	— 35 00
China clay (Kaolin), imported, powdered	net ton	30.00	35.00
Feldspar, crude, f.o b. Maryland and North Carolina points	gross ton	8.00	— 14.00
Feldspar, crude, f.o.b. Maine	net ton	7 50	— 10 00
Feldspar, ground, f.o.b Maine	net ton	21.00	— 23 00
Feldspar, ground, f o b. North Carolina	net ton	17.00	— 21.00
Feldspar, ground, f o.b. N Y State	net ton	17 00	— 21.00
Feldspar, ground f o b Baltimore	net ton	27.00	— 30.00
Fuller's Earth, f.o.b. New York	net ton	...	— 18.00
Fuller's earth, granular, f.o.b. Fla.,	net ton	25.00	— . . .
Fuller's earth, powdered, f.o b. Fla	net ton	18.00	— . .
Fuller's earth, imported, powdered	net ton	35.00	— 40 00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	...	— .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07	- .09
Graphite higher lubricating grades	lb.	.11	— .40
Pumice stone, imported, lump	lb.	.04	— .50
Pumice stone, domestic, lump	lb.	.06	- - ....
Pumice stone, ground	lb.	.04	— 07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	...	- 10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	......	— 14 00
Quartz (acid tower) rice, f o b Baltimore	net ton	....	— 17 00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7 50
Shellac, orange fine	lb.	1.00	- - 1.05
Shellac, orange superfine	lb.	1.05	1.10
Shellac, A. C. garnet	lb.	90	95
Shellac, T. N.	lb.	85	- 95
Soapstone	ton	15 00	— 25 00
Sodium Chloride	long ton	. .	- - 17.50
Talc, paper making grades, f.o b. Vermont	ton	12.00	— 22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50	— 15.00
Talc, rubber grades, f o b. Vermont	ton	12.00	— 18 00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	— 15.00
Talc, imported	ton	60 00	— 70 00
Talc, California Talcum Powder grade	ton	20 00	— 45 00

Refractories

Item	Unit	Price
Bauxite brick, 56% Al, f o b Pittsburgh	1,000	160
Chrome brick, f o b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55–60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o b Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	55 60
Fire clay brick, 2nd quality, 9-in shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in straight	net ton	110
Magnesite brick, 9 in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f o b Birmingham district	1,000	56 61
Silica brick, 9-in sizes, f o b Mt Union, Pa	1,000	55 60

Ferro-Alloys

All f.o.b. Works

Item	Unit	Price	
Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200 00	—$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	— .19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.17	— 18
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00	— 175.00
Ferro-manganese, 76-80% Mn, English	gross ton	165.00	— 170 00
Spiegeleisen, 18-22% Mn	gross ton	75.80	— 80.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 00	- - 2.50
Ferro-silicon, 10-15%	gross ton	60.00	- 65.00
Ferro-silicon, 50%	gross ton	80.00	- - 85.00
Ferro-silicon, 75%	gross ton	....	— 160 00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.75	— .90
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	— .
Ferro-vanadium, 30-40% per lb of contained V	lb.	6.50	— 7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Item	Unit	Price	
Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20% silica, not more than 8% moisture	gross ton	$10 00	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	70	75
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	65 —	.75
Coke, foundry, f.o b ovens	net ton	10 00	12 00
Coke, furnace, f o b ovens	net ton	8.00 - -	10 00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	26 00
Fluor spar, lump, f o b. Tonuco, New Mexico	net ton	17.50 —	.
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	27 50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	01½
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit		50
Manganese ore, chemical (MnO_2)	gross ton	60.00 -	70 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	65 —	70
Monazite, per unit of ThO_2, c i f, Atlantic seaport	unit	35 00 -	
Pyrites, Spanish, fines, c i f, Atlantic seaport	unit	12	
Pyrites, Spanish, furnace size, c i f, Atlantic seaport	unit	.17 —	
Pyrites, domestic, fines, f o b mines, Ga	unit	.12 -	14
Rutile, 95% TiO_2 per lb ore	lb	.15 —	
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	6.00	
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50 —	5 00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb	2 75 -	3 00
Uranium oxide, 96%, per lb. contained U_3O_8	lb	2.75 —	3 00
Vanadium pentoxide, 99%	lb	12.00 —	14 00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	2.00 —	
Zircon, washed, iron free	lb	05 -	

Non-Ferrous Metals

New York Markets

Item	Cents per Lb
Copper, electrolytic	15 75
Aluminum, 98 to 99 per cent	38 75
Antimony, wholesale lots, Chinese and Japanese	6.12@6 25
Nickel, ordinary (ingot)	43 00
Nickel, electrolytic	45.00
Tin, 5-ton lots	39.00
Lead, New York, spot	7 25
Lead, E St. Louis, spot	7 05
Zinc, spot, New York	7 00
Zinc, spot, E St Louis	6 60

OTHER METALS

Item	Unit	Price
Silver (commercial)	oz	$0 91½
Cadmium	lb	1 40@1 50
Bismuth (500 lb. lots)	lb	2 55
Cobalt	lb	6 00
Magnesium (f o b. Niagara Falls)	lb	1.75
Platinum	oz.	85 00@ 90 00
Iridium	oz	350 00@400 00
Palladium	oz.	85 00
Mercury	75 lb.	58 00@ 60 50

FINISHED METAL PRODUCTS

Item	Warehouse Price Cents per Lb
Copper sheets, hot rolled	23 50
Copper bottoms	34 00
Copper rods	29.00
High brass wire and sheets	27 50
High brass rods	19 00
Low brass wire and sheets	30.50
Low brass rods	24.00
Brazed brass tubing	36 25
Brazed bronze tubing	41.50
Seamless copper tubing	28 00
Seamless high brass tubing	27 00

OLD METALS The following are the dealers' purchasing prices in cents per pound

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 50	17 00	12 00	13 50
Copper, heavy and wire	12 00	16 00	11 75	12 50
Copper, light and bottoms	10 00	14 00	10 00	11 00
Lead, heavy	5 50	4 75	5 50	6 00
Lead, tea	4 50	3 75	3 75	5 00
Brass, heavy	7 00	10 50	8 00	12 50
Brass, light	5 50	7 50	5 00	6 50
No 1 yellow brass turnings	7 00	10 00	6 00	6 75
Zinc	4 50	5 00	3 75	5 00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in by ¼ in and larger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4 15	$4 47	$3 47	$3 44	$3 37	$4 08	$3 47
Soft steel bars	4 15	4 62	3 37	3 84	3 27	3.98	3 37
Soft steel bar shapes	4 15	4.62	3 37	3 84	3 27	3 98	3 37
Soft steel bands	5 50	6 32	4 07	6 25			
Plates, ¼ to 1 in thick	4 15	4 67	3 67	3 64	3 57	4 28	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

PASADENA - Throop College of Technology, East California St., has awarded the contract for the construction of a 1-story laboratory to W. C. Crowell, Chamber of Commerce. Estimated cost, $150,000.

WATTS -The city plans to construct a sewage disposal plant. Koebig & Koebig, 341 Fire Insurance Bldg., Los Angeles, consult engrs.

Colorado

DENVER The State Bd. of Regents plans to build a hospital and laboratory for the curable insane. Bonds were authorized last election Nov. 2 for the construction.

WELLINGTON The Du Pont Sugar Co., 627 19th St, Denver, will soon award the contract for the construction of a sugar factory Estimated cost, $1,000,000. Schwartz Eng Co, 310 Mack Bldg., Denver, engr.

Illinois

CHICAGO The Union Stock Yards Casting Co, 831 West 19th Pl., is having plans prepared for the construction of a 1- and 2-story, 60x125-ft foundry at 4813 South Morgan St. Estimated cost, $28,000 O. Ritter, 110 South Dearborn St, archt.

WAUKEGAN --The city plans to construct a filtration plant, pumping station and intake Estimated cost, $600,000. Hood & Decker, engrs

Iowa

AMES The city will receive bids in February for the construction of a sewage disposal plant, etc Estimated cost, $125,000. P F Hopkins, engr.

Kansas

TOPEKA The city is having plans prepared for the construction of a filtration and softening plant using the Kansas River water Estimated cost, $535,000 Black & Veatch, Mutual Bldg., Kansas City, Mo., engrs Noted Oct 6

Maryland

BALTIMORE The Baltimore Mfg Co., manufacturer of chemicals, vinegar, yeast, etc, controlled by the Fleischmann Co., Perry and Plum Sts., Cincinnati, O., plans to construct additions to its 2 plants on Buren and Monument Sts. and Central Ave and Bank St Estimated cost, $1,000,000

Minnesota

ST PAUL The city voted $3,000,000 bonds to enlarge water plant, including filter plant, etc. Oscar Claussen, City Hall, engr

Missouri

ST LOUIS The Perfection Mfg. Co., Montgomery and Leffingwell Sts., will build a 1-story, 60x60-ft enameling plant at 2701 Leffingwell St. Estimated cost, $7,000 Work will be done by day labor.

New York

HADLEY The No Era Paper Co. has awarded the contract for the construction of an addition and alterations to the machine shop to the H. P. Cummings Constr. Co., 14 Prospect St., Ware, Mass. Estimated cost, $100,000

LONG ISLAND CITY--James H. Rhodes & Co., 115 Fulton St., New York City, has awarded the contract for the construction of a factory for the manufacture of abrasives and polishing materials to the Guarantee Constr. Co., 110 Cedar St, New York City. Estimated cost, $200,000.

ROCHESTER The Bartholmay Brewing Co, 555 St. Paul St., is in the market for $100,000 worth of machinery for crude oil refining

Ohio

ELYRIA --The Lakeshore Rubber Co., 731 Natl. City Bldg., Cleveland, has awarded the contract for the construction of a 2-story factory, to the Donnelly Constr. Co., Lorain. Estimated cost, $150,000.

WARREN Brier Hill Steel Co., Youngstown, has taken an option on a 480-acre site for the purpose of constructing a steel mill Estimated cost, $1,500,000. E. L. Ford, chn. of the Advisory Com.

Oklahoma

VINITA- The city voted $160,000 bonds to construct 2 dams, purification plant, etc. H. G. Olmsted, 417 Oil Exch., Oklahoma City, engr.

Pennsylvania

PHILADELPHIA — The L. Martin Co., Milnor St. south of Bleigh St., will build a 1-story, 27x17x55-ft. addition to its lampblack factory. Estimated cost, $25,000. Work will be done by day labor.

PHILADELPHIA - The Westmoreland Color & Chemical Co., 22d and Allegheny Sts., has awarded the contract for the altering its present factory, to McNeil Valentine, 811 North Broad St. Estimated cost, $10,000.

Texas

CORPUS CHRISTI- W. A. Chambers will build an oil refinery to have a daily capacity of 1,500 bbl. of refined oil and gasoline. Estimated cost, $100,000. Work will be done by day labor.

Wisconsin

AMHERST The Bd. Educ. is having preliminary plans prepared for the construction of a 3- or 4-story, 60x150-ft. high school on North Main St. A chemical and physical laboratory will be installed in same. Estimated cost, $200,000. W. C. Alban, Endicott Bldg., St. Paul, Minn., archt.

APPLETON The Fox River Paper Co. has awarded the contract for the construction of a 2-story, 26x165-ft. paper mill to the Appleton Constr Co.

FOND DU LAC The Fond du Lac Paper Co, 298 Forest Ave, is having plans prepared for the construction of a 1- and 2-story, 100x300-ft. paper board factory. F. Stepnoski, 111 Marquette St., archt. Noted Nov 3.

FREDERICK — The Bd. Educ., Lynn Bldg., is having plans prepared for the construction of a 2-story, 100x175-ft. high school. A chemical laboratory will be installed in same Estimated cost, $140,000. E. J Hancock, Eau Claire, archt. and engr.

GRANVILLE The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., plans to construct a tie treating plant, including 3 steel buildings. Estimated cost, $100,000. J. S. Penney, engr.

JEFFERSON The Jefferson Rubber Co. is building a 1-story, 80x320-ft. tire factory on Main St. Estimated cost, $100,000.

WEBSTER — The Bd. Educ. is having plans prepared for the construction of a 2 story, 160x175-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $175,000. E. J. Hancock, Eau Claire, archt. and engr.

New Brunswick

BEAR RIVER The Clarke Bros., Ltd., will receive bids until Jan. 15 for the construction of a paper mill. Estimated cost, $100,000.

New Foundland

BONNE BAY—The St. Lawrence Timber Pulp & Steamship Co., Ltd., plans to build a plant including a sulphite mill.

Ontario

LONDON--E. T. Jenkens, Y. M. C. A., 129 Wellington St., plans to build a Y. M. C. A. building. A chemical purification system for a swimming pool will be installed in same. Estimated cost, $300,000.

Quebec

MONTREAL—The Royal Duke Refining Co., 157 St. James St., plans to build a plant in East Montreal. Plans include equipment. Estimated cost, $250,000.

New Publications

THE CASTOR-OIL INDUSTRY, by J. H. Shrader. Bull. 867 issued by the U. S. Department of Agriculture.

ARTHUR D. LITTLE, INC., chemist and engineer, 30 Charles River Road, Cambridge, Mass., announces that a limited number of copies of its monograph on "the Petroleum Outlook" are now available for distribution to bankers, brokers, manufacturers and investors free of charge on application. This work comprises an economic study of "The Petroleum Outlook," with especial reference to American fields, a large map and several charts, arranged for comparative reference, with an illuminating discussion of the status of the numerous oil fields. The text, written in popular style, deals with the geology, production history and apparent state of exhaustion of our petroleum resources and may readily be understood by any intelligent layman. It is an impartial, forceful presentation of the petroleum problem without reference to the companies or interests that own or operate in the respective sections. This is one of the most complete and interesting publications for the lay reader that has been issued upon this subject.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies Building from Dec. 7 to 10 inclusive.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

TAYLOR SOCIETY will hold its annual meeting Dec. 2, 3 and 4 in the Engineering Societies Bldg., New York City. The meeting of Dec. 3 at 8 p.m. will be of special interest to metallurgists. The subject will be "The Long Day in the Steel Industry."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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American Engineering Council Founded Under Hoover's Direction

IT WOULD be difficult to conceive more favorable auspices for the launching of a new organization than those surrounding the first meeting of American Engineering Council. The hearty response given by seven national societies and fourteen local organizations, the latter from eleven different states and the District of Columbia, to the invitation for charter membership can be considered a fair index of widespread interest in the civic duties and opportunities of the engineer. With so many organizations ready to unite for a common purpose, it was doubly fortunate that they were able to find in HERBERT HOOVER a leader who typifies not only the ideals but the achievements of engineers in public service. These two factors—the widespread interest in the movement and the acceptance of leadership by Mr. HOOVER—augur well for the success of American Engineering Council.

It is typical of Mr. HOOVER that he should propose immediately a very definite and tangible work for Council—namely, an investigation of industrial wastes in time, labor, material and money. But it is more than a coincidence that he should have suggested this as its first work. He has long been interested in the subject. He was vice-chairman of the Second Industrial Conference, which made constructive suggestions for new and improved relations between employer and employee. Only recently he was invited to sit in conference with Mr. GOMPERS and other officials of the American Federation of Labor, for the purpose of formulating a program of readjustment on the economic problems now confronting the country. Perhaps it was as a result of that conference that news later emanated from the American Federation of Labor announcing a new attitude toward engineers. Mr. WOLL, vice-president of that organization, is said to have stated: "The viewpoint of the engineer is valuable because it is the viewpoint of a man whose position is such as to enable him to see the whole broad problem involved. He is in a position to know fully the value of being able to realize the creative energy of workers, to bring into play their interest and intelligence."

Here is tangible evidence of the influence of engineering thinking on economic problems and an acceptance by one of the great factors in industry of the soundness of the engineer's viewpoint. We hope that developments will show that American Engineering Council has come into being at an opportune moment, when different elements in industry realize the value of engineering thought and opinion on vital economic problems. A happy conjunction of events points in that direction. A sense of professional solidarity has been aroused. There is work to do and a united disposition to do it.

Psychology of Inflation And Readjustment

IN RETROSPECT, what has occurred in business and industry generally since the Armistice seems natural enough. There was a reaction from war-time conditions. Sellers had been restricted as to prices, either by law, by agreement with the Government or by conscience, and when restrictions disappeared most of them were disposed to secure the highest prices obtainable. Workmen had worked hard during the war and were disposed to relax afterward, endeavoring to get the most money for the least service.

Many men were misled by false logic. In the experience of a generation before the war, activity and prosperity had gone together, and it was inferred that activity meant prosperity. But that was not the case; there was much activity that did not involve real prosperity or progress. The country's experience after the Civil War had been forgotten. For eight years after the Civil War there was great activity, except for a few short periods, but when the panic of 1873 came it was found that there had not been a corresponding degree of prosperity and progress.

For the present, however, our disillusionment has come and the reaction from war-time conditions has spent itself. Men are getting over their spell of endeavoring to do the least work for the most money. These changes are chiefly psychological.

A clear distinction must be made between business conditions that arise from psychological influences and those arising from material influences. In 1908, after the panic of October, 1907, there were some "sunshine clubs" formed. It was preached that the depression was all in men's minds and prosperity could be created by establishing what was called "confidence." The scheme did not work. There was a five-year industrial depression from 1873 to 1878 and another of equal duration from 1893 to 1898. In neither of those periods would it have been possible to make business "good" by men changing their minds. Those depressions were not psychological at all. The country had over-expanded. Facilities had been created that were not needed. Liquid capital had been turned into fixed capital to too great an extent, and the capital could not yield an adequate return.

That is not the condition today. The country has too little railroad facilities. There is not too much capital tied up in railroads, but too little. There are not too many dwelling houses and skyscraper office and hotel buildings, but too few. There is no physical foundation for a business depression. The depression is due to wrong mental attitudes that must be replaced by right ones.

The readjustment, whereby we shall attain an industrial activity that will involve real prosperity and advancement, consists in mental attitudes being

changed. Manufacturers, wholesalers and retailers must become reconciled to receiving smaller profits and working harder for those profits. Labor must bring itself to work harder and more intelligently and be content in many cases with smaller pay in dollars, though the purchasing power of the month's earnings may eventually be increased.

Mass psychology, however, seems endued with a characteristic akin to momentum. Sometimes it swings so far that it swings part way back again. It is quite possible that while everyone is now talking about "readjustment" and predicting that we shall in this readjustment get to a perfectly sound and safe basis, we may after all have another reaction toward inflation from which in turn we shall have to recover. It is doubtful, in other words, whether everything will be "fixed up" to stay.

Ignorance Of Science

IN THESE days when the colleges are being criticised from various points of view and many innovations are being introduced into education, anything that throws light upon the subject should be welcome. One of the most illuminating criticisms of the failings of education is contained in H. G. WELLS' recently published "Outline of History." Mr. WELLS, as is well known, received a scientific education and believes, as HUXLEY did before him, in the need for leavening the old-time classical studies with a considerable proportion of well-taught physical science.

It is in his account of Mr. GLADSTONE that Mr. WELLS assails the old pedantic education that, in spite of its virtues, has so hampered our colleges. Mr. WELLS explains the old-time classical training as consisting mainly of "the study, without any archæology or historical perspective, of the more rhetorical and 'poetic' of the Latin and Greek classics." The graduates from such a course, continues Mr. WELLS, had no vision of history as a whole, were ignorant of the elementary ideas of biological science, of modern political, social and economic science and modern thought and literature. Such an education as Mr. GLADSTONE'S is typical of that of many of our public men, lawyers and even some business men. Mr. WELLS' test of an education is whether it enables one to interpret correctly the life around him; of Mr. GLADSTONE he says that he never attained any real vision of the world in which he lived.

For instance, "When Mr. GLADSTONE was taken by Sir JOHN LUBBOCK to see CHARLES DARWIN, he talked all the time of Bulgarian politics, and was evidently quite unaware of the real importance of the man he was visiting. DARWIN, Lord MORLEY records, expressed himself deeply sensible of the honor done him by the visit of 'such a great man,' but he offered no comments on the Bulgarian discourse." Obviously this Eton and Oxford graduate, intellectual as he was supposed to be, had little conception of the world-moving importance of DARWIN'S work in science. Therefore, reasons Mr. WELLS, since he could not interpret correctly the life around him, he was not educated.

Again, Mr. GLADSTONE paid a visit to FARADAY, "the English electrician, whose work lives wherever a dynamo spins, who is in the airplane, the deep-sea cable, the lights that light the ways of the world, and wherever electricity serves our kind . . . The man of science tried in vain to explain some simple piece of apparatus to this fine flower of the parliamentary world. 'But,' said Mr. GLADSTONE, 'after all, what good is it?' 'Why, sir,' said FARADAY, doing his best to bring things home to him, 'presently you will be able to tax it.'" If Mr. GLADSTONE could see the great power-houses and electric lines today, all of which have come from FARADAY'S humble experiments of a century ago, he would see "what good it is"; and he might see also how poorly his education in what Mr. WELLS calls rhetorical literature fitted him to understand the progress of his time.

But Mr. GLADSTONE is not the only prominent man who has failed to do justice to science because of a narrow education. Our own Congress hesitated six years over voting $30,000 to test MORSE'S telegraph, even after he had demonstrated its merits. When the appropriation was being discussed, one Congressman proposed an amendment that half the money be given for an investigation of mesmerism. When the vote was taken on the original motion, (the amendment having been defeated), it carried by only 89 to 83. MORSE meanwhile had nearly starved to death, after vainly trying to get European nations to buy his invention.

Coming down to the present, it is not difficult to see similar blindness to the importance of science by men trained according to the old classical standards. Congress still votes huge appropriations for more or less useless projects, while cutting to the minimum any sums devoted to engineering or to scientific research. When, occasionally, large amounts are voted for necessary engineering undertakings, men untrained in science are as likely as not to be put in charge. Engineers and technologists employed by the national, state and municipal governments are given as little authority as possible, and are paid salaries astonishingly small compared with what Government-employed lawyers and publicists are paid.

One of the most striking examples of lack of knowledge of science is in our newspapers and general magazines. Reporters with almost no understanding of science are assigned to write accounts of scientific importance, and the way in which they garble the facts and falsehoods they pick up is a disgrace. The apportionment of space in the newspapers further emphasizes the prevailing ignorance of science among men who have received the traditional arts education. Half a page is devoted to a murder or a scandal, or even to a wedding or a society rumor, whereas a tiny paragraph in the lower corner has to do for an important scientific discovery.

It is interesting to observe how ignorant people in general are when a scientific matter is mentioned. Speak in the ordinary club or at a general social gathering some such term as "organic acid" or "fuselage" or "metallurgy," and notice the blank looks that follow. As HERBERT SPENCER pointed out, the customary education that most people receive makes them more anxious to pronounce correctly some word of merely literary significance, such as "Iphigenia" or "Don Quixote" or "L'Allegro," than to understand the scientific phenomena among which they live. Listen to the remarks of the average citizen as a street car passes a bridge under course of construction, or when the composition of the latest anarchist bomb is discussed. In spite of all the books on science available, and all the science courses in our schools and colleges, the average citizen, like the lawyer and the reporter and the public man, is astonishingly ignorant of science and engineering.

Concerning Communism

TO THOSE whose mental make-up is such that they shrink from the increasing intensity of the competitive organization of society, the complete fiasco made in the most colossal communistic experiment of all history—Soviet Russia—must appear as a death-blow to their hopes. To the hypothesis of a possible communistic organization of society there attaches a fascination akin to the search for perpetual motion. Primitive men looked upon the competitive beasts of prey with fear and aversion; but the bee, the example par excellence of communism in the animal world, they regarded with admiration of his energy and efficiency mingled with respect for his powers of self-defense. It is natural, therefore, that throughout the ages men have been attracted by the idea of pooling their resources so that each should contribute what he best could to the common store and each withdraw from it in accordance with his needs.

But the verdict of human experience to date is that, except under special circumstances and to only a limited degree, such an organization simply will not work. To the engineer it is at once evident that there are certain fundamental factors in such a plan. The total amount contributed by the group must exceed the total withdrawn by a factor of safety sufficient to create a reserve that may be drawn upon in periods of heightened consumption or lowered production, otherwise the project will collapse, as it has in Russia.

A close analogy would be with a life insurance association, where the premiums paid in must be sufficient to meet the death payments and create a reserve to tide over periods when payments are unusually heavy. The life insurance problem is not difficult when sufficient actuarial data are available, for the amount of the payments is agreed upon and it remains only to fix the amount of the premiums. But there can be no actuarial data for a communistic society, because "the sky is the limit" for the demands that may be made upon it and there is no means of determining the amount which the individual must contribute. We say must contribute, but pure theoretical communism simply predicates that each shall contribute according to his ability and withdraw according to his needs, in the simple faith that the Providence which looks after three well-known groups (one of which is fast vanishing) will somehow arrange it that there will always be enough for all.

However, every time the experiment is tried there never is enough for all. The reasons why are two—optimism and ambition. Mankind on the average tends to believe that everything will come out all right; the Chinese expression for "tomorrow" is *ming tien*—"bright day." If everything will come out all right "there is no use breaking our necks," "you only live once, you know," and so mankind on the average is a little slack, needing some spur or urge to bring out its full powers. And mankind is ambitious; few there are who have attained the Nirvana of having their desires no greater than their means of gratification and those who have so attained are far above the level of the average. With such material to work upon, the engineer can prophesy the outcome as easily as he can prophesy what will happen when the flow from a reservoir exceeds the input.

Communism cannot work except by the remodeling of human nature.

Trade Secrets and Industrial Chemists

SOBER reflection over the thoughts advanced at the Chicago and Milwaukee A.C.S. intersectional meeting detailed elsewhere in this issue leads to the conclusion that much information on chemical processes is now being uselessly suppressed to the retardation of industry. Trade secrets are in a large majority of cases the common property of operators within the trade. The only object in the suppression of such information is to prevent competitors from profiting thereby. But since they are already advised, an open procedure can work no harm. It may do inestimable good to other industries; for it is always true that operation in one industry may be modified for profitable adaptation to work entirely outside the line in which it originates.

There are exceptions to spreading information immediately in the case of patents and certain non-patentable mechanical features. Time is the governing factor, however. The other fellow soon discovers the new development.

A certain manufacturer has very rigid rules regarding secrecy of his operations. He signs up his employees, surrounds his plant with mystery and a high board fence. But the fence is not high enough to hide the heavy niter fumes issuing from the towers of his sulphuric acid plant. Directly across the street is a large set of acid chambers operating at full capacity. Not the slightest mist is apparent over its stack. This plant is operated by a company with a broad open-handed policy that makes for advancement throughout the technical departments. The first company cannot well muster the "brass" to ask to inspect the plant where other folks are welcome. They will probably send a representative in the dark of the night or disguised as a workman to find out how it's done. Meanwhile the fume waves in the prairie breeze like a flag proclaiming ingrown industrial degeneracy to the passing chemist.

When you feel secretive, remember the other fellow may have a better line of information than yourself. Dissemination of information brings returns and is therefore not simply altruistic.

Civil Engineers And the Federation

CORRIDOR gossip at the recent meeting of American Engineering Council in Washington concerned the action of the Civil Engineers in declining by a decisive majority to join the new organization. While regret was expressed that the A. S. C. E. had not seen fit to unite with the other founder societies in the movement for public service, the opinion was frequently ventured that the Civils would yet change their minds and come into the fold. The situation reminded one of that other time when they stood upon their dignity and declined to join the founder societies in accepting Mr. CARNEGIE'S offer of a permanent home. Subsequently, after everybody was settled in the building, they decided to come in.

No fault can be found with the action of the Civil Engineers in declining to join American Engineering Council. One may question, however, whether the Board of Direction of the A. S. C. E. was not exhibiting a petty attitude and a dog-in-the-manger policy when it formally directed its representatives on the present Engineering Council to decline to transfer the activities of that body to American Engineering Council.

First Meeting of American Engineering Council

An Account of the Organizing Sessions at Washington, Nov. 18 to 20—Twenty-one Member-Societies Join the Federation—Herbert Hoover Elected President—Washington Selected as Permanent Headquarters—Investigation of Industrial Wastes Authorized

QUITE fulfilling the expectations of its sponsors, the first meeting of American Engineering Council of the Federated American Engineering Societies, held in Washington, Nov. 18 to 20, was a marked success from the point of view of member-societies represented and official personnel selected to launch the organization. Practically all of the three-day session was consumed with the routine of organization, but did not lack in a number of inspirational addresses interspersed with the more prosaic business of putting the Council's machinery in running order.

Herbert Hoover was elected president by unanimous vote, and Washington, D. C., was chosen as the permanent headquarters of Council.

In response to a suggestion made by Mr. Hoover in his address, the Executive Board indorsed his plan for an investigation of industrial wastes, and authorized him to create an organization for that purpose.

Twenty-one Member Societies

The first session was called to order by Richard L. Humphrey, chairman of the Joint Conference Committee which was charged at the organizing conference last June with the duty of bringing American Engineering Council into existence in accordance with the provisions then made. In his opening address Mr. Humphrey reviewed the work of the Joint Conference Committee in keeping in active touch with the 116 organizations which had been invited to join the Federated American Engineering Societies. As a result of its labors this first meeting was called to order with 21 member-societies representing an aggregate membership of about 60,000, which is 50 per cent of the aggregate membership of all organizations invited to join. Mr. Humphrey concluded his address with a review of some of the work which American Engineering Council can undertake.

Complete List of Charter Member-Societies

The complete list of charter member-societies and their representatives as of Nov. 20, 1920, is as follows:

Alabama Technical Association, Birmingham, Ala.: Paul Wright.

American Institute of Chemical Engineers, Brooklyn, N. Y.: Harrison E. Howe.

American Institute of Electrical Engineers, New York: Calvert Townley, Comfort A. Adams, A. W. Berresford, H. W. Buck, F. L. Hutchinson, G. A. Waters, William McClellan, L. F. Morehouse, John H. Finney, Charles S. Ruffner, Charles F. Scott, Lewis B. Stillwell.

American Institute of Mining and Metallurgical Engineers, New York: Herbert Hoover, J. Parke Channing, Arthur S. Dwight, Edwin Ludlow, Allen H. Rogers, Philip N. Moore, P. E. Barbour, Joseph W. Richards.

American Society of Agricultural Engineers, Ames, Iowa: Samuel H. McCrory.

American Society of Mechanical Engineers, New York: L. P Alford, Charles T. Main, Arthur M. Greene, Jr., E. S. Carman, Arthur L. Rice, Dexter S. Kimball, Paul Wright, W. A. Hanley, William B. Gregory, V. M. Palmer, H. P. Porter, Robert H. Fernald, L. C. Nordmeyer, Fred J. Miller (alternate), Robert Sibley (alternate), Charles Whiting Baker (alternate).

Associated Engineering Societies of St. Louis: William E. Rolfe.

Detroit Engineering Society, Detroit: D. J. Sterrett.

Engineering Association of Nashville, Tenn.: A. F. Ganier.

Engineering Society of Buffalo, N. Y.: W. B. Powell.

Grand Rapids Engineering Society, Grand Rapids, Mich., Burritt A. Parks.

Kansas Engineering Society, Topeka, Kan.: L. B. Smith.

Louisiana Engineering Society, New Orleans, La.: W. B. Gregory.

Mohawk Valley Engineers' Club, Utica, N. Y.: Byron E. White.

Taylor Society: Morris L. Cooke.

Technical Club of Dallas, Tex.: O. H. Koch.

Cleveland Engineering Society: John F. Oberlin.

Engineers' Club of Baltimore, Md.: W. W. Varney.

Society of Industrial Engineers: L. W. Wallace.

Washington Society of Engineers, Washington, D. C.: E. C. Barnard.

York Engineering Society: William J. Fisher, H. A. Delano (alternate).

The following organizations, which are considering membership but have not taken final action, participated in the meeting and sent delegates as indicated:

American Institute of Architects, Washington, D. C.: Percy C. Adams.

American Society of Heating and Ventilating Engineers, New York: Champlain L. Riley.

American Society for Testing Materials, Philadelphia, Pa.: C. D. Young, C. L. Warwick.

Florida Engineering Society, Gainesville, Fla.: L. R. McLain.

Illuminating Engineering Society, New York: Walter C. Allen.

Iowa Engineering Society, Iowa City, Iowa: John H. Dunlap.

National Fire Protection Association, Boston, Mass.: Ira H. Woolson, D. Knickerbacker Boyd.

Society of Automotive Engineers, New York: Howard E. Coffin, David Beecroft, Coker F. Clarkson, H. M. Crane, C. F. Kettering, H. M. Swetland.

Society for the Promotion of Engineering Education, Pittsburgh, Pa.: F. L. Bishop.

Engineering Society of Western Massachusetts: C. L. Newcomb.

Election of Temporary Officers

Election of temporary officers resulted in the appointment of E. S. Carman, American Society of Mechanical Engineers, temporary chairman, and William E. Rolfe, Associated Engineering Societies of St. Louis, temporary secretary. In accepting the position Mr. Carman acknowledged the honor paid through him to the American Society of Mechanical Engineers, which was the first to accept charter membership in the Federation. He also emphasized public service as the keynote of the organization and meeting.

At this point Philip N. Moore offered a resolution of regret that Richard L. Humphrey and his colleagues of the American Society of Civil Engineers, who had worked so zealously for the success of the Federation, were, by the action of their society, eliminated from

OFFICERS of AMERICAN ENGINEERING COUNCIL of the FEDERATED AMERICAN ENGINEERING SOCIETIES



CALVERT TOWNLEY
AMERICAN INSTITUTE of ELECTRICAL ENGINEERS, VICE-PRESIDENT



WM. E. ROLFE
ASSOCIATED ENGINEERING SOCIETIES of ST. LOUIS, VICE-PRESIDENT



HERBERT HOOVER
PRESIDENT



DEXTER S. KIMBALL
AMERICAN SOCIETY of MECHANICAL ENGINEERS, VICE-PRESIDENT



J. PARKE CHANNING
AMERICAN INSTITUTE of MINING AND METALLURGICAL ENGINEERS, VICE-PRESIDENT



L. W. WALLACE
SOCIETY of INDUSTRIAL ENGINEERS
TREASURER

further participation in the Federation's affairs. The privilege of the floor was extended to Mr. Humphrey and his associates.

A number of temporary committees were appointed to formulate immediate business of the Council and report at later sessions. Care was taken to apportion membership on these committees among the national, state and local representatives. These committees and their chairmen were as follows: Program, Percy E. Barbour, A. I. M. E.; Credentials, O. H. Koch, Technical Club of Dallas, Tex.; Constitution and By-laws, C. F. Scott, A. I. E. E.; Nominations, W. B. Powell, Engineering Society of Buffalo, N. Y.; Plan and Scope, L. D. Nordmeyer, A. S. M. E.; Budget, Calvert Townley, A. I. E. E.; Resolutions, F. E. Webner, Society of Industrial Engineers.

Determination of Districts and Representation on Executive Board

In order to constitute the Executive Board of American Engineering Council as provided in the by-laws it was necessary at this point to consider the division of the United States into districts from which the various members of the Executive Board should be selected.

The constitution provides for an Executive Board of thirty, of whom six shall be officers of the Council and twenty-four selected partly by the national societies, and the remainder by the local, state and regional societies and affiliations according to districts. In view of the fact that new member-societies were likely to join the organization and desire representation on the Executive Board it was suggested by L. P. Alford that only twenty members of the board be selected at this time, fourteen from the national societies and six from the locals. This was readily agreed to, as was also the following division of the United States into six districts: 1, New England and New York; 2, Michigan, Wisconsin and Minnesota; 3, Ohio, Indiana and Illinois; 4, New Jersey, Pennsylvania, Delaware, Maryland and District of Columbia; 5, Southern States below the Potomac and Ohio rivers, with Louisiana and Texas; 6, remaining states west of the Mississippi River.

As finally constituted the Executive Board consists of twenty members apportioned among the national societies and the six districts as follows:

American Institute of Chemical Engineers, 1, Harrison E. Howe.

American Institute of Electrical Engineers, 4, H. W. Buck, William McClellan, Charles F. Scott and Lewis B. Stillwell.

American Institute of Mining and Metallurgical Engineers, 3, Arthur S. Dwight, Edwin Ludlow and Philip N. Moore.

American Society of Agricultural Engineers, 1, Samuel H. McCrory.

American Society of Mechanical Engineers, 4, L. P. Alford, Arthur M. Greene, Jr., E. S. Carman and Fred J. Miller.

Taylor Society, 1, Morris L. Cooke.

District No. 1, one-half each for *Engineering Society of Buffalo*, W. B. Powell, and *Mohawk Valley Engineers' Club*, Byron E. White.

District No. 2, one-half each for *Detroit Engineering Society*, D. J. Sterrett, and *Grand Rapids Engineering Society*, Burritt A. Parks.

District No. 3, 1, *Cleveland Engineering Society*, John F. Oberlin.

District No. 4, 1, *Engineers' Club of Baltimore*, W. W. Varney.

District No. 5, 1, *Technical Club of Dallas*, O. H. Koch.

District No. 6, 1, *Kansas Engineering Society*, Lloyd B. Smith.

In view of the fact that all of the societies which have been invited to join the Federation have not yet been able to reach a decision it was the sense of the meeting that the time for accepting invitation to charter membership should be extended to July 1, 1921, and formal action was taken to that effect.

Washington Chosen as Headquarters

Philip N. Moore then brought up the subject of permanent headquarters for American Engineering Council and addressed his remarks particularly to the advantages of Washington, D. C., for this purpose. His suggestion resulted in a lively discussion of the merits and demerits of various locations for headquarters. New York was favored by some on account of its business facilities, while others were favorable to inland cities on account of their central location. In view of the evident time-consuming nature of this discussion and the impossibility of reaching a decision at that session the matter was made a special order of business for the afternoon session. At that time favorable action was taken on Mr. Moore's resolution to the effect that it was the sense of the meeting that headquarters for American Engineering Council should be established in Washington. An amendment to refer the matter to the Executive Board with power to act was lost by a wide margin, though it became incumbent upon the Executive Board later to recognize the sentiment of the Council and formally select Washington as headquarters.

Prior to adjournment of the morning session Mr. Hutchinson, one of the directors of Engineering Societies Service Bureau, New York, told of the work of that organization for the first nine months of 1920. The work of this organization is of interest to American Engineering Council, as the latter is expected to take over its duties. At present the Bureau is expending a total of about $9,000 per annum, but should have a budget of at least $15,000 for 1921. In view of increasing unemployment its service is likely to be much needed during the coming winter, and it was felt that the most efficient service possible should be placed at the disposal of the engineering profession.

Address on Conservation of Labor

The session on Friday morning, Nov. 19, was opened with an address by L. W. Wallace, Society of Industrial Engineers, on "Conservation of Labor." His thesis was that in view of the tremendous loss of labor resulting from the war, as well as the lowered morale consequent upon the general dislocation of business and industry, it was of the utmost importance to increase the potential value of human beings in industrial processes. He mentioned four great factors in accomplishing this end—namely, the safety adviser, the welfare adviser, the industrial medical adviser, and industrial education. He showed statistically the effect of the safety movement in reducing accidents with the consequent loss of time and production. Welfare work, in whatever name it might be undertaken, was, in the speaker's opinion, a failure as long as it was offered as a substitute for wages or other just compensation, but a marked success if undertaken as a conservation measure in the interest of both employer and employee. The industrial medical adviser he found to be an important factor in reducing time lost due to preventable illness. But it was in industrial education that Mr. Wallace

found great hope for the future. Since the trained mind excels the untrained it is of first importance to raise the general level of intelligence of all labor. The object of industrial education should be not so much to make the worker a better machine but to increase his usefulness to society by broadening his mind and developing his intelligence. One of the greatest opportunities of industrial education is to develop intelligent subordinate leaders, foremen, etc. The speaker believed that it was one of the functions of engineers to improve industrial conditions through their recognition of the laws of cause and effect and to devise such means of avoiding industrial waste, and to so administer them that they would accomplish their purpose. He closed his address with a plea for the "industrially handicapped" who now finds it impossible to serve society usefully on account of lack of training. Mr. Wallace was of the opinion that the great loss of labor occasioned by war was making it more and more necessary to make use of individuals handicapped by loss of arms, legs, eyes, etc.

Hoover Chosen as President

The report of the Committee on Nominations was received with the greatest interest because the result of its deliberations was conceded to be of the most vital importance to the success of Council. In making its report the committee explained that it had endeavored to pick men who were imbued with the spirit of public service, which is the underlying motive of the Federation. It also explained that an effort had been made to distribute representatives fairly among the national and local societies. Keeping these factors in mind, it suggested the following officers:

President: Herbert Hoover.

Vice-presidents for a two-year term: Calvert Townley, American Institute of Electrical Engineers, and William E. Rolfe, Associated Engineering Societies of St. Louis.

Vice-presidents for one-year term: Dexter S. Kimball, American Society of Mechanical Engineers, and J. Parke Channing, American Institute of Mining and Metallurgical Engineers.

Treasurer: L. W. Wallace, Society of Industrial Engineers.

The nominations were accepted and the nominees unanimously elected. Mr. Hoover was immediately escorted to the chair amid loud and prolonged applause, the audience rising in recognition of its approval. Mr. Hoover said that he found it impossible to refuse to accept service where it is of importance to the engineering profession and the country at large. He said he had long been interested in giving the engineer a voice in the community and that there never had been a time when his voice was so much needed as now. In view of the fact that he had an important engagement with the American Red Cross it was necessary for him to be excused. Mr. Townley then took the chair and called upon each of the newly elected officers for a brief talk.

Reports of Other Committees

The Council then proceeded to consideration of the report of the Committee on Constitution and By-laws. The committee based its recommendation on the document prepared by the Joint Conference Committee and adopted by the Organizing Conference on June 4, 1920. A few minor changes were made. In Article VI, relating to funds, the sentence reading "No portion of such funds shall be applied to the use of local affiliations or state councils" was changed to read "No portion of such funds shall be appropriated for the operating expenses of local affiliations or state councils." It was felt that the original wording would prevent Council from lending active assistance to local bodies where participation might be desired and needed.

Chapter V of the by-laws, on publicity, was the cause of much irrelevant discussion, but was finally allowed to stand as originally written. The constitution and by-laws were then adopted as amended in minor particulars.

The Committee on Plan and Scope suggested a number of matters of public interest to which Council might devote its attention. This report was subsequently revised in conference with Mr. Hoover and considered by the Executive Board. Their action is announced elsewhere in this report.

In reporting for the Budget Committee Mr. Channing said that they had considered a minimum and maximum income, basing the former on the present actual membership of the Federated American Engineering Societies and the latter on a prospective membership. Under the former an annual income of approximately $59,000 would be available, while the maximum possibility would be $80,000. The fixed expenses for office and overhead, Service Bureau, meetings, committees, traveling, etc., were estimated to amount to a minimum of $56,500 which would be well within the estimated income. The report was accepted for guidance of the Council.

At the evening session of Nov. 19 Mr. Hoover delivered an address embodying his conception of the work of American Engineering Council and outlining in some detail the problems which it might consider. His address is published in full elsewhere in this issue. The evening session was followed by an informal reception and smoker tendered by the Engineering Societies of Washington, D. C. This closed the first meeting of American Engineering Council.

Meeting of Executive Board

The meeting of the Executive Board was convened at 9 a.m. Nov. 20, with Vice-President Rolfe in the chair and C. F. Scott secretary pro tem. The first matter under consideration was the selection of an executive secretary. In view of the importance of this matter the Board appointed a committee to canvass eligible persons and report back to the Board at its next meeting. This committee consists of Mr. Hoover, ex officio; L. W. Wallace, chairman, Box 588, Baltimore, Md., and Messrs. Townley, Moore, Scott, Oberlin and Alford. The committee will be glad to receive suggestions for executive secretary. The Board formally ratified the selection of Washington as headquarters, but deferred selection of offices until the executive secretary is elected. It also extended until July 1, 1921, the time for acceptance to charter mmbrship by those societies originally invited to join the Federation. In accordance with its principle for full publicity the Board decided to establish means for making available to the daily and technical press and the publications of constituent bodies complete information and news relating to the Federation and Council.

Indorsement of Plan to Establish Department of Public Works

The resolution by Mr. Moore recognizing the importance of the movement to secure a federal Department

of Public Works and favoring continuance of efforts to that end brought forth prolonged and earnest discussion, centering chiefly in the question of what kind of support American Engineering Council should give such projects. It was the consensus that Council should not establish the precedent of committing itself to financial support of these movements, but should direct its efforts toward the creation of public sentiment and the preparation of reliable information for dignified and legitimate use. In this connection Mr. Stillwell described the procedure of the French Engineering Council as a medium for expressing the engineer's voice in public affairs. Mr. Moore finally made clear the purport of his resolution and it was adopted.

Discussion of the report of the Committee on Plan and Scope as subsequently modified after conference with Mr. Hoover resulted in the adoption of the following items, which are arranged approximately in the order of their appropriateness and importance:

1. To serve the public interest by investigation and advice to all public governmental and voluntary bodies dealing with national economic problems.
2. Department of Public Works.
3. Conservation of natural resources.
4. Co-operation with other national organizations, technical, industrial and commercial.
5. Technical education.
6. Transportation, particularly highways.
7. Advice to state, regional and local societies.
8. National Bureau of Economic Research.
9. Public fire protection.
10. Patents.
11. National Board for Jurisdictional Awards.
12. International affiliation of engineers.
13. State organization of local affiliations.
14. Licensing and local registration of professional engineers.
15. Classification and compensation of engineers.
16. Engineering Societies' service bureau.

In order that the Executive Board might continue functioning until the executive secretary is elected L. P. Alford was elected secretary pro tem. Matters pertinent to Council's affairs may be addressed to him care American Society of Mechanical Engineers, 29 West 39th St., New York City.

The Executive Board then adjourned subject to the call of the president not later than Jan. 31, 1921.

Canada's Pulpwood Laws and Regulations

When the Canadian provinces were confederated into the Dominion of Canada, one of the articles of confederation conferred upon the respective provinces was the sovereignty and control over their own natural resources. The same authority confers upon the Canadian Parliament the sole power to legislate on matters affecting tariffs as to both exports and imports. Regulations have been adopted by Ontario, Quebec and New Brunswick which require that pulpwood cut from the Crown lands in these provinces must be manufactured into pulp or paper in Canada. These have been summarized by Consul Johnson of Kingston, Ont., in *Commerce Reports.*

An order in council passed Jan. 13, 1900, which was later amended by a law (63 Victoria, chap. 11), requires lumber cut from the Crown lands in Ontario to be manufactured in Canada. It was not until 1902 that this regulation was also applied to pulpwood.

Timber Licenses at Auction

In the Province of Quebec licenses to cut timber on Crown lands are disposed of at public auction. The license thus acquired entitled the holder to "cut timber on ungranted lands of the Crown at such rates and under such restrictions as may from time to time be established by the Lieutenant Governor in council and of which notice shall be given in the *Official Gazette.*" Article 1,598 provides that no license shall be granted for longer than twelve months.

Article 1,600 stipulates that "such license shall vest in the holder thereof all rights of property in all trees, timber and lumber cut within the limit of the license during the term thereof, whether cut by authority of the owner of the license or by any other person with or without his consent."

The regulations now in force by virtue of the first-cited article of the law are embodied in an order in council under date of April 26, 1910, revoking all previous regulations "incompatible with the present" and amended in its turn by an order in council of June 13, 1918.

Other clauses having a bearing on the subject are:

1. All licenses to cut timber are subject to a yearly ground rent of $5 per square mile or fraction of a square mile, dating from the first of September, 1910. They are granted for twelve months, from the first of May to the thirtieth of April, and after their issue no claim shall be admitted for the repayment of any overcharge for ground rent or fire tax due to the incorrect measurement of the area of the limit.
2. Licenses expire on the thirtieth of April following the date of their issue, but the licensee having complied with existing regulations is entitled, up to the first of September following, to a renewal of his license. He shall forfeit such right through any infringement of the law and of the regulations. The Minister of Lands and Forests may, however, permit the renewal of the license on payment of the ground rent and of any other penalty he may be pleased to impose.

Besides increasing the stumpage dues, the amendment adopted in 1918 also raises the ground rent to $6.50 for the years 1919-20 to 1923-24 and to $8 for the years 1924-25 to 1928-29, inclusive, and provides that in the case of licensees who do not exploit their limits such ground rent may at any time be augmented, the Crown to determine the quantity of wood to be cut for constituting sufficient exploitation. "Transfers of limits or of divided or undivided portions thereof are effected in writing, subject to the Minister's acceptance and to the payment of a transfer bonus of $4 for every square mile or fraction of a square mile."

Regulations Governing Use of Timber

Regulations as to the use of timber cut under license were adopted by the Quebec Government on April 26, 1910, which read:

> All timber cut on Crown lands after the first of May, 1910, must be manufactured in Canada—that is to say, converted into pulp or paper, deals or boards, or into any other article of trade or merchandise of which such timber is only the raw material. The following shall not be considered as manufactured within the meaning of the regulation: Timber simply cut into lengths, piled, barked, or otherwise worked preliminary to the manufacture of pulp or paper, deals or boards or any other articles of commerce.

New Brunswick passed similar legislation on April 26, 1911. There are no statutes prohibiting or regulating the export of pulpwood from Nova Scotia or British Columbia.

Freehold lands are not subject to the manufacturing clause restrictions, and wood cut on these lands may be exported or handled in any way that the owner sees fit.

Investigation on Pyrolytic Production of Phosphoric Acid

Briquetted Charge of Sand, Coke and Mine Run Hard Rock Phosphate Smelted in a Furnace Fired With Fuel Oil—Phosphoric Anhydride and Water Vapors Condensed in a Cottrell Precipitator, Giving an Acid Solution—Commercial Possibilities Shown

BY WILLIAM H. WAGGAMAN AND THOMAS B. TURLEY

FROM the standpoint of conservation the production of phosphoric acid by smelting mixtures of phosphate rock, sand and coke has always appeared particularly attractive, and since Ross, Carothers and Merz[1] pointed out the advantages and demonstrated the feasibility of collecting the fumes of phosphoric acid by means of the Cottrell precipitator the volatilization method of producing this acid has taken on an added interest. Not only is it possible to treat relatively low-grade phosphates by this method but the product obtained is sufficiently concentrated to admit of the expense of long freight hauls and heavy handling charges.

The furnace process of treating phosphate rock is by no means new, but is based upon the old method of making phosphorus. The scheme was proposed and patented in this country as far back as 1889[2] and more than twenty patents[3] have since been issued on devices and treatments designed to effect the nearly complete evolution of phosphoric acid from phosphate rock mixed with either sand or coke, or both. In most of these patents the arc furnace is the type stipulated as necessary to smelt the phosphatic charge and therefore it is generally believed that the complete volatilization of this acid from such mixtures can be brought about only under the conditions and at the temperatures attained in the electric furnace.

FUEL VERSUS ELECTRIC SMELTING

The commercial feasibility of using the electric furnace for the production of phosphoric acid, however, appears somewhat dubious except where a pure product commanding a high price is desired. For fertilizer purposes pure phosphoric acid is not required and the cost of the product must be relatively low. Assuming that electric power might be available at $25 per hp.-yr., Carothers[4] in his report on the electric smelting of phosphates places the cost of P_2O_5 (exclusive of interest charges, taxes and depreciation) at 3.39c. per lb. Waggaman and Wagner[5] later showed that this cost might be materially reduced by using "mine run" phosphates instead of the more costly washed rock and employing the phosphoric acid produced therefrom to treat a fresh batch of the mineral, obtaining available phosphoric acid in the form of double superphosphate as the final product. But even under the most favorable conditions it is still an open question whether or not phosphoric acid for fertilizer purposes can be produced by the electric-furnace process at a price which will compete with that obtained by the sulphuric-acid method.

Since the electric furnace, however, performs no other function in this process than that of heating the charge to a temperature where phosphorus and phosphoric acid are readily evolved, and is simply a convenient form of apparatus to bring about the decomposition of the phosphate rock under reducing conditions, it seems evident that if these same conditions can be fulfilled by means of fuel in lieu of the electric arc a great saving in the cost of production should be effected.

The writers have found that practically the same results can be obtained at the temperatures attained in a fuel-fed furnace, and in the preliminary report[6] on this process data were presented showing that the nearly complete evolution of phosphoric acid from a phosphate mineral is perfectly feasible where gas or oil is used as the heating agent, provided reducing conditions are maintained until the mass is brought to a molten condition. From 60 to 98 per cent of phosphoric acid has been driven off from such mixtures by means of fuel in the laboratory, and similar yields were obtained by the use of a furnace holding about 200 lb. of charge. As the process finally developed, however, the furnace used in these larger-scale experiments proved to be poorly designed to handle the charge and the bulk of the slag produced did not show a volatilization of more than 63.2 per cent of P_2O_5. It was decided, therefore, to continue the work with more suitable equipment and under more favorable conditions.

It is recognized that the final proof of the value of this furnace process must rest in a plant of commercial size, but the funds were not available to construct such a plant, so a furnace of semi-commercial size with the auxiliary equipment for burning the combustible gases and collecting the phosphoric acid evolved was erected at Arlington Farm, Va., with a view to solving some of the numerous chemical and mechanical details involved and obtaining sufficient data to approximate the cost of producing phosphoric acid by this process.

Considerable work yet remains to be done before the best type of furnace and equipment is finally established. Insufficient funds made it necessary to utilize much machinery and material illy adapted to the purpose and this fact, coupled with a very limited personnel, has made the problem a difficult one. The small size of the furnace employed has necessarily caused an enormous loss of heat units through radiation and the relatively short duration of the experimental runs has indicated a higher fuel consumption than would be shown in protracted tests. Nevertheless the results obtained are on the whole quite satisfactory and it is believed that the investigation has been carried to the point where the commercial feasibility of the process has been demonstrated and its ultimate economic success practically assured.

[1] *J. Ind. Eng. Chem.*, vol. 9 (1917), p. 6.
[2] U. S. Pat. 417,943 (1889).
[3] U. S. Pats. 452,821; 540,124; 669,271; 689,286; 709,138; 733,316; 862,092; 862,093; 984,769; 1,076,499; 1,014,957; 1,017,864; 1,018,186; 1,103,910; 1,112,211; 1,167,755; 1,173,960.
[4] *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 35.
[5] *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 353.
[6] Waggaman and Turley, *J. Ind. Eng. Chem.*, vol. 12 (1920), p. 646.

The firebrick furnace used* in these experiments is a combination of the open-hearth and blast-furnace types and is heated by means of two oil burners, one at either end of an elongated slag chamber. This slag chamber is boat shaped and was originally 8 ft. in length, 9 in. in width (inside) at either end (where the oil burners are located) but widening to 20 in. in the center. In the center of the arched roof of this chamber is a circular opening leading up into a shaft or charge chamber 6 ft. in height and having the shape of the usual type of blast furnace. The throat of the chamber where it discharges onto the furnace hearth was 12 in. in diameter and widened out gradually until at the top of the bosh the internal diameter was 2 ft. From here on the walls of the chamber taper gently till at the top of the shaft the opening is only 14 in. in diameter. This chamber holds a total briquetted charge of 700 lb. One foot from the top of the furnace shaft is a 6-in. flue leading into the dust chamber. The walls of the furnace and slag chamber range from 13½ to 18 in. in thickness and were originally constructed entirely of firebrick.

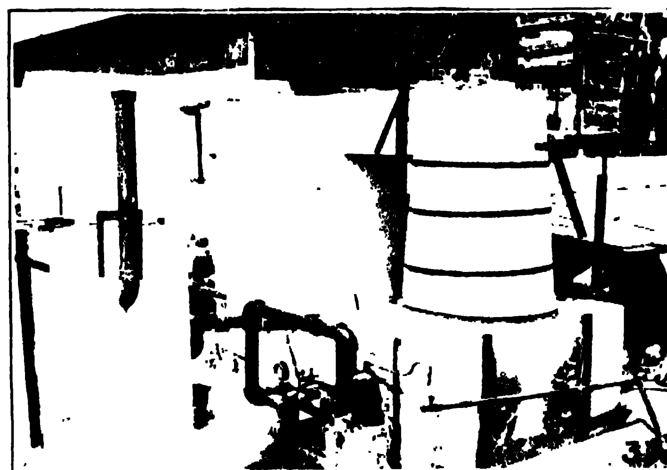
After several preliminary runs with this furnace it was deemed wise to increase the length of the slag chamber in order to give the oil flame a better chance for combustion. Accordingly the furnace was extended 2 ft. at either end, giving a total length of 12 ft. It was also found that the heat attained was so close to the melting point of firebrick that it was necessary to replace them in part by carborundum brick, which stand satisfactorily the temperatures attained in the center of the furnace. In a larger installation, where adequate funds are available, the furnace would be cooled either by bronze plates inserted in the walls and through which water is kept circulating, or by some other convenient water-cooling device employed in blast-furnace practice. In Figs. 1 and 2 the furnace is shown in the course of construction and Fig. 3 is a view of the completed plant. The furnace proper is at the extreme right in these pictures.

Oil Burners and Oil Supply

The oil burners finally adopted for this furnace are manufactured by the Lalor Fuel Oil System Co., of Baltimore, Md. They operate with high-pressure oil (from 50 to 250 lb.), but use air at a relatively low pressure (4 to 8 oz.). The consumption of oil is controlled by the pressure and also by the size of the opening in the tips used. These burners have proved eminently satisfactory as long as the oil fed to them is thoroughly filtered. In order to prevent the ends of the burners from melting or getting too hot they are surrounded by steel water jackets set into each end of the furnace at an angle of about 60 deg. from the horizontal so that the oil flame plays upon the furnace hearth. These burners were designed to be placed several inches from the furnace opening and in addition to operating on the air furnished by a volume blower also utilize for combustion the air drawn in around the furnace opening. In this type of furnace, however, the air required to burn the fuel was preheated and entirely supplied through the air main from









FIGS 1 AND 2. PROGRESS VIEWS OF CONSTRUCTION OF FURNACE
FIG. 3. COMPLETED FURNACE
4 CONNECTION AT STOVES WHERE COMBUSTIBLE GASES FROM FURNACE ARE BURNED

the volume blowers. The burners operated very satisfactorily under these conditions.

A steel tank holding 500 gal. is used as the main reservoir for the fuel oil and this is connected with a small 80-gal. tank provided with a gage to measure the oil consumption. The oil is fed by gravity to a pump which forces it to the burners under a pressure of from 50 to 200 lb. The oil tanks are shown in Fig. 7.

Dust Catcher

The dust catcher into which the gases and fumes from the furnace pass was originally designed to act also as a preheater for the air supplying the oil burners and has an annular space surrounding the gas chamber. The use of the dust catcher, however, as a preheater was early abandoned because of the impracticability of rendering the wall between the air and gas chambers air-tight. A bleeder is located in the flue leading from the dust catcher to the stoves where samples of the furnace gases are withdrawn for analysis from time to time during a run.

Stoves

From the dust catcher the gases are led through sliding valves into the stoves, which are three in number. These stoves were intended, first, to burn the combustible gases evolved from the furnace, and second, to absorb the heat units thus produced by means of brick checkerwork; the heat thus absorbed being returned to the system by passing the air required for the oil burners through the heated checkers. The three stoves, however, were built together with a view to reducing radiation losses, and here also it was found impossible to render the common walls sufficiently tight to prevent the gases in one stove from mixing with the air passing through the adjoining one. The likelihood of thus causing an explosion rendered it necessary to abandon them as a means of heating the air to the oil burners. They are used, therefore, only to burn the combustible gases evolved from the furnace. From the stoves the gases are led through a 6-in. brick flue 25 ft. in length to the Cottrell electric precipitator, where the acid is collected. A monel metal exhaust fan placed in this flue serves to withdraw the gases from the furnace and discharge them into the precipitator pipes. The stoves are shown on the extreme left in Figs. 1 and 2, and in Fig. 4 the air and gas connections to the stoves can be seen.

Electric Precipitator

The electric precipitator used in this work was designed and built to handle the phosphoric acid evolved from an electric furnace. The electrical equipment has already been described by Ross, Carothers and Merz,[7] but the precipitator proper consists of six 6-in. terra cotta pipes, 12 ft. in length, under which is a stone basin to receive the acid dripping therefrom. The gases enter the precipitator through a 6-in. opening below this basin. Since this electric treater has been erected four years, several of the terra cotta pipes are now considerably out of plumb, making it impossible to center the wires hung in them. Much trouble was encountered due to the current arcing across to the sides of the pipes when a high voltage was employed. Not only is this precipitator located too far from the furnace but its capacity is too low to handle the quantity of phosphoric acid at the velocity with which it is evolved and discharged into the system. The precipitator proper is shown in Fig. 6 and the electrical equipment in Fig. 8.

[7]*Loc. cit.*

Air Supply and Preheater

The air required for the oil burners is furnished by three Leiman positive pressure blowers, two of which have a capacity of 160 cu.ft. of free air per minute each, and the third a capacity of 360 cu.ft. When the furnace is in normal operation one large and one small blower are employed to supply the air. These discharge into a 4-in. steel main which is constricted at each burner to 3 in. in diameter.

Since the stoves could not be utilized to preheat the air furnished to the oil burners a preheater was built containing a coil of 60 ft. of 4-in. steel pipe heated by means of a small oil burner. During a furnace run pyrometers were located in the air main following the preheater, in the gas main leading from the dust catcher to the stoves, and in the flue leading from the stoves to the electric precipitator. The preheater is shown in the left foreground of Fig. 3.

Materials Used

The phosphate used in these experiments consisted of "mine run" material furnished by the Cummer Lumber Co., of Jacksonville, from hard rock phosphate mines near Newberry, Fla. As pointed out in the previous report[8] on this process, the "mine run" phosphates from these deposits usually contain sufficient phosphate to admit of their furnace treatment without being reinforced with higher grade rock[9]—in fact, in most cases sand must be added in order to



FIG. FORMS OF BRIQUETS

obtain the proper silica-lime ratio (approximately 41 per cent CaO to 59 per cent SiO_2) to bring about the required reactions in the furnace. It has also been shown that these deposits contain considerable quantities of soft phosphate, a clay-like substance which acts as an excellent binder when the material is moistened and pressed into briquets. Such briquets will stand a drop of from 6 to 8 ft. upon a cement floor without shattering.

Two forms of briquets were used in the final experimental runs: The first in the shape of eggettes, 2 x 1½ x 1½ in., and the second in the form of pillows, 2 x 2 x 1½ in. The former shape has the advantage of having no sharp corners to sluff away, but the latter type does not pack so tightly in the furnace shaft and therefore allows a somewhat freer passage for the gases through the charge. While both forms of briquets worked quite satisfactorily in the furnace, showing no signs of cracking while being heated to

[8]*Loc. cit.*

[9]The last batch of three tons of "mine run" phosphate, however, had to be reinforced with pebble phosphate.

TABLE COMPOSITION OF BRIQUETTED CHARGE USED IN FURNACE EXPERIMENTS

	Per Cent
Moisture	0 60
SiO_2	33 61
Al_2O_3, Fe_2O_3	6 71
CaO	24 67
MgO	not determined
P_2O_5	17 02
F_2	not determined
CO_2	1 29
C (contained in coke)	12 10
Total	96 00

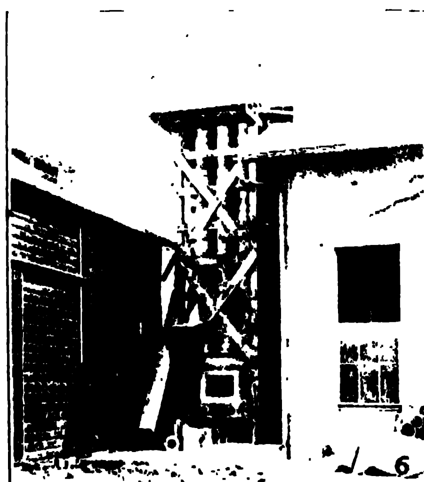
Ratio of CaO to SiO_2 = 42 to 58
P_2O_5 content exclusive of carbon and moisture = 19 99 per cent

a smelting temperature, the pillow form is preferable where the briquets do not have to be shipped or handled too frequently. The various types of briquets used during the development of this process are shown in Fig. 5.

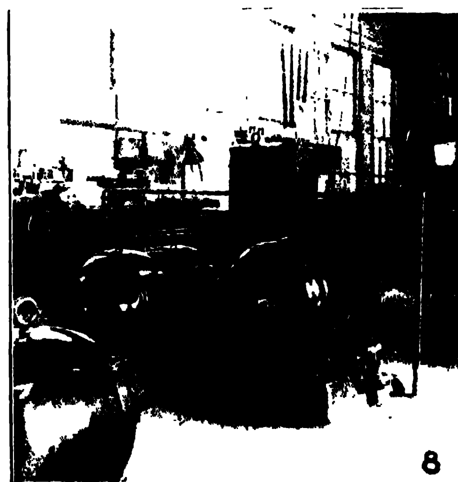
experiments. This oil was purchased in barrel lots both from the Texas Co. and the Standard Oil Co. and varied from time to time in viscosity and specific gravity. The average weight per gal. was 7.5 lb. and the calorific value was in the neighborhood of 19,000 B.t.u. per lb., or 142,500 B.t.u. per gal. Either crude oil or the residuum of petroleum can be used and there appears to be no reason why powdered coal burners should not be employed where this fuel can be obtained at a lower cost than oil.

SUMMARY OF THE LAST TWO RUNS OF FURNACE

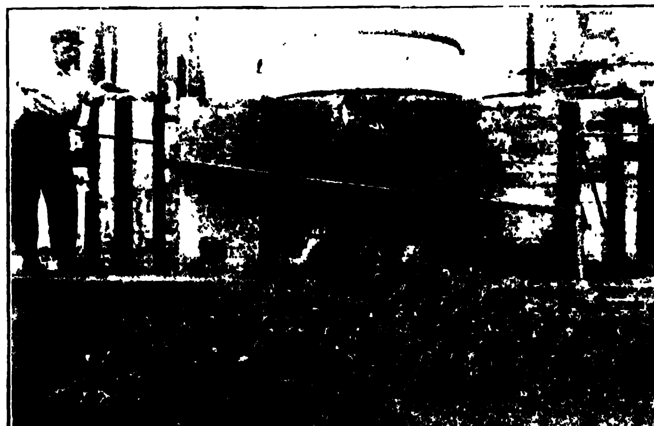
Since the completion of the present type of oil-burning furnace at Arlington Farm, Va., with its auxiliary equipment for the collection of phosphoric acid, at least six tests have been conducted in smelting briquetted charges of "run of mine" rock from the Florida phosphate fields. These tests were conducted for periods











FIGS. 6 TO 10

Ele trical pre ipitat ... eting pho ... ic vapors ... Fig. 7. Fuel-oil tan ... Fig. 8. ... erator, rectifier and transformer fo ... cipitator current. ... Figs ... and tapped slag.

The use of a briquetted charge was adopted in using the "mine run" phosphates of Florida for two reasons: First, the finely divided condition of these phosphates renders it essential to nodulize or briquet them before they can be handled in a plant of the blast-furnace type; and second, the necessity of maintaining reducing conditions until the mass has reached a smelting temperature. The latter requirement can be effectually fulfilled by incorporating coke in the briquetted charge.

The chemical composition of the briquets is shown in Table I.

Crude oil was used as the heating agent in these

of from six to twenty hours and the amounts of briquetted material charged ranged from 500 lb. to 1½ tons. While valuable data were obtained in practically all of these experimental runs, the furnace was in every instance except the last closed down before it was working at its maximum efficiency. In most cases the experiments were discontinued because of mechanical difficulties, which, however, were largely overcome in the last two tests. Only these last two runs therefore are recorded below.

At 8 a.m. on Oct. 6, 1920, the oil burners of the furnace were started and the first charge (50 lb.) of

briquetted material was added at 10:45 a.m., when the furnace shaft was nearly full of coke and the air supply to the oil burners preheated to a temperature of 210 deg. C. The first charge was followed at intervals of from ten to fifteen minutes by additional charges of from 50 to 200 lb. of briquets, till at 12:30 p.m., 1¾ hours later, a total of 650 lb. had been added. At this time the temperature of the air to the oil burners was 260 deg. C. and the fumes of phosphoric acid were being copiously evolved. The furnace shaft being then four-fifths full, the top was closed down, the exhaust fan started, and the current turned into the electrical precipitator. Twenty-five minutes later the acid was dripping from the basin below the precipitator pipes, the first half gallon being collected in thirty-five minutes and having a concentration of 15 per cent H_3PO_4. The exhaust fan used to draw the gas from the furnace, however, was not being run at sufficient speed to handle the volume of gas forced over from the furnace, so there was considerable back pressure at the stoves where the combustible gases were burned, which resulted in a large loss of phosphoric acid and caused the furnace to work rather irregularly.

At 1:20 p.m. 400 lb. more of briquetted charge was added and twenty minutes later the furnace was tapped. It was found that the entire charge had worked through to the hearth and the viscous nature of the slag made it difficult to withdraw the partly smelted product. By increasing the oil pressure and the volume of air to the burners, however, the slag was rendered considerably more molten and was finally removed. During the next three hours 850 lb. of briquets was added. The top of the furnace was then closed and the slag holes were automatically plugged by allowing successive waves of the molten slag to flow forward and freeze at these openings.

One hour later (5:20 p.m.) it was found that the entire charge (850 lb.) had completely worked through to the hearth, so 300 lb. more of briquets was added. At this time the air to the oil burners showed a temperature of 250 deg. C. and the gas entering the stoves showed a similar temperature—namely, 250 deg. C. The rate of consumption of the fuel at this time was only 9 gal. per hour for both burners. Twenty-five minutes later, or at 5:45 p.m., the last charge (300 lb.) was also found to have smelted and worked through to the furnace hearth.

No further material was added, and at 6:15 p.m., one-half hour later, an attempt was made to tap the furnace again, but owing to the fact that the slag had been allowed to accumulate and cool in the tap-holes it was found impossible to break through to the molten mass within. The slag being at the level of the oil burners, it was necessary to close down. The phosphoric acid was flowing from the precipitator at the rate of 1½ gal. an hour, but the concentration was only 21 per cent of H_3PO_4. Analyses of the slag obtained after the furnace had cooled and was opened up showed a phosphoric acid content of from 7.99 to 13.63 per cent, or a volatilization of from 38 to 65.3 per cent of that originally in the charge.

The outstanding feature of this run was the rapid rate at which the material was reduced to a state of incipient fusion. No preparation was made to handle a large volume of slag in a limited time, and when this partly fused mass worked down through the furnace shaft, covering the slag already on the hearth, it seemed to cool the latter to the point where the evolution of phosphoric acid was much retarded. An analysis of the last slag produced, however, or that upon the surface, showed that over 52 per cent of the phosphoric acid was apparently evolved while the charge was being reduced to a state of fusion. In this particular instance the evolution was at the rate of about 80.5 lb. of P_2O_5 per hour, with a fuel consumption of 9½ gal. of oil, giving a yield of approximately 8.5 lb. of P_2O_5 per gal. of oil. The present selling price of soluble phosphoric acid for fertilizer purposes is 6½c. per lb. The price of fuel oil in the Florida phosphate fields is in the neighborhood of 5c. per gal., so on this basis the cost of the fuel was 9.4 per cent of the value of the product. It was unfortunate that the furnace had to be closed down just at the time when it was heated to about the proper temperature to cause more rapid and complete evolution of the phosphoric acid, as a more protracted run would undoubtedly have yielded further valuable data. The highest temperature observed on the furnace during this run was about 1,500 deg. C., but no readings were made when the system was closed down.

The Second Test

Before undertaking the next test the throat of the furnace charge chamber was constricted from 12 to 9 in. in diameter in order to keep the charge from working down upon the hearth too rapidly. In addition to this a column or solid platform of carborundum brick was built under the mouth of this charge chamber to support the partly fused material being discharged therefrom and prevent its dropping directly into the more molten slag. The speed of the exhaust fan used in sucking the evolved gases through the stoves and precipitator was also increased so that the velocity of these gases in the 6-in. precipitator pipes reached seven linear feet per second. Since the precipitator was originally built to handle the phosphoric acid from an electric furnace where the velocity of the gases did not exceed three linear feet per second, it was expected that this incrase in speed would result in a great loss of P_2O_5.

This last experiment was begun at 8:30 a.m. on Oct. 28, after having heated up the furnace the previous day with a charge of coke. The first charge of 100 lb. of briquets was added at noon and twenty minutes later phosphoric acid was being copiously evolved. This charge was followed by others of from 100 to 200 lb. each at intervals of from ten minutes to one-half hour until at 2:15 p.m. 600 lb. had been charged. The furnace top was then closed and the exhaust fan started. At this time the air to the oil burners showed a temperature of 240 deg. C.,

Fifteen minutes later, or at 2:30 p.m., the current was turned into the electrical precipitator and here trouble developed almost immediately. It was found that one of the precipitator pipes was so badly buckled that it was impossible to center the wire sufficiently well to prevent the current from arcing across to the side. In spite of the fact that the precipitator was working only intermittently a small stream of acid was flowing from the basin within fifteen minutes. At 3 o'clock, however, it was decided to shut off the precipitator entirely, as the trouble grew steadily worse. The furnace was tapped for the first time at 3 p.m. and owing to the difficulty experienced in removing the slag and residual coke the tap-holes were left open until

4:20 p.m., or one and one-half hours. During this time 800 lb. more of briquetted charge was added. The average slag obtained from this first tap showed a content of 10.72 per cent P_2O_5, or a volatilization of only 52.0 per cent of that originally present. A sample of more liquid slag dripping from the charge chamber upon the hearth and withdrawn from the furnace just before the tap-holes were closed showed also a content of 10.72 per cent P_2O_5.

This seems to bear out the conclusions reached in the first tests that approximately one-half of the phosphoric acid was evolved quite rapidly during the fusion of the mass. At 5:35 p.m. 150 lb. more of briquets was added, making a total of 950 lb. since the tapping of the furnace was begun. The furnace top was closed down and the gas again passed through the precipitator. Apparently the charge worked down to the furnace hearth quite rapidly, for at 6 p.m., when an analysis was made of these gases, they showed only 1.20 per cent of PH_3 and 4 per cent of CO. These gases were not sufficiently combustible to burn at the stoves.

At 6:30 p.m. the furnace was again tapped. The slag was also similar to that obtained in the first instance, but showed upon analysis 12.08 per cent of P_2O_5, or a volatilization of only 45.03 per cent. Both the furnace top and slag holes were left open until 9:30 p.m., during which time 600 lb. of material was charged and the temperature of the air supplying the oil burners rose to 350 deg. C. At this time it was decided to cut out the faulty pipe in the electrical precipitator. This, of course, resulted in increasing the velocity of the gases in the remaining five pipes to 8.4 linear feet per second, but the precipitation of acid was much improved. The slag holes were then closed, the top of the furnace was lowered, and at 9:45 p.m. the current was again thrown on the precipitator.

While this apparatus was unable to collect more than one-third of the P_2O_5 passing through it, a stream of dilute acid was soon flowing from the basin below the pipes at the rate of ½ gal. in eighteen minutes. The concentration of the acid collected steadily rose as the temperature of the gases from the stoves increased from 100 to 145 deg. C. The first bottle (½ gal.) showed a concentration of 19.28 per cent H_3PO_4; the second bottle 21.5 per cent; the third 21 per cent; the fourth 23 per cent; the fifth 31 per cent; the sixth 41 per cent; and the seventh 60 per cent. The last runnings showed a concentration of 64 per cent H_3PO_4. Had it been possible to continue the test longer the strength of the acid would no doubt have reached 80 to 90 per cent.

No more briquets were added until 11:10 p.m., when it was found that the charge chamber was completely empty. Then 400 lb. was added, but it ran through to the hearth almost immediately. At this time the temperature of the air to the oil burners had dropped to 325 deg. C., but the temperature of the gases to the stoves had risen to 300 deg. C., showing that there was practically no green charge in the shaft to absorb the heat units from the gases. On analysis these volatile products showed only about 6½ per cent of combustible gases, exclusive of the phosphorus. This quantity was insufficient to cause the gases to burn. One hour later, however, it seemed apparent that the furnace was operating at its highest efficiency and therefore it was decided to charge all of the remaining briquets and fill the furnace shaft to the flue. Accordingly 950 lb. was added between 12:15 a.m. and 1:14 a.m., Oct. 29. Fifteen minutes after the last addition of briquets the gases from the furnace were analyzed and showed the following composition:

	Per Cent		Per Cent
PH_3	2 2	O_2	0.2
CO_2	7 7	CO	13 8

These gases were able to support combustion and burned quietly at the stoves, increasing the temperature of the P_2O_5 going to the precipitator and also the strength of the acid collected. It was found at this time that the oil pressure, and therefore the amount consumed, could also be considerably lowered without cooling the furnace, and the rate of consumption was finally reduced to 8.3 gal. per hour for both burners. The furnace was allowed to run until 4 a.m., when it was again tapped and this time a very molten slag was obtained which continued to flow from the furnace in a steady stream for about one-half hour. Upon cooling this slag exhibited the characteristics of a brittle glass and ranged in color from grayish green to dark blue. Analysis of average samples of this slag are shown in Table II.

TABLE II PHOSPHORIC ACID CONTENT OF FINAL SLAG PRODUCED IN FURNACE RUN AND PERCENTAGE OF VOLATILIZATION OBTAINED

Sample No.	Description of Slag	Content of P_2O_5 Per Cent	Amount of P_2O_5 Volatilized Per Cent
4d	Bluish black, very glassy (1st runnings)	0 56	97 75
5d	Dark gray to green, very glassy (2nd nnings.	0 76	96.95
6d	Dark gray to green, very glassy (last runnings)	1 00	96.00
Average slag...		0 77	96.90

The average phosphoric acid content of this final slag, as will be noted, was 0.77 per cent, which means that nearly 97 per cent of the acid present in the original charge was volatilized. This elimination of acid from the slag is about as complete as that obtained by the use of the electric furnace for the same purpose.

Yield and Cost of Product

It is rather difficult to arrive at a fair figure showing the yield of acid (P_2O_5) per gal. of fuel oil consumed in a test of such short duration, particularly when the furnace was not functioning at its best until the latter part of the run. It seems fair, however, to take the rate of fuel consumption during the last two hours of the run, when the furnace attained its maximum temperature (between 1,500 and 1,600 deg. C.) as that at which the oil could be fed to the burners had it been possible to conduct the experiment for a longer period. During the last 3½ hours of the test 950 lb. of briquets was charged into the furnace shaft and completely reduced to a molten slag with the evolution of 161.9 lb. of phosphoric acid (P_2O_5), or 96.90 per cent of that present in the original mass. The amount of oil consumed (at the rate of 8.3 gal. per hour) in driving off this acid was 29.15 gal. This gives a yield of 5.56 lb. of P_2O_5 per gal. of fuel. At the present price of oil and phosphoric acid given above the cost of the fuel consumed was 14.4 per cent of the value of the product for fertilizer purposes. It will be noticed, however, that the cost of fuel per lb. of acid produced appears actually higher than that obtained in the previous furnace run when the volatilization of acid was

much less complete. Probably better figures would have been obtained had the furnace been tapped earlier, as the acid may have been largely eliminated from the slag long before the latter was run out of the furnace. There is certainly little doubt, however, that in a prolonged test with a larger furnace a much lower fuel consumption per lb. of acid produced would result.

Yet even on the basis of these figures this process appears economically superior to the present method of producing soluble phosphates for fertilizer purposes. In manufacturing acid phosphate, for instance, sulphuric acid is used as the reagent and the cost of this

TABLE III AMOUNTS AND COST OF MINE RUN PHOSPHATE AND COKE BREEZE REQUIRED PER TON OF PHOSPHORIC ACID, AND COST OF BRIQUETTING THIS MIXTURE FOR FURNACE TREATMENT

Charge and Its Manipulation for Furnace Treatment	Quantity Lb.	Cost per Ton of Material	Cost per Ton of P_2O_5
Mine run phosphate and sand	10,542	....	.
Mining	10,542	$1 00	$4 70
Drying	10,542	0 50	2 35
Grinding..	10,542	0 50	2 35
Coke Breeze.	1,438	8 00	5 14
Grinding..	1,438	0 50	0 32
Mixing and briquetting ...	11,990	1 25	6 69
Total.		11 75	

acid represents at least 23 per cent of the value of the product. In the furnace process, on the other hand, fuel oil is the reagent used and even with the small and admittedly inefficient experimental plant the cost of fuel oil required to bring about the desired reactions was less than 15 per cent of the value of the product. To the cost of the fuel oil there must also be added, however, the price of the coke incorporated in the briquets, but this does not appreciably increase the expense of treatment.

In Table III the estimated cost of preparing the briquetted charge for furnace treatment is given, and in Table IV is shown the approximate cost of producing phosphoric acid by the furnace process in a plant

TABLE IV. COST PER TON OF PHOSPHORIC ACID (P_2O_5) 90 PER CENT YIELD, PRODUCED BY SMELTING A "RUN OF MINE" PHOSPHATE IN AN OIL-BURNING FURNACE

Daily Output 30 Tons of P_2O_5	
Briquetted material........................	$21 55
Fuel oil, 360 gal. @ 5c. per gal	18 00
Power..	3 50
Interest on $75,000 @ 6 per cent..............	0 41
Depreciation on $75,000 @ 20 per cent..........	1 37
Labor - 18 men at $5 per day..................	3 00
Insurance....................................	0 50
Overhead expenses............................	1 50
Total.	$49.83

capable of turning out thirty tons per day of twenty-four hours. While some of the cost items are based on the data gathered in the runs of the experimental furnace at Arlington, Va., others are estimated or based on estimates received on the cost of building a larger plant. This plant would comprise the furnace and auxiliary equipment, including the electric precipitator and also grinding and briquetting machinery, storage bins, a mixer, drier, etc. The costs are also based on the assumption that the plant would be located in the Florida phosphate fields.

Even in making the most liberal allowances for the various items of expense the total cost of manufacturing phosphoric acid by the furnace process amounts to only $49.83 per ton, or 2.49c. per lb., as against the present selling price of 6.25c. per lb.

It is interesting to compare this cost with that of producing a ton of phosphoric acid in the form of acid

TABLE V. AVERAGE COST OF PHOSPHORIC ACID (P_2O_5) PER TON IN THE FORM OF ACID PHOSPHATE

Phosphate rock, 6,250 lb @ $7 60 per ton	$23 75
Sulphuric acid, 6,250 lb @ $9 50 per ton	29 69
Shrinkage, 6,250 lb	6 56
Labor	6 25
Power.	5 00
Depreciation	2 50
Overhead, insurance, taxes . .	7 50
Total....	$81 25

phosphate. In Table V is shown the average cost of this commodity as given by three large manufacturers.

Under the most favorable conditions the present cost of producing phosphoric acid in the form of acid phosphate is $81.25 per ton, or 4.6c. per lb. Many manufacturers claim their cost of production is considerably higher than this figure.

On the basis of the data so far obtained, therefore, the cost of manufacturing phosphoric acid by the furnace method should be little more than one-half of that of producing it by the sulphuric acid process. When we take into consideration also the facts that by using the smelting process a concentrated product would be obtained which can stand heavy transportation and handling charges and that the life of the phosphate deposits would be greatly prolonged because the waste of low-grade phosphates would be largely eliminated the future of this process appears very promising indeed.

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Vanadium*

By Frank L. Hess

The minerals of vanadium are the sulphide, patronite; the oxidation products, vanadinite, descloizite, dechenite, psittacinite and related minerals found in the oxidized parts of lead and copper veins, carnotite and roscoelite (a vanadium mica). It is also present in unknown form and small fractions of 1 per cent in ilmenite, some asphaltites and some iron ores, such as the minette ores of northeastern France and other iron ores of France.

Patronite, now the most important vanadium ore, furnishing probably two-thirds of the world's vanadium, is found at only one place, Minasragra, Peru, where it occurs in a single mass of asphaltic material with a roughly lenticular horizontal section in sedimentary rocks. The depth to which it extends is unknown. Carnotite is found in this country in flat-lying soft sandstone beds, as a deposit formed by the replacement of wood or other vegetable remains, now fossilized, and as material impregnating the sandstone. Roscoelite occurs as a thin flat vein and as an impregnation in flat-lying sandstone near Placerville and Vanadium, Col.

Many ilmenites, segregations from igneous rocks, carry a small fraction of 1 per cent of vanadium but have not yet been worked for vanadium.

Imports

Vanadium ore imported during the last six months of 1918 amounted to 1,772,215 lb., valued at $5,333. No separate record was kept prior to July, 1918.

*Advance sheets, Mineral Resources of the U. S., 1918.

The United States, as the largest steel-making nation, is the largest user of vanadium. England, Germany and France buy ferrovanadium from this country and also buy ores when possible.

The Minasragra deposit is owned by an American company, the American Vanadium Co., but of course the political control is wholly in the hands of Peru.

The exports from Peru and the production in the United States since 1912 have been as shown in the accompanying table.

APPROXIMATE WORLD'S PRODUCTION OF VANADIUM, 1912-1918

	Peru (ore)— Quantity (Short Tons)	Percentage of V_2O_5	Vanadium Contained (Short Tons)	United States (ore and concentrates) Vanadium Contained (Short Tons)
1912	3,048	45.00	768	300
1913	None			432
1914	14.5	45.00	4	452
1915	3,145	45.58	803	627
1916	3,448	40.00	772	460
1917	4,083	35.78	821	484
1918	2,183	19.10	234	276

TECHNOLOGY

In a general way the sulphide patronite is roasted and fused with a soda salt to form sodium vanadate, which after extraction is smelted in an electric furnace to ferrovanadium carrying between 35 and 40 per cent of vanadium.

The vanadates of lead, copper and zinc are commonly fused with a soda salt, the lead separating as metal and the vanadium going into the slag as sodium vanadate, from which point the general process is the same as for patronite.

In the treatment of carnotite for radium, vanadium is separated as oxide or iron vanadate, which is reduced in the electric furnace to ferrovanadium.

Roscoelite-bearing sandstone is roasted with salt and pyrite, lixiviated, filter-pressed, the solution treated with a ferric salt to precipitate the vanadium, the precipitate filtered out, and the ferric vanadate smelted in an electric furnace to ferrovanadium.

Some asphaltite has been burned in Peru and the ash shipped to the United States for treatment, presumably by fusing with soda, and so on.

In smelting the minette ores of France, the vanadium is carried into the slag and is extracted from that.

USES

The one use that makes vanadium of large economic value is as a scavenger and alloy in steel. Added to steels in quantities of 0.25 to 1.50 per cent, it is said to remove occluded oxygen and nitrogen and also to combine with the steel. In the smaller quantities, it is said to give great toughness and is used in steels for automobile axles and other parts on which severe strains come, for locomotive tires and frames and in similar steels. The larger quantities are used in high-speed and other tool steels. Its use is now as standard as that of tungsten in high-speed steels. Small quantities of vanadium have been used in dyes and medicines, and still smaller quantities for other purposes.

In the manufacture of steel, efforts are now being made to use molybdenum as a toughener and titanium as a scavenger as substitutes for vanadium, but these substitutes are not common. Titanium has been used in cast steels, though not with entire success.

Active or Available Chlorine

BY J. R. MACMILLAN*

Although the following notes may seem to cover the simplest form of chemistry, the writer has encountered some peculiar ideas concerning the principles involved.

The term "active" or "available" chlorine is used to define the chlorine in bleaching powder that has oxidizing power, to distinguish this from the chlorine present in the form of chlorides or chlorates. It is the usual practice in routine analysis of bleaching powder to determine the active chlorine and also the total chlorine present. The difference in percentage between the active and total chlorine is called chloride chlorine or inert chlorine. Thus good bleaching powder may test:

	Per Cent
Active chlorine	37.5
Total chlorine	38.1
Chloride chlorine	0.6

while decomposed bleaching powder may test

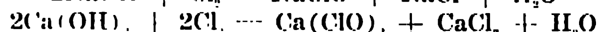
	Per Cent
Active	29.5
Total	36.5
Chlori	7.0

If bleaching powder could be made under ideal conditions, the percentage of active and total chlorine would be the same.

When bleaching powder is dissolved, however, the term "active" chlorine becomes somewhat of a misnomer, as the active principle then is the oxygen in the calcium hypochlorite. However, as two atoms of chlorine are required to react to place one atom of oxygen in calcium hypochlorite, the results, if this is understood, are expressed correctly either in terms of chlorine or oxygen. The same is true when chlorine is absorbed in alkaline solutions or in milk of lime. If conditions as to temperature and distribution of gas are properly maintained, all of the chlorine absorbed will be indicated by analyses to be "active," although only one-half of it will be present in the hypochlorite formed. For instance, consider the reactions



$$2NaOH + Cl_2 = NaClO + NaCl + H_2O$$



$$2Ca(OH)_2 + 2Cl_2 = Ca(ClO)_2 + CaCl_2 + H_2O$$

Thus a pound of chlorine gas is equivalent to a pound of active chlorine in bleaching powder.

If some of the chlorine present in the form of chloride, according to these reactions, can be removed from the solution, then it is possible to get an analytical result showing a higher percentage of "active" chlorine than the percentage of total chlorine present. This is possible because the oxidizing power of the solution is really what is determined, although it is expressed in terms of chlorine. This condition can be demonstrated by passing chlorine slowly into strong, well-cooled caustic soda solution of say 40 per cent strength, and filtering off the salt crystals that form.

These statements are offered with the hope that they may be of assistance to some, as the following opinions have been encountered a number of times: First, that when chlorine is absorbed in an alkaline solution, only one-half of it can be "active," because the other half forms chlorides; second, that since, in a properly prepared solution made from chlorine and an alkali, the percentages of active and total chlorine as determined are equal, while only one-half of the chlorine is present in the hypochlorite formed, an efficiency of 200 per cent is attained in some unexplained manner.

A careful study of the valences involved will indicate the fallacy of both of these views.

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Process and Equipment for Refining Benzene Hydrocarbons

A Detailed Discussion of Benzene Washer Construction—Materials of Construction: Cast Iron, Wrought Iron, Riveted and Welded, Sectional Plates, and Lead—Design of Body—Types of Agitators

By A. THAU*

NEARLY all modern benzene works are now arranged so as to be able to supply pure or washed products complying with the trade specifications, and in the design of the benzene plants such perfection has been reached during recent years that the consumers are content to buy the finished products instead of taking the crudes and purifying them at their own plants.

The purifying of the benzene products is, with suitable plant and properly trained men in charge, not a difficult task; but the most troublesome piece of apparatus in a benzene plant is undoubtedly the washer, in which the products are brought into intimate contact with different washing mediums, the effect of which is to take up and remove certain impurities from the benzene hydrocarbons which would otherwise impair their purity.

Washing Light Oil Direct

The crude benzene hydrocarbons are transferred into the washer, consisting of a vertical cylindrical vessel which they fill to only such a height that ample room remains for the addition of the respective washing mediums. When the benzene industry was comparatively young, the crude benzene or light oil distilled off the wash oil in the first stage, having a strength of 55 to 65 per cent, was accumulated and treated directly in the washer. There are a number of plants at work yet practicing this old wasteful method, which causes a great loss of both benzene and washing acid. In all modern plants the light oil is redistilled and divided into two or more fractions. A comparatively great amount of residue is recovered at the same time, consisting mainly of wash oil and naphthalene, which, though not of great value in itself, facilitates the washing process considerably by its absence and is responsible for great economy by reduced acid consumption and benzene losses compared with the first-mentioned method.

Intermittent Redistilling

The recently built, large benzene plants can, according to their working methods, be divided into two classes. In the one, forming the majority, the light oil is transferred into a retort still having the form of a large horizontal boiler, carrying in place of the dome a high fractionating column. The light oil is distilled and the products fractionated according to their boiling point, conducted to different collecting tanks and each fraction is washed and finally redistilled separately as soon as a sufficient quantity of the respective product has been accumulated. The light oil is by this method redistilled in an intermittent process, after the conclusion of which the residue, consisting of wash oil with naphthalene in solution, is transferred to a crystallizing pan, in which the naphthalene settles and the wash oil can be decanted off.

Continuous Redistilling

The above-mentioned second method in redistilling light oil owes its existence to the efforts to make the whole benzene plant a continuously working process. These efforts have so far been crowned with success that it has been possible to make the whole distilling of the crude products continuously working—that is, up to the point where they must be subjected to washing. In the continuous redistilling of the light oil by this method, two fractions are obtained, a larger one consisting of 90 per cent benzene and a smaller one consisting of those hydrocarbons which have a higher boiling point than benzene. The residue runs off continuously in a thin stream conducted into a crystallizing pan.

Continuous Fractionating

Although it is not intended to go fully into detail in this article as to the comparative merits of these two methods, it may appear to be disadvantageous to obtain only two fractions, making a further fractionating during the final distillation compulsory. Some benzene plant constructors claim to be able to provide continuous working stills yielding any desired number of fractions, but even at its best, these fractions are so roughly separated that a further close fractionating will be necessary during the final distilling. A splitting up in more than two fractions makes a continuous working still rather complicated and requires very close attention in maintaining certain temperatures.

Two Fractions While Redistilling

From a practical point of view, especially in consideration of the washing process, dividing into more than two fractions is not an advantage, particularly as even with a very close fractionating of the crude products in the intermittent process a further, though slight, fractionating during the finishing distillation cannot altogether be avoided. The division of the crude products into two fractions simplifies the plant in that only two store tanks for the intermediate products are required, while such a plant is at a disadvantage in being unable to allow the sale of crude toluene, xylene, solvent naphtha, heavy benzene, etc. The demand of those products in the crude state is, however, limited.

Methods of Washing Different Fractions

Thus, in washing crude benzene hydrocarbons, there are, depending upon the arrangement of the plant, three different possibilities: 1, The light oil is washed

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without redistilling. 2. The light oil is redistilled intermittently and split up in a number of distinct fractions which differ from the finished products only in that they contain chemical and mechanical impurities. 3. The light oil is, in continuous working stills, redistilled and separated in two fractions—viz., 90 per cent benzene, and hydrocarbons with a higher boiling point than benzene. Of course by the arrangement of the plant according to the second method it is also possible to divide the products into two fractions as in the third method, although this is rarely done.

As already mentioned, the first of these methods, though still practiced in a few old plants, is antiquated and too wasteful to be worthy of further consideration in this connection.

Washing Particular Fractions

In a plant using method 2 or 3 there is the 90 per cent benzene to be treated by itself in the washer. The specific gravity of the crude benzene is about 0.88, that of the respective washing medium—viz., sulphuric acid, water and alkaline lye -1.8, 1.0 and 1.15 respectively. It is thus evident that a considerable difference exists between the specific gravity of benzene and the respective washing medium with which it is treated, and as in the washing of benzene not much heat is developed, the two fluids do not mix readily, but separate easily. The same remarks apply to the next fraction--viz., toluene – though the temperature when mixing the acid with the toluene is raised somewhat higher than in the case of benzene. Coming to the last separately obtained crude fraction, the solvent naphtha, such a heat is set up by the reaction of the acid and the lye upon the hydrocarbons that a temperature approaching the boiling point of water is frequently reached. Taking into consideration that, in the case of a liquid, specific gravity means density, it will be quite apparent that an increase of temperature considerably facilitates the mixing of the liquids and jeopardizes their separating after washing. These facts make the treatment of solvent naphtha in the washer difficult and wasteful. Solvent naphtha forms with acid and lye an intimate mixture which can justly be called an emulsion. Once an intimate contact is reached between solvent naphtha and acid or lye, its temperature is raised so much that a settling and draining of the washing medium can be effected only after the lapse of a considerable time, during which the contents of the washer have somewhat cooled down. It must, however, be understood that the difference in specific gravity between solvent naphtha and the respective washing medium is for practical purposes equally as great as in the case of benzene and the washing medium, the only difference being that the washing medium acts quickly upon benzene, generating little reactionary heat, while with solvent naphtha the action is much slower. The temperature, however, is raised to a much higher degree, thereby balancing the former difference in specific gravity (or, better expressed, density) and facilitating the formation of an emulsion which even when cooled down will not dissociate completely. The washing medium drained off the solvent naphtha contains thus always a great proportion of hydrocarbons, and this is mainly responsible for the great losses in treating this faction, which amount to 30-40 per cent at its best, not taking into account the time spent, which, to obtain a fair separating after the washing, may cover even several days.

It will thus be readily understood that method 3, by which only two fractions have to be treated, has its advantages as far as the washing is concerned, while greater attention must be paid to the final distilling to obtain the proper fractions. The care necessary to be taken thereby cannot be called a disadvantage, as it does not entail extra cost for heat or labor and with a little skill the fractions can be separated with equal precision as if they had been fractionated before.

By splitting the light oil in two fractions, benzene and heavy hydrocarbons, while redistilling it, the latter consist approximately two-thirds of toluene and xylene and one-third solvent naphtha and still heavier compounds. Naturally such a compound fraction is more easily and quickly washed than if the solvent naphtha were treated by itself, though I have not been able to get any evidence that the washing losses are proportionately smaller. From the amount of liquid hydrocarbons in both cases, I am inclined to believe that the losses of solvent naphtha are in both washing methods proportionately equal. It is thus apparent that too close fractionating in redistilling the light oil is not an advantage.

Means and Effects of Washing

Without going into detail as to the actions taking place between hydrocarbons and washing medium, it may be said that the acid precipitates the greatest part of the impurities, which coagulate to a tarry consistency while warm, and in the colder state become of a pitchy nature and may even form lumps if not withdrawn quickly. In the heavier hydrocarbons some of the impurities are polymerized and remain in solution. They are recovered as residue in the still after the liquid hydrocarbons are driven off and can be evaporated to any desired consistency by vacuum distillation, forming the slightly transparent cumaron resin.

A certain amount of acid is retained by the hydrocarbons in the washer, which would be detrimental to their further use and injure the apparatus in which they are subjected to final distillation. To neutralize these remains of acid the hydrocarbons are equally intimately mixed with an alkaline lye; caustic soda lye at a density of 1.15 is probably the best. Ordinary washing soda or milk of lime is applied in some plants for the same purpose. Washing soda has the disadvantage of greater bulk. Soda lyes have the advantages over milk of lime that a smaller quantity need be applied in proportion to the effect, that no stirring arrangements are required to keep the alkali in suspension and that the whole method of application is much cleaner and more easily controlled.

As it would be a waste of alkali to neutralize all the acid which remains mechanically mixed with the hydrocarbons, these receive a preliminary washing with water, which removes a great proportion of the acid, and only those particles which are intimately mixed with the hydrocarbons and held in close suspension need be neutralized afterward. By this intermediate washing with water, the consumption of alkali is reduced considerably, no excessive reactionary heat is created and boiling over of the contents in the washer is prevented.

Re-using Sulphuric Acid for Washing

In many, perhaps in most, modern plants provision is made to run the sulphuric acid which may have been used for a second or third washing into a specially provided store tank, from which it can be transferred to

the benzene washer again for further use later on. Appealing as this arrangement may seem from an economic standpoint, it is of little use in practice and if employed is generally the cause of more bother than economy owing to the impurities obstructing the connecting pipes and settling in the collecting tank. As all the acid used for washing benzene hydrocarbons is in any case regenerated and worked up in the manufacture of sulphate of ammonia, it is better not to take any risks as to the possibility of being able to apply the once-used acid a second time.

Arrangement of Washing Apparatus

As will be gathered from the foregoing remarks, the washing apparatus must be of suitable design to induce a very rapid mixing and intimate contact between hydrocarbons and the respective washing medium and also must facilitate an easy settlement and separation of the two fluids afterward.

The position of the washer in the benzene plant must be elevated so that the used acid, decanted off at the bottom outlet, can run by gravity to a regenerating plant and so that the washed hydrocarbons can, also by gravity, be transferred to the finishing still.

Capacity of Washer

The washer body consists of a vertical cylinder, and its capacity must be such as to be in direct proportion to that of the finishing still, or where the latter is much greater the washer capacity may be one-half or one-third that of the finishing still. In all cases the proportion to the capacity must be such that the washer can be emptied completely into the finishing still. As the latter cannot be filled to the top, some free space must be left above the surface of the liquid.

Material of Washer—Cast Iron

The washer is made either of cast or of wrought iron. If of the latter, it must be lead lined. The objection against cast iron is the great weight, making a very strong and substantial substructure necessary to carry the whole apparatus. The difference in weight between a good lead-lined wrought-iron washer and one of bare cast iron of $1\frac{1}{2}$ to 2-in. thickness is, however, not so very large. The rule has been in recent years to employ bare cast iron of about $1\frac{3}{4}$-in. thickness and use it till the effect of the acid makes itself felt by a number of irregular holes eaten in the shell. The washer is then lined with sheet lead of $\frac{1}{2}$ to $\frac{5}{8}$-in. thickness fastened by cutting out pieces corresponding with the holes eaten in the shell. The cut-out pieces are then run full of lead, which fills the holes in the shell and gives the lining a hold in as many places as possible.

Even under most favorable conditions the difference in price between sheet lead and cast iron is so great that the writer has found it more economical to calk holes eaten through the shell with soft lead. After the apparatus gets too highly depreciated it is replaced. In the long run it is cheaper than lead lining it, unless one gets a casting with a number of bad sand holes.

Wrought Iron, Riveted

A fabricated wrought-iron washer must be lead lined, otherwise the acid will dissolve the iron scale around the rivets,* which then become loose and leak almost immediately. To enable the lining to be placed evenly into the shell, the rivets must be countersunk on the inside. Through numerous holes drilled into the shell, lead rivets are driven to which the lining is attached by burning while the rivets are knocked flat on the outside of the shell. As there is a great difference in the expansion coefficient of lead as compared with wrought iron, the iron expanding and contracting with temperature more than lead, the use of lead-lined wrought-iron receptacles cannot be recommended at all in cases where temperature variations are had as in a benzene washer.

Wrought Iron, Welded

If wrought iron is employed as material for the washer shell, only a cylinder with autogenously welded seam should be selected for the purpose and this covered inside homogeneously with a coating of lead about $\frac{1}{2}$ in. thick. Such a washer is preferable, even compared with one of cast iron, but its price is several times higher. While in the case of wrought iron the shell can be made of one single length, there are generally two or three pieces flanged together in a cast-iron washer.

Sectional Plates, Lined

There is a method of constructing washers of wrought- or cast-iron sections with horizontal and vertical flanges. The edges of the corresponding lead sheets are caught between these flanges, which are then bolted together tightly. Such washers last just as long as homogeneously lead-covered ones, if the single sections do not have too large surface dimensions. However, the large number of joints inside the washer give acid and impurities places for lodging and thus make clean washing almost impossible.

Lead Lining

With lead-lined washers, the trouble caused by expansion makes itself felt. The lead sheeting gradually loses its elasticity. If not fastened over an area greater than 12 sq.in., it begins to bulge and warp. Then after a short time it will crack just over the bulges. In exceptionally bad cases the whole lining has dropped to the bottom of the washer because it had not been fastened in a sufficient number of places or over the necessary area. This trouble is avoided with washers built in sections that are flanged and bolted in both directions as well as with homogeneously lead-covered ones, because cast iron does not expand and contract as much as wrought iron. Also, owing to the greater thickness of a cast-iron shell, it is quite obvious that a lead-lined cast-iron washer will last longer than a wrought-iron one.

Top of Washer

The top of the washer ends in a flange to which a lid is bolted, on which in most cases the gear and bearing for the internal stirring arrangement are mounted. The lid is provided with several openings, one in the center through which the shaft of the stirrer is introduced, one manhole with loose removable lid for inspection and several pipe openings for the introduction of the benzene hydrocarbons, acid and alkali respectively.

Shape of Washer

The design of the washer, the shape of its bottom and in particular the stirring arrangements are briefly described by a number of sketches of which Fig. 1 shows the simplest form in use.

*Editor's Note: American practice overcomes this difficulty by fusing the edges of the rivets and calked joints electrothermally. Oxide, to be sure, is included, but the acid is prevented from working under the rivet head.

This washer is built up of three cylindrical flanged sections of cast iron. To the top flange a lid is bolted, which supports on two bracket bearings a horizontal shaft with fast and loose pulley at the end. The driving shaft is geared by a pair of cog wheels at the center of the lid to the vertical stirrer shaft, which is suspended freely from the lid and supported by means of ball bearings. At the bottom end an ordinary propeller is keyed to the shaft so that it will agitate the contents of the washer when revolving. The bottom section of the washer tapers in funnel shape into an outlet branch with flange. The arrangement shown in Fig. 1 of supporting the washer by vertical columns or joints is rather an exception now. To make the bottom connections of the washer as short as possible and easily accessible, modern washers are provided with brackets on the shell which rest on a horizontal girder frame. This may be placed in a corner of the building so that three sides of the frame are supported by the walls of the building and the fourth by a column. The shape of the bottom shown in Fig. 1 has in its steep taper the disadvantage that the heavy solid impurities collect immediately above the bottom outlet. If the drain cock cannot be opened at once for any reason, these tars upon cooling set hard, and great difficulties are then experienced in removing the charge. However, this bottom is of ideal shape for separately drawing off water or lye without loss of benzene hydrocarbons.

FIG 1 SECTIONAL CAST-IRON WASHER

The bottom of the majority of washers is now tapered much less. The practice of having an acid washer from which the benzene is transferred into a second one for washing with water and lye has been abandoned nearly everywhere.

Propeller Agitator

The stirring arrangement is the most vital part of these washers. It is not enough simply to impart motion to the liquids. Owing to their comparatively great difference in density, they dissociate quickly and in order to maintain them in intimate contact, a very effective mixing is necessary. The acid has a tendency to settle on the bottom and the hydrocarbons tend to form a distinct upper layer. The propeller drives the acid upward into the hydrocarbon zone, from which it settles in a finely divided state. Experience has proved that the contents of the washer revolve with the propeller and the mixing is not sufficiently violent. Some improvement has been obtained by mounting in addition a horizontal paddlewheel just above the bottom section, geared by means of cog wheels to the vertical propeller shaft. The paddlewheel breaks up the boundary between the two liquids and acts as a brake to the rotating motion of the liquid in the washer. The disadvantage of such an arrangment is obvious in that the internal arrangement is not sufficiently accessible and cannot be oiled or greased.

Turbine Agitators

A similar washer with wrought-iron cylindrical shell and cast-iron lid and bottom section is shown in Fig. 2. A vertical pipe is rigidly fixed in the center of the lid extending into the washer guiding the agitator shaft, which reaches down as close to the bottom as possible.

The peculiar turbine wheel-like shape of the agitator insures better mixing and the semi-spherical shape of the bottom enables the stirring wheel to be placed very close to the draining outlet. This design, however, has not always proved advantageous. In cases where a large amount of solid impurities has settled out, these impurities cannot be withdrawn entirely without an accompanying amount of hydrocarbons, which, being fluid, have a tendency to force themselves through from above, before the impurities deposited on the sides have had time to reach the outlet. In all other respects the washer resembles the one shown in Fig. 1.

Different Methods of Agitating

It has generally been observed that the tendency of the two liquids in the washer to separate is greater than the effect of any stirring arrangement to mix them. To get a better washing effect with the new type of washers it is not enough simply to stir the liquids but one must be pumped through the other. This is accomplished in one of two ways. The hydrocarbons are pumped from the upper part of the washer and forced through the washing medium layer at the bottom, or the action is reversed and the washing medium is pumped from the bottom and forced into the upper zone through the hydrocarbons. In the former the benzene rises in finely divided drops to the top, in the latter the acid is sprayed through the benzene. In both cases an equally intense washing effect is obtained. As to the respective advantages and disadvantages of these washers, they appear to be about balanced. If the benzene is pumped from above through the acid, the pump rotor must be placed in the bottom and rotate and rest continually in the acid, the corrosive effects of which are soon felt, especially if a guide bearing for the shaft is provided at the bottom. If the bottom cock gets obstructed with congealed impurities, then the impeller wheel gets obstructed by these deposits, which impair the effect so much that it

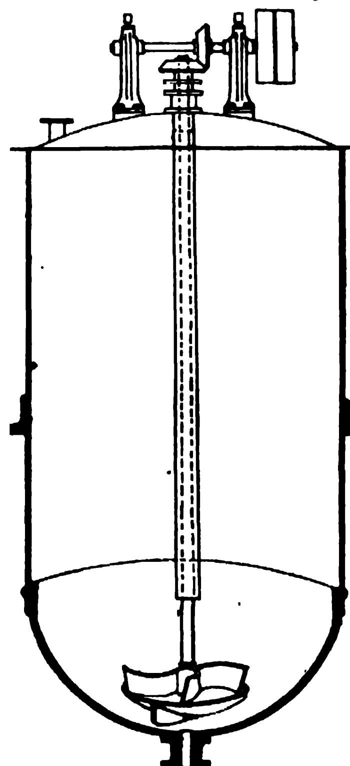


FIG 2 WROUGHT IRON WASHER WITH TURBINE STIRRER

must be cleaned by hand. The advantage of the above type rests with the fact that small charges of hydrocarbons can be treated, as the washer need not necessarily be full.

Free from the above-mentioned disadvantages is the second group of washers, in which the impeller is placed in the upper zone so that it comes in contact only with the acid while rotating. The quantity of hydrocarbons treated each time must always be sufficient to immerse the impeller completely. For plants which treat benzene hydrocarbons in great bulk and always work with full charges, this latter type of washer is to be recommended.

Upward Propelling Agitator

A simple type of washer in which the benzene is forced through the respective washing medium is shown in Fig. 3A. To the agitator shaft there is attached by spokes and brackets an inverted conic frustum, within which there is fastened an Archimedean screw. By revolving the frustum, the washing medium is drawn up by the screw and discharged at the top, where it passes down through the hydrocarbons to be circulated again.

Downward Propelling Agitator

In the type represented in Fig. 3B the action is reversed. Otherwise the arrangement is identical with that shown in Fig. 3A. The conical frustum is narrow at the top and wide at the bottom. The screw inside is arranged so that the hydrocarbons are forced downward through the cylinder and dispersed through the washing medium at the bottom, rising outside of the cylinder to the top, an action which is continuous.

Upward Propelling Agitator

In the washer shown in Fig. 3C the frustum around the Archimedean screw is stationary. It is held by a number of brackets on the washer bottom so that a passageway is formed underneath the cylinder edge. In the deepest part of the tapered bottom section of the washer, just over the draining outlet, a guide bearing is fixed in a star-shaped bracket, guiding the lower end of the vertical shaft. The washing medium is driven up through the middle cylinder by the screw and falls down through the hydrocarbons in the annular space between the inner cylinder and the washer shell. By reversing the drive of the stirrer the action can be reversed.

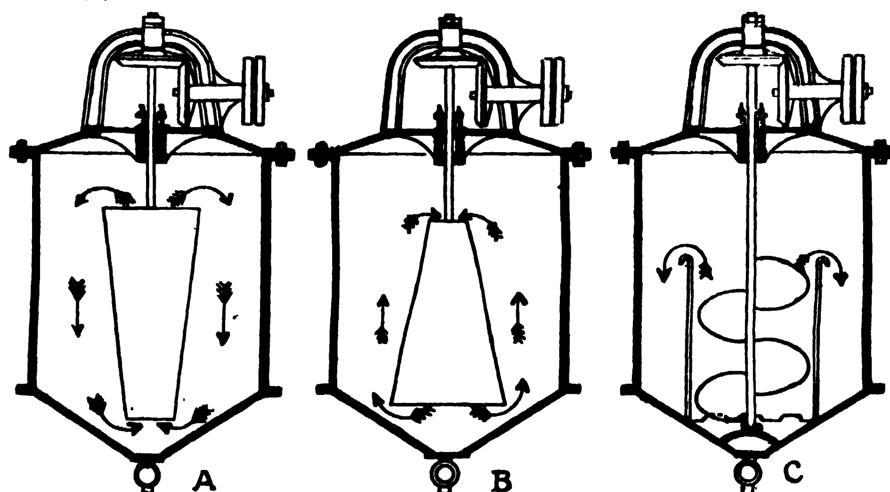


FIG. 3. UPWARD AND DOWNWARD PROPELLING AGITATORS

The design shown in Fig. 3C has been improved to cover the whole diameter of the washer with the stirrer as shown in Fig. 4. The inner cylinder does not extend completely down to the tapered bottom of the washer, but rests on a number of brackets projecting horizontally inside. Under these brackets the star-like impeller, keyed to the suspended vertical shaft, is arranged; its diameter corresponds with that of the washer inside. The blades of the impeller are twisted propeller-like underneath the internal cylinder, and the ends extending outside of this cylinder are shaped like ordinary fan blades. When revolving the shaft, the twisted inner portion of the impeller creates a suction inside the inner cylinder through which the hydrocarbons are forced down, and by leaving the cylinder at the bottom, passing through the washing medium, they are again effectively mixed by being agitated from the fan blades.

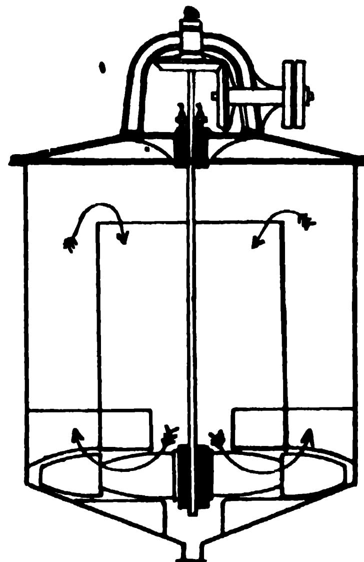


FIG. 4. COMBINED MIXING AND PROPELLING AGITATOR

While in the types shown in Figs. 1 and 2 the contents of the washer are simply agitated, in Figs. 3A, B and C they are mixed by forcing the two zones through each other. In the latest designs of washers efforts have been made to combine both types to obtain the double effect. The first construction of this kind is shown in Fig. 4, where mechanical agitation is provided in addition to pumping.

Turbine Pump in Bottom

In the most modern types of washers a specially constructed turbine impeller has been adopted which not only pumps the liquid upward or downward but also throws it out with centrifugal force divided in very fine streams. Such a washer is shown in Fig. 5 which at the same time gives a good design for the bottom. The impeller has the form of a pipe which broadens out trumpet-like at the bottom and is built similar to a turbine pump with fine openings at its periphery and slots in the upper face. The impeller casting is fastened to the driving shaft by keys going right through the bushes and shaft. The impeller casting is bored out and slides over a pivot protruding through the

washer bottom and fastened tightly by a tapered bolt with nut at the end. The pivot serves as a guide; the shaft with impeller casting does not rest upon it, but is suspended freely and held by a ball bearing placed in a collar in the centre of the washer lid. The hydrocarbons are sucked down through the central tube and with centrifugal force are sprayed out of the openings on the periphery while the surplus is thrown out of the slots on the face, insuring a very effective mixing. The unfavorable effect of the acid upon the pivot is obvious and it need hardly be mentioned that the fine slots in the impeller get easily obstructed, if the impurities are allowed to congeal in the bottom.

Turbine Pump in Upper Part

The best type of washer for the treatment of full charges is represented in Fig. 6. Under the lid of the washer a number of right angle brackets are fastened, holding the vertical suction pipe, which broadens out at the top trumpet-like and reaches down close to the deepest point of the washer. It is fixed rigidly and does not revolve. Over the upper end of the pipe a turbine pump impeller of corresponding diameter to that of the trumpet end of the suction pipe rotates.

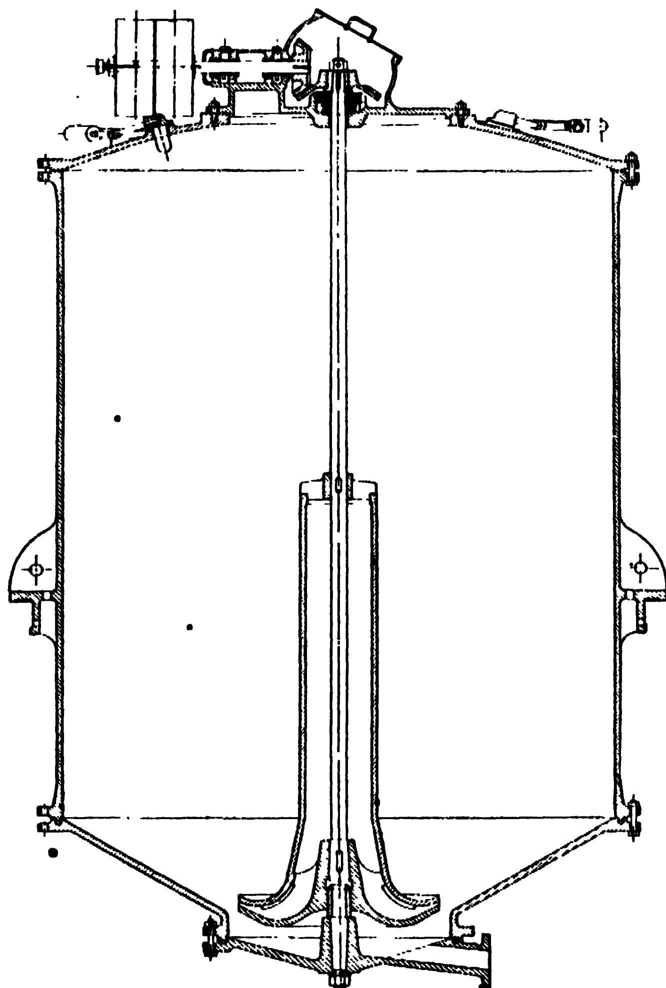


FIG. 5. TURBINE IMPELLER AGITATOR AT BASE

Under the top bearing in the lid of the washer a second bearing is arranged in a projecting bush about half way between washer lid and impeller, serving as a guide to the short impeller shaft. By revolving the impeller the washing medium is drawn up through the fixed pipe and thrown with centrifugal force in a spray through the hydrocarbons.

The advantages of this latter type are too obvious to call for much comment. Owing to the short impeller shaft, it requires less power and does not get out of order easily. No movable parts are immersed in acid and with proper construction of the lid, the internal parts can be made readily accessible without entering the washer. By comparing Figs. 5 and 6 it will be

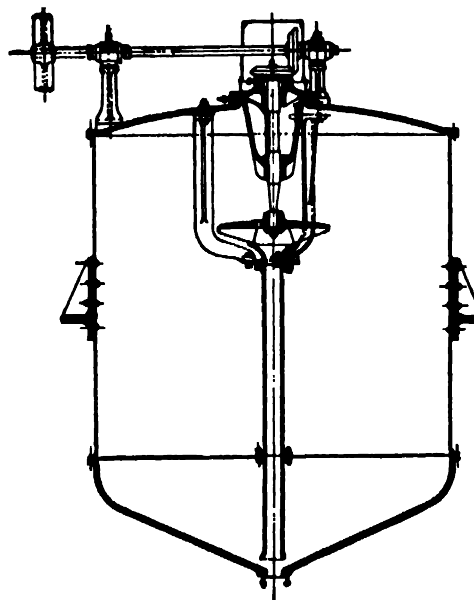


FIG. 6. TURBINE IMPELLER AGITATOR AT TOP

noted that the washer shown in Fig. 6 must be more than three-fourths full to immerse the impeller so as to obtain a washing effect. In Fig. 5 the washer need be only half full to immerse the top end of the impeller suction pipe.

Agitating by Compressed Air

Even at its best the placing of mechanical stirring or pumping devices inside the washer is disadvantageous. To make the interior of the washer accessible and safe for men to enter, it must be boiled out and ventilated a considerable time to insure the absence of poisonous vapors. Efforts have been made to construct washers in which all internal moving parts are obviated. The most obvious arrangement is the proper application of compressed air introduced into the washer in a great number of places. Though good mechanical washing can be obtained by this means, the direct application of compressed air for this purpose is not practicable, since the air gets carburetted and charged with benzene vapors while passing through the liquid. As a supplementary means, in cases of emergency, a compressed air connection to the bottom outlet pipe of the washer is, however, an advantage, should the outlet become obstructed or the internal stirring arrangement get out of order before washing is completed.

Washer Without Agitator

A good suggestion for a washer without internal moving parts is shown in Fig. 7, where a T-piece is provided under the washer outlet. To one end of this T-piece a centrifugal pump is connected by means of a cock or valve, the delivery pipe of which is conducted into the top of the washer and leads into a perforated coil. This coil is led round the periphery of the washer and has cross branches leading spoke-like to the center of the washer. The pump, which must be of

ample capacity, draws the washing medium from the bottom and forces it into the top coil, where by means of the perforations a fine distribution is obtained, while an intimate mixing is effected in the pump itself. To the suction pipe of the pump a water supply is connected for priming, so that the rest of the mixture contained in the pump and pipes can be driven out by water after the washing is completed and the valve in the suction pipe closed. Trials with this arrangement have been very promising as far as efficiency and convenience go; the only difficulty experienced rests with the glands of the pump, which wear out rapidly by coming in contact with acid and alkalis respectively.

Continuous Washers

In the endeavor to make the complete benzene plants continuous from the wash oil entering to the point where the finished products run into the store tanks, continuously working washers had necessarily to be introduced. The designs so far tried have not given promising results. They have had to be discarded and at this stage it would serve no useful purpose to dwell upon their design.

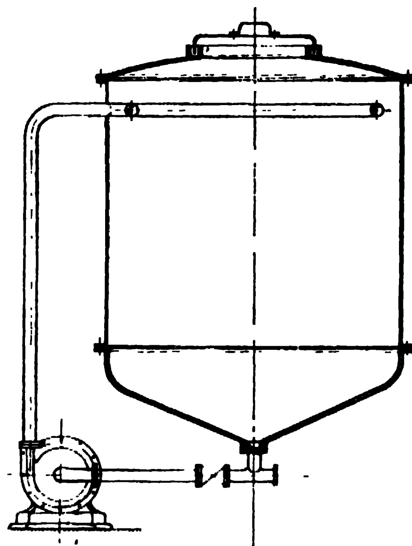


FIG. 7. WASHER WITH CENTRIFUGAL PUMP

Benzene Separator

Under the washer there is generally an open catch box arranged with central partition not reaching quite down to the bottom, and in such a manner that the flow entering from the washer outlet is spread out in a flat stream so as to make the appearance of hydrocarbons visible at once. The catch box must be fitted with easily operated valves or cocks so that its outlets can be closed suddenly to recover any hydrocarbons which may have entered and are retained by the central partition.

French North African Phosphate Deposits

A recent discussion among the French North African phosphate-mining interests has brought out the statement that the total annual production of phosphates in Tunisia, Algeria and Morocco is susceptible of an increase to 5,000,000 tons, of which amount Tunis should produce 2,000,000 tons. The present deficiency, reports Consul Cookingham at Tunis, of output is attributed largely to scarcity of available labor and lack of transportation facilities.

Effect of Ultra-Violet Rays on the Eye*

By Dr. C. R. Kindall†

Recently thirty men were viewing the demonstration of a new portable electric arc-welding outfit. A few hours later seventeen of the thirty men reported to the doctor for treatment. They were suffering from traumatic conjunctivitis. In two cases the pain was very severe and the symptoms were similar to those of iritis. Morphine had to be administered to afford relief from pain. Only two men of the thirty were not affected in some way from this exposure. These two men wore thick-lensed orange-colored glasses. Several of the men wore orange-colored glasses with thin lenses, but the latter were not heavy enough to afford protection against an exposure as long as took place. The distance of the eye from the arc also influences the possibility of injury. Conjunctivitis is an inflammation of the conjunctiva; the conjunctiva is the mucous membrane covering the inside of the eyelids and part of the eyeball. Traumatic conjunctivitis is caused by foreign bodies in the eye, exposure of the eyes to high winds, dust, smoke, intense light from electric arc lamps and from electric-welding apparatus. In the instance mentioned above, the inflammation was due to the ultra-violet rays. The ultra-violet rays lie beyond the violet rays in the spectrum and are invisible to the eye. In some cases the effect is so severe that, in addition to conjunctivitis, an inflammation of the skin similar to sunburn is produced.

The symptoms of conjunctivitis caused by intense light or by the ultra-violet rays are marked photophobia (abnormal intolerance to light), excessive secretion of tears, intense smarting of the lid, contraction of the pupil, sometimes swelling of the lid and small ulcers developing on the eyeball or cornea. Unless properly treated by a physician immediately, chronic inflammation of the conjunctiva, cornea, iris or retina, and possibly blindness, may result.

Under proper treatment most cases get well in a few days. All treatments should be under the direction of a physician. That usually advised is to place ice packs on the patient's eyes three or four times daily. The pack should be left on from fifteen minutes to an hour. The eyes should be irrigated with normal salt solution (a teaspoonful to a quart of sterile water) or a saturated solution of boric acid several times daily. If there is a discharge of pus, a few drops of a 25 per cent solution of argyrol or a 5 per cent solution of protargol should be placed in the eyes three to six times daily. The patient should be confined to a darkened room until his condition improves in order to avoid complications. These treatments will reduce the swelling, give the patient comfort, and prevent the development of chronic conjunctivitis. In severe cases it may be necessary to administer morphine to relieve the pain.

At every plant where electric arc-welding outfits are used there should be an adequate supply of glasses the lenses of which are made up of alternate layers of red and blue glass or orange glasses of sufficient thickness to protect the eyes from the effects of ultra-violet rays. There should also be on hand at the plant dispensary or hospital a supply of boric acid, sterilized water, ordinary table salt, argyrol and protargol for immediate use. As previously mentioned, all cases of traumatic conjunctivitis caused by exposure to bright light or ultra-violet rays should be treated under the direction of a physician.

*From Reports of Investigations, United States Bureau of Mines.
†Surgeon, Bureau of Mines.

The Fundamentals of the Electrolytic Diaphragm Cell*—II

Effect of Washing Diaphragms on Voltage and Current and Decomposition Efficiencies—Removal of Alkaline Earths From Brine—Use of Purified and Crude Brine Liquors†

BY HUGH KELSEA MOORE

THERE has been a great deal said and written about the merits of this cell and that cell, but little has been said about the use and abuse of cells in general or cells of the same type.

It thus happens that the exponent of one make of cell can take data from a plant using his cell running under favorable conditions and compare this with data taken from a plant using his competitor's cell running under unfavorable conditions. Neither of these results gives the buyer the exact truth, though it may help to sell the product inasmuch as the purchaser may be fooled into accepting these statements as representative of what may be expected of different makes of cells, when in most cases differences in the results can be more than accounted for by methods of operation.

Suppose an exponent of one cell goes to a would-be purchaser of some cell and gives A the following line of talk: "Come and visit our plant at Y and look at our records. You will find these cells running in a voltage of 3.4 to 3.6, amperes 1,200, current efficiency 95 to 97 per cent, decomposition efficiency 52 per cent, average power efficiency of 63 per cent, age of diaphragm 280 days, life of carbons 16 to 18 months, etc.

"If you will go to town W you will find an installation of our competitor's cells. You will find this plant running with cells having a voltage ranging from 3.3 to 4.7, or at an average of 4 volts. The current efficiency varies from 97 per cent on some cells to 66 per cent on others. The current varies from 1,200 to 1,800 amp. with a power efficiency varying from 67 per cent to 29 per cent, averaging perhaps 48 per cent. The age of the diaphragm in this plant is eighty-four days and the life of the carbons four months."

With two statements before him like this he would undoubtedly take the cell represented by Plant Y, especially if he knew nothing about electrolytic cells and their operation. And yet he may be very far from the truth. Do you know that the method of operation in two installations of the same cell can and does make greater differences than those stated above? One plant may be able to run its installation with a non-varying current density at the cathode while another plant finds that owing to conditions of varying load on other parts of the line it cannot furnish a constant current. One operator may not see the necessity of purifying his brine, while another may. These conditions alone will make startling differences in the results obtained.

EFFECT OF WASHING ON VOLTAGE

To show this Fig. 7 is submitted with curves *A*, *B* and *C*. *A* is a cell run constantly at 1,200 amp. current, with purified brine and with the diaphragm washed with water for a period of twenty-four hours once every thirty days. *B* is a cell running on purified brine, with amperage varying from 1,200 to 1,900. The varying voltages in this and *C* have been adjusted by means of a correction chart to 1,200 amp. In this case washings were made at the end of sixty-one days, at the end of ninety days and at the end of 113 days. Curve *C* is a case where a cell running on impure brine has been washed at the end of sixty-one days, ninety days and 115 days. Curves *A* and *B* are on cells of purified brine.

In curve *C* unpurified brine was used. In order that

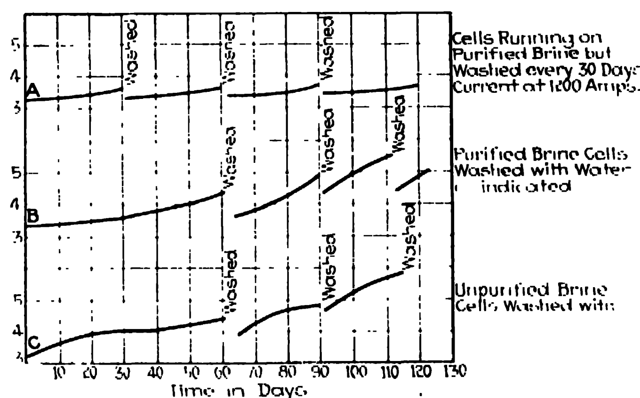


FIG EFFECT OF WASHING ON VOLTAGE

there may be no misunderstanding in relation to the salt and brine, the following compositions are given and in considering curves 7*A*, *B* and *C*, you will consider that the brine does not vary from what is given here.

For example, let us take a salt which analyzes as follows:

	Per Cent		Per Cent
Insoluble matter	0 40	$CaSO_4$	0 70
$CaCl_2$	0 36	NaCl	98.54
$MgCl_2$	Trace		
			100.00

With brine made up 2½ lb. to the gallon we get from the above:

	Grams per Liter		Grams per Liter
Insoluble matter	1 20	$CaSO_4$	2 10
$CaCl_2$	1 08	NaCl	285.62
$MgCl_2$	Trace		- - - -
Total grams other than water per liter			290 00

After adding soda ash to about 1 per cent excess of the requirements, filtering and neutralizing with HCl, we get a solution of the following composition:

	Grams per Liter		Grams per Liter
Insoluble matter	None	$CaSO_4$	Heavy trace
$CaCl_2$	None	Na_2SO_4	2.20
$MgCl_2$	Trace	NaCl	286 76

Now let us see the results of feeding the above-mentioned impure brine to a cell and compare these with the results obtained from the purified brine.

It will be observed that in *C* the voltage rises to 3.6 at the end of ten days, while in *A* and *B* the voltage

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.
†For Part 1 see CHEM. & MET. ENG., vol. 23, No. 21, Nov. 24, 1920, p. 1011.

does not rise to 3.6 until thirty days. If now the cells running on purified brine are washed at the end of thirty days for twenty-four hours, with water, it will be found upon starting up the voltage will have dropped to somewhere between 3.3 and 3.4. In the case before you the voltage upon starting up was 3.3. If the cell is again washed at the end of another thirty days or less we will have a similar drop, though slightly less.

Variation of Voltage With Use

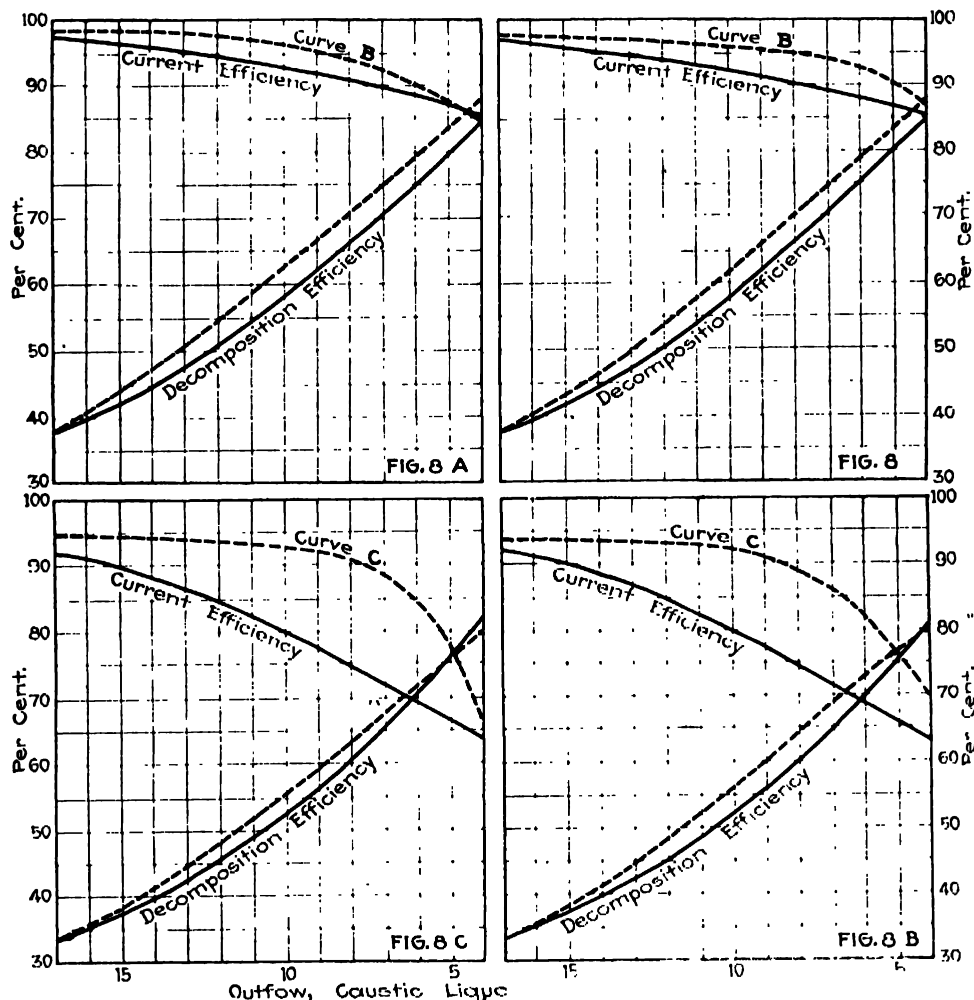
Curves *B* and *C* may be misleading unless certain explanations are made. It will be noticed that after thirty days the voltage goes up at a faster rate than at the beginning of this period. This is due to some extent to the accumulation of impurities during the thirty-day period, but in the main this is due to the great increase in impurities in the diaphragm due to excessive amperage. During this time the amperage was uniformly higher than 1,200 amp., going at times to nearly 2,000 amp. Consequently more brine had to be fed to the cells in a given time, with the consequent increase of impurities in the diaphragm. While the voltage has been corrected for excessive amperage, it has not been corrected for these accumulated impurities. Compare curve *C*, which represents a cell running under the same conditions as that in curve *B* with the exception that the brine is not purified. It will be noticed that the curve rises very rapidly at the start but flattens out as the age increases. This is due to the fact that with more impurities in the brine the plugging of the diaphragm was greater and the liquor in the cell rising to its limit automatically checked the inflow of liquor coming in through the float valve. Now cells represented by curve *C* started in at an initial flow of 21.00 c.c. per amp.-hr. (1,200 amp., 26.5 sq.ft. of diaphragm), and at the end of ten days the flow in spite of the increasing static head had been reduced to 7 c.c. per amp.-hr., or only one-third as much as at first. A flow of about 9 c.c. per amp.-hr. is good practice. The cell represented by *C* has had its diaphragm plugged so rapidly that the diaphragm should have been washed at the end of ten days and this washing would not have been entirely satisfactory.

Now cells represented by curves *A* and *B* start in with an initial rate of flow of 30 c.c. per amp.-hr. and at the end of ten days, without any raise of static head, drop to a rate of 15 c.c. per amp.-hr. From the above you would naturally expect a flat voltage curve on curve *B*, as there are few impurities and the flow is so rapid that one would expect that they would lodge only to a small extent in the diaphragm. You would also expect a rapidly rising voltage curve on curve *C*, as we have here all the impurities and the flow is so reduced that they must lodge in the diaphragm.

Diaphragms Improve With Use After Washing

I wish to bring out another fact oftentimes not appreciated, and that is that washing the diaphragm not only saves the cost of a new diaphragm together with the labor needed to change the same but the washed diaphragm is actually a better diaphragm than a new diaphragm. In order to show this I submit Fig 8, corresponding with curve *B* of Fig. 7, showing the effect the washing has on the current efficiency. The ordinates are current efficiencies, and decomposition efficiencies and the abscissæ are c.c. of flow per amp.-hr. The heavy black line shows efficiencies in terms of the rate of flow in c.c. per amp.-hr. on a diaphragm which has not been washed out. The dotted line shows the change in current efficiency on same diaphragm after washing with water. It will be noticed that the current efficiency and decomposition efficiency are raised for the same rate of flow in both cases.

If you refer to Fig. 8A, representing curve *B*, Fig. 7, you will see the effect of the second washing. The heavy black line represents the same facts as in Fig. 8. Similarly Fig. 8B and Fig. 8C, corresponding to curve *C*, show that both the current efficiency and decomposition efficiency are raised for the same rate of flow for both efficiencies by washing with water. I have



FIGS. 8, 8A, 8B AND 8C. CURRENT AND DECOMPOSITION EFFICIENCIES. DASHED LINES AFTER FIRST WATER WASH AND SOLID LINES BEFORE WATER WASH

many such charts of cells run under many different conditions and find that practically all show this characteristic. In order that the information contained in the above may be available to users of cells having varying diaphragm areas I will state that these areas of diaphragm in the above cases were 26.5 sq.ft. each. I should like to give more time to this subject, but must drop it at this point in order to take up other subjects.

TABLE VII

Electrolytic Plant of Dill & Collins, July 19, 1919. Current amperes, 1,200

Cell No.	Days Run	Voltage	Percent Current Eff.	Liters per Hr.	Cell No.	Days Run	Voltage	Percent Current Eff.	Liters per Hr.
1	151	3.50	102.2	17.6	32	169	3.70	a	a
2	195	3.50	96.3	15.4	33	157	3.60	a	a
3	125	3.50	95.5	15.6	34	172	3.65	a	a
4	201	3.50	91.2	13.0	35	170	3.55	a	a
5	171	3.55	100.6	18.6	36	199	3.50	91.4	18.6
6	168	3.50	102.6	17.0	37	163	3.50	91.4	18.6
7	145	3.60	93.0	14.4	38	120	3.50	a	a
8	201	3.50	94.8	13.6	39	174	3.50	89.4	18.6
9	146	3.50	101.3	18.0	40	146	3.60	90.0	16.4
10	104	3.66	104.6	15.0	41	184	3.60	94.1	14.8
11	201	3.60	94.4	17.6	42	168	3.55	95.5	17.8
12	168	3.50	96.2	17.8	43	168	3.60	99.0	16.1
13	49	3.50	95.2	14.6	44	168	3.50	94.2	17.0
14	117	3.60	98.8	17.0	45	140	3.50	92.3	17.2
15	191	3.55	96.8	17.2	46	196	3.60	86.7	15.0
16	192	3.65	91.5	16.0	47	143	3.60	93.6	17.0
17	156	3.50	106.6	15.6	48	219	3.55	100.4	18.8
18	146	3.60	94.1	17.4	49	196	3.60	116.8	19.8
19	168	3.50	98.3	16.0	50	191	3.50	95.2	17.6
20	109	3.55	97.6	14.8	51	177	3.55	94.8	14.6
21	141	3.50	91.5	15.4	52	173	3.65	96.7	15.4
22	192	3.50	96.4	17.4	53	191	3.65	90.5	16.2
23	119	3.60	95.9	15.6	54	174	3.55	93.8	17.8
24	154	3.60	95.2	14.8	55	227	3.50	94.8	15.6
25	196	3.60	92.0	16.6	56	248	3.55	92.0	12.4
26	199	3.60	95.2	15.2	57	97	3.55	90.7	17.0
27	173	3.60	97.8	19.2	58	186	a	a	a
28	166	3.55	a	a	59	94	3.60	93.4	16.2
29	170	3.45	a	a	60	191	3.50	96.1	12.8
30	173	3.55	a	a	61	177	3.55	87.8	14.4
31	171	3.65	a	a	62	120	3.60	93.4	16.2

a Cells had been shut down to wash and had just started up, so efficiencies had not been taken.

Average run in days, 165. Average voltage, 3.55. Average current eff., 95.6. Average liters per hr., 16.3. Current held at 1,212 amp. Decomposition efficiency held as close to 50 per cent as possible.

I cannot, however, let the matter drop without giving at least one illustration as to how curve *A* may be carried out in practice. I submit Table VII, taken from Dill & Collins' plant, July 19, 1919.

Average Data Necessary

It will be noticed that no cell had been changed for forty-nine days, while the oldest cell was 248 days. It will be noticed that certain cells show an efficiency of over 100 per cent. These are errors which may occur in various ways. The low efficiencies may also be errors. The average efficiency is undoubtedly correct. I shall discuss later some of the factors contributing to calculations of current efficiency in an electrolytic cell, but right here I wish to mention a factor which will show why even though the high and low figures may be wrong, the average of the total may be correct. In testing for the current efficiency of a cell the amount of caustic liquor which runs off in a given period of time is tested for caustic soda and the current efficiency is calculated from the above and the number of amperes passing through at the time. Now if due to evaporation there is an accumulation of salt in the outlet pipe, we would have a slight damming up of caustic in the cathode chamber and we would be getting a less amount of caustic liquor than actually flowed through the diaphragm and consequently the current efficiency for such cells would show lower than the actual. If, on the other hand, the salt which had partially obstructed the flow of caustic liquor should dissolve out while the test is being taken, the flow from the cell would be greater than the flow through the diaphragm and consequently the current efficiencies for such cells would show higher than they actually are. The caustic solution is always unsaturated as regards both caustic and salt so that the obstructions are bound to dissolve out. Of course the longer the test the less will be the effect of such disturbances. Of course if long tests are taken the efficiencies of all the cells cannot be taken at one time. So the short cell test has a certain advantage, even though there may in a few cases be a small inaccuracy. On a large number of cells it has been found that the increasing flow in some cells compensates for the decreasing flow in other cells, so that the average efficiency for all the cells checks with the efficiency of the plant. Consequently, with this explanation it is better to submit all the figures as taken than to take the risk of rejecting the high and low figures.

The decomposition efficiencies are not tabulated, but each cell is run as close to 50 per cent decomposition efficiency as factory operation will allow. This table is not a selected table, but one which was taken on the date when two of my representatives happened to visit the plant. This is especially instructive in showing how systematic washing of cells combined with efficient management can keep cells from deteriorating. Dill & Collins' plant will show results comparable to the above any day in the year. I have been informed that the carbons in this plant last sixteen to eighteen months.

Compare the life of the carbons in a plant run as above with the life of carbons in a cell using impure brine as in curve *C* in Fig. 7. In this case the carbons other than the spacing blocks were used up in less than 120 days. In cells represented by curve *B* the carbons were whole and good for a much longer time.

From the above it will be seen that proper care of an electrolytic cell is as important a factor as the proper care of an engine. Perhaps I can bring this more forcibly to your attention if I give some comparative figures of costs.

TABLE VIII. COST PER TON SALT, DECOMPOSED

	Curve A	Curve B	Curve C
Carbons......	$1 03	$2 11	$4 34
Asbestos.......	0 38	0 58	0 72
Power..........	9 46	11 85	15 61
Total.	$10 87	$14 54	$20 67

Assuming carbons at 22c. per lb., asbestos paper at $1 per lb., 1 hp.-yr. (24 hr. a day) $40, we find that the costs for these three items alone come to the figures shown in Table VIII.

(Part III will appear in a subsequent issue.)

Lizard-Skin Industry in India

The lizard-skin industry forms a new branch in the hides and skins trade in India, states Consul Foss, of Calcutta. There are being manufactured from these skins, in various shades, ladies' and children's shoes, purses and handbags and other articles which are now being made from calfskin and kid, and the wear has proved to be as good as articles made from glacé kid. The skins, averaging 2 sq.ft., are collected from the jungles of Orissa and manufactured in the tanneries at Cuttack. Prices for the prepared skins are 32c. each and the shoes manufactured from them are being made to order at $4 per pair.

Temperature Conversion Tables

By Albert Sauveur

—459.4 to 0

C.		F.
—273	**—459.4**	
—268	**—450**	
—262	**—440**	
—257	**—430**	
—251	**—420**	
—246	**—410**	
—240	**—400**	
—234	**—390**	
—229	**—380**	
—223	**—370**	
—218	**—360**	
—212	**—350**	
—207	**—340**	
—201	**—330**	
—196	**—320**	
—190	**—310**	
—184	**—300**	
—179	**—290**	
—173	**—280**	
—169	**—273**	—459.4
—168	**—270**	—454
—162	**—260**	—436
—157	**—250**	—418
—151	**—240**	—400
—146	**—230**	—382
—140	**—220**	—364
—134	**—210**	—346
—129	**—200**	—328
—123	**—190**	—310
—118	**—180**	—292
—112	**—170**	—274
—107	**—160**	—256
—101	**—150**	—238
— 95.6	**—140**	—220
— 90.0	**—130**	—202
— 84.4	**—120**	—184
— 78.9	**—110**	—166
— 73.3	**—100**	—148
— 67.8	**— 90**	—130
— 62.2	**— 80**	—112
— 56.7	**— 70**	— 94
— 51.1	**— 60**	— 76
— 45.6	**— 50**	— 58
— 40.0	**— 40**	— 40
— 34.4	**— 30**	— 22
— 28.9	**— 20**	— 4
— 23.3	**— 10**	14
— 17.8	**0**	32

0 to 100

C.		F.	C.		F.
—17.8	**0**	32	10.0	**50**	122.0
—17.2	**1**	33.8	10.6	**51**	123.8
—16.7	**2**	35.6	11.1	**52**	125.6
—16.1	**3**	37.4	11.7	**53**	127.4
—15.6	**4**	39.2	12.2	**54**	129.2
—15.0	**5**	41.0	12.8	**55**	131.0
—14.4	**6**	42.8	13.3	**56**	132.8
—13.9	**7**	44.6	13.9	**57**	134.6
—13.3	**8**	46.4	14.4	**58**	136.4
—12.8	**9**	48.2	15.0	**59**	138.2
—12.2	**10**	50.0	15.6	**60**	140.0
—11.7	**11**	51.8	16.1	**61**	141.8
—11.1	**12**	53.6	16.7	**62**	143.6
—10.6	**13**	55.4	17.2	**63**	145.4
—10.0	**14**	57.2	17.8	**64**	147.2
— 9.44	**15**	59.0	18.3	**65**	149.0
— 8.89	**16**	61.8	18.9	**66**	150.8
— 8.33	**17**	63.6	19.4	**67**	152.6
— 7.78	**18**	65.4	20.0	**68**	154.4
— 7.22	**19**	67.2	20.6	**69**	156.2
— 6.67	**20**	68.0	21.1	**70**	158.0
— 6.11	**21**	69.8	21.7	**71**	159.8
— 5.56	**22**	71.6	22.2	**72**	161.6
— 5.00	**23**	73.4	22.8	**73**	163.4
— 4.44	**24**	75.2	23.3	**74**	165.2
— 3.89	**25**	77.0	23.9	**75**	167.0
— 3.33	**26**	78.8	24.4	**76**	168.8
— 2.78	**27**	80.6	25.0	**77**	170.6
— 2.22	**28**	82.4	25.6	**78**	172.4
— 1.67	**29**	84.2	26.1	**79**	174.2
— 1.11	**30**	86.0	26.7	**80**	176.0
— 0.56	**31**	87.8	27.2	**81**	177.8
0	**32**	89.6	27.8	**82**	179.6
0.56	**33**	91.4	28.3	**83**	181.4
1.11	**34**	93.2	28.9	**84**	183.2
1.67	**35**	95.0	29.4	**85**	185.0
2.22	**36**	96.8	30.0	**86**	186.8
2.78	**37**	98.6	30.6	**87**	188.6
3.33	**38**	100.4	31.1	**88**	190.4
3.89	**39**	102.2	31.7	**89**	192.2
4.44	**40**	104.0	32.2	**90**	194.0
5.00	**41**	105.8	32.8	**91**	195.8
5.56	**42**	107.6	33.3	**92**	197.6
6.11	**43**	109.4	33.9	**93**	199.4
6.67	**44**	111.2	34.4	**94**	201.2
7.22	**45**	113.0	35.0	**95**	203.0
7.78	**46**	114.8	35.6	**96**	204.8
8.33	**47**	116.6	36.1	**97**	206.6
8.89	**48**	118.4	36.7	**98**	208.4
9.44	**49**	120.2	37.2	**99**	210.2
			37.8	**100**	212.0

100 to 1000

C.		F.	C.		F.
38	**100**	212	260	**500**	932
43	**110**	230	266	**510**	950
49	**120**	248	271	**520**	968
54	**130**	266	277	**530**	986
60	**140**	284	282	**540**	1004
66	**150**	302	288	**550**	1022
71	**160**	320	293	**560**	1040
77	**170**	338	299	**570**	1058
82	**180**	356	304	**580**	1076
88	**190**	374	310	**590**	1094
93	**200**	392	316	**600**	1112
99	**210**	410	321	**610**	1130
100	**212**	413	327	**620**	1148
104	**220**	428	332	**630**	1166
110	**230**	446	338	**640**	1184
116	**240**	464	343	**650**	1202
121	**250**	482	349	**660**	1220
127	**260**	500	354	**670**	1238
132	**270**	518	360	**680**	1256
138	**280**	536	366	**690**	1274
143	**290**	554	371	**700**	1292
149	**300**	572	377	**710**	1310
154	**310**	590	382	**720**	1328
160	**320**	608	388	**730**	1346
166	**330**	626	393	**740**	1364
171	**340**	644	399	**750**	1382
177	**350**	662	404	**760**	1400
182	**360**	680	410	**770**	1418
188	**370**	698	416	**780**	1436
193	**380**	716	421	**790**	1454
199	**390**	734	427	**800**	1472
204	**400**	752	432	**810**	1490
210	**410**	770	438	**820**	1508
216	**420**	788	443	**830**	1526
221	**430**	806	449	**840**	1544
227	**440**	824	454	**850**	1562
232	**450**	842	460	**860**	1580
238	**460**	860	466	**870**	1598
243	**470**	878	471	**880**	1616
249	**480**	896	477	**890**	1634
254	**490**	914	482	**900**	1652
			488	**910**	1670
			493	**920**	1688
			499	**930**	1706
			504	**940**	1724
			510	**950**	1742
			516	**960**	1760
			521	**970**	1778
			527	**980**	1796
			532	**990**	1814
			538	**1000**	1832

1000 to 2000

C.		F.	C.		F.
538	**1000**	1832	816	**1500**	2732
543	**1010**	1850	821	**1510**	2750
549	**1020**	1868	827	**1520**	2768
554	**1030**	1886	832	**1530**	2786
560	**1040**	1904	838	**1540**	2804
566	**1050**	1922	843	**1550**	2822
571	**1060**	1940	849	**1560**	2840
577	**1070**	1958	854	**1570**	2858
582	**1080**	1976	860	**1580**	2876
588	**1090**	1994	866	**1590**	2894
593	**1100**	2012	871	**1600**	2912
599	**1110**	2030	877	**1610**	2930
604	**1120**	2048	882	**1620**	2948
610	**1130**	2066	888	**1630**	2966
616	**1140**	2084	893	**1640**	2984
621	**1150**	2102	899	**1650**	3002
627	**1160**	2120	904	**1660**	3020
632	**1170**	2138	910	**1670**	3038
638	**1180**	2156	916	**1680**	3056
643	**1190**	2174	921	**1690**	3074
649	**1200**	2192	927	**1700**	3092
654	**1210**	2210	932	**1710**	3110
660	**1220**	2228	938	**1720**	3128
666	**1230**	2246	943	**1730**	3146
671	**1240**	2264	949	**1740**	3164
677	**1250**	2282	954	**1750**	3182
682	**1260**	2300	960	**1760**	3200
688	**1270**	2318	966	**1770**	3218
693	**1280**	2336	971	**1780**	3236
699	**1290**	2354	977	**1790**	3254
704	**1300**	2372	982	**1800**	3272
710	**1310**	2390	988	**1810**	3290
716	**1320**	2408	993	**1820**	3308
721	**1330**	2426	999	**1830**	3326
727	**1340**	2444	1004	**1840**	3344
732	**1350**	2462	1010	**1850**	3362
738	**1360**	2480	1016	**1860**	3380
743	**1370**	2498	1021	**1870**	3398
749	**1380**	2516	1027	**1880**	3416
754	**1390**	2534	1032	**1890**	3434
760	**1400**	2552	1038	**1900**	3452
766	**1410**	2570	1043	**1910**	3470
771	**1420**	2588	1049	**1920**	3488
777	**1430**	2606	1054	**1930**	3506
782	**1440**	2624	1060	**1940**	3524
788	**1450**	2642	1066	**1950**	3542
793	**1460**	2660	1071	**1960**	3560
799	**1470**	2678	1077	**1970**	3578
804	**1480**	2696	1052	**1980**	3596
810	**1490**	2714	1088	**1990**	3614
			1093	**2000**	3632

2000 to 3000

C.		F.	C.		F.
1093	**2000**	3632	1371	**2500**	4532
1099	**2010**	3650	1377	**2510**	4550
1104	**2020**	3668	1382	**2520**	4568
1110	**2030**	3686	1388	**2530**	4586
1116	**2040**	3704	1393	**2540**	4604
1121	**2050**	3722	1399	**2550**	4622
1127	**2060**	3740	1404	**2560**	4640
1132	**2070**	3758	1410	**2570**	4658
1138	**2080**	3776	1416	**2580**	4676
1143	**2090**	3794	1421	**2590**	4694
1149	**2100**	3812	1427	**2600**	4712
1154	**2110**	3830	1432	**2610**	4730
1160	**2120**	3848	1438	**2620**	4748
1166	**2130**	3866	1443	**2630**	4766
1171	**2140**	3884	1449	**2640**	4784
1177	**2150**	3902	1454	**2650**	4802
1182	**2160**	3920	1460	**2660**	4820
1188	**2170**	3938	1466	**2670**	4838
1193	**2180**	3956	1471	**2680**	4856
1199	**2190**	3974	1477	**2690**	4874
1204	**2200**	3992	1482	**2700**	4892
1210	**2210**	4010	1488	**2710**	4910
1216	**2220**	4028	1493	**2720**	4928
1221	**2230**	4046	1499	**2730**	4946
1227	**2240**	4064	1504	**2740**	4964
1232	**2250**	4082	1510	**2750**	4982
1238	**2260**	4100	1516	**2760**	5000
1243	**2270**	4118	1521	**2770**	5018
1249	**2280**	4136	1527	**2780**	5036
1254	**2290**	4154	1532	**2790**	5054
1260	**2300**	4172	1538	**2800**	5072
1266	**2310**	4190	1543	**2810**	5090
1271	**2320**	4208	1549	**2820**	5108
1277	**2330**	4226	1554	**2830**	5126
1282	**2340**	4244	1560	**2840**	5144
1288	**2350**	4262	1566	**2850**	5162
1293	**2360**	4280	1571	**2860**	5180
1299	**2370**	4298	1577	**2870**	5198
1304	**2380**	4316	1582	**2880**	5216
1310	**2390**	4334	1588	**2890**	5234
1316	**2400**	4352	1593	**2900**	5252
1321	**2410**	4370	1599	**2910**	5270
1327	**2420**	4388	1604	**2920**	5288
1332	**2430**	4406	1610	**2930**	5306
1338	**2440**	4424	1616	**2940**	5324
1343	**2450**	4442	1621	**2950**	5342
1349	**2460**	4460	1627	**2960**	5360
1354	**2470**	4478	1632	**2970**	5378
1360	**2480**	4496	1638	**2980**	5396
1366	**2490**	4514	1643	**2990**	5414
			1649	**3000**	5432

NOTE:—The numbers in bold face type refer to the temperature either in degrees Centigrade or Fahrenheit which it is desired to convert into the other scale. If converting from Fahrenheit degrees to Centigrade degrees the equivalent temperature will be found in the left column, while if converting from degrees Centigrade to degrees Fahrenheit, the answer will be found in the column on the right. These tables are a revision of those by Sauveur & Boylston, metallurgical engineers, Cambridge, Mass. Copyright, 1920.

INTERPOLATION FACTORS

C.		F.	C.		F.
0.56	**1**	1.8	3.33	**6**	10.8
1.11	**2**	3.6	3.89	**7**	12.6
1.67	**3**	5.4	4.44	**8**	14.4
2.22	**4**	7.2	5.00	**9**	16.2
2.78	**5**	9.0	5.56	**10**	18.0

Legal Notes

By Wellington Gustin

Option in a Chemical Contract Must Be Exercised Within a Reasonable Time

Finding that the Chatham Manufacturing Co., seller, did not exercise within a reasonable time an option to increase the total amount of acid sold to the Avery Chemical Co., the Supreme Judicial Court of Massachusetts at Suffolk has ruled denying the seller the right to increase the order from 500 to 2,500 bbl. and claim damages for failure of the chemical company to accept the larger quantity.

Under a written contract the chemical company agreed to buy 500 bbl. of pyroligenous acid at 5c. per gal., the amount to be increased at the seller's option to 2,500 bbl., "shipments to begin as soon as possible." This acid was a byproduct from the distillation of soft pine lumber and formerly was a waste product. At the time of making the contract, in January, 1918, it was in demand for the making of iron liquor used in the dyeing and coloring of khaki cloth for the Government. The demand for this ceased later in 1918, and from that time the acid had no market value. The seller's weekly output was about 75 gal., at a cost of ½c. a gal.

None of the acid was shipped to the buyer until August, during which month 125 bbl. was received and paid for. After several letters were passed between the parties, the buyer notified seller to ship no more of the acid, conceded its liability for failure to accept 375 bbl. and damages at 4½c. a gal., amounting to $863.34. The seller attempted to recover damages for the failure to take 2,000 bbl., which, under the option, it claimed the right to deliver. The principal question presented to the court was whether the option, if it should be decided it was exercised by the seller, was exercised within a reasonable time.

No time limit was set for carrying the option into effect. The trial court said that in order to bind the buyer it was essential that the option should have been exercised within a reasonable time, and so the Supreme Court ruled.

What Is a Reasonable Time?

Now where all the facts are shown it is a question of law what was a reasonable time for exercise of the seller's option to increase the quantity deliverable from 500 to 2,500 bbl. of acid. The facts show that the contract was made in January, 1919, and various communications were exchanged concerning delays on the part of the buyer, until the seller wrote the buyer Nov. 23, 1918, saying that it expected the buyer to take 2,500 bbl. of pyro acid.

The court thought the delay in exercising this option was not a reasonable length of time, considering the other circumstances that the contract involved called for a kind of acid useful solely for the dyeing of soldiers' clothing. When that demand ceased the acid contracted for was no longer salable, facts which the seller well knew. The court found that with a production of 75 bbl. weekly the 500 bbl. contracted for would be ready for delivery by April 1. No notice was then given that the seller intended to exercise the option, and there was no such notice until several months later. The court said the option could not remain open indefinitely and the seller knew the war crisis caused execution of the contract. A letter in August was held to extend the time of deliveries and likewise the time for exercising the option. The court here held such extension must be for a reasonable time.

Finding that the notice by the seller that it exercised the option to increase the quantity of acid to be delivered was given after signing of the armistice and cessation of hostilities, when seller knew there was no further demand for its product, the court was convinced that the option was not exercised within a reasonable time. Therefore the seller could not recover on its claim.

Injury to Employee From Fumes in Factory

The Court of Appeals of Georgia has refused to dismiss the amended petition of Ryan, administrator of the estate of Arthur Durant, in his action for personal injuries against the American Agricultural Chemical Co., brought in the Superior Court for Chatham County, Ga.

The amended petition alleged that the chemical company operated a plant for the manufacture of fertilizer and maintained a nitrate tank 8 ft. square, 4 ft. deep and standing 3 ft. above the floor, and that there was another receptacle a few feet from the tank, known as a boot, 18 in. in diameter, 2 ft. deep, the top being flush with the floor, while a lead pipe ran from the bottom of the tank to the boot; that in flushing out the tank an employee was required to hold the nozzle of a hose over the top of a tank, which washed the accumulations in the tank through the pipe into the boot; that vapors and gases arose from the accumulations, which were of a poisonous nature, so that the employee engaged in washing out the tank was required to keep his head to the side of the tank, so as to not inhale the fumes; that Durant, while holding the hose to flush out the tank on orders from his foreman, was subjected to fumes not easily discernible by the sense of smell and his clothing was saturated therewith; that the foreman refused to allow a co-employee to place a sack over the boot to prevent such fumes escaping; that Durant was rendered partly unconscious by the fumes, and while in such condition he wandered to a lower floor of the building and sat down near a mill acid tank, from which dangerous position he was rescued and taken to a hospital in a police ambulance. The petition then alleges that his throat and lungs were seriously affected, to his damage in the sum of $20,000.

The action was originally brought by Arthur Durant, the employee, but upon his death an administrator was appointed. The questions presented to the court were those of diligence and negligence on the part of the employer in preventing the injury and rescuing the employee, coupled with contributory negligence of the employee. These questions, the court said, were matters of fact peculiarly for the jury to determine, and a court will decline to solve them except in plain and indisputable cases.

Citing a controlling decision in another case, it was said that the allegations do not show, as a matter of law, that no other legal conclusions could be reached than that the employee's injuries were the result of his failure to exercise ordinary care, or that by the exercise of such care the consequences of the employer's alleged negligence could have been avoided.

Engineers and Public Service

An Address Before American Engineering Council of the Federated American Engineering Societies Outlining Some of the Public Service Problems to Which the New Organization May Profitably Devote Its Attention

BY HERBERT HOOVER*

THIS federation of engineering societies, embracing the membership of between 50,000 and 100,000 professional engineers, has been created for the sole purpose of public service. This initial meeting surely warrants some discussion of a few of the problems to which this organization, for expression of the engineering mind, can quite well give consideration.

Some of the greatest of the problems before the country and, in fact, before the world are those growing out of our industrial development. The enormous industrial expansion of the last fifty years has lifted the standard of living and comfort beyond any dream of our forefathers. Our economic system under which it has been accomplished has given stimulation to invention, to enterprise, to individual improvement of the highest order, yet it presents a series of human and social difficulties to the solution of which we are groping. The congestion of population is producing subnormal conditions of life. The vast repetitive operations are dulling the human mind. The intermittency of employment due to the bad co-ordination of industry, the great waves of unemployment in the ebb and flow of economic tides, produce infinite wastes and great suffering. Our business enterprises have become so large and complex that the old personal relationship between employer and worker has to a great extent disappeared. The aggregation of great wealth, with its power of economic domination, presents social economic ills which we are constantly struggling to remedy.

NO MAN CAN DRAFT A UNIVERSAL PANACEA

I propose to traverse only a small fraction of these matters. I do not conceive that any man, or body of men, is capable of drafting in advance a plan that will solve these multiple difficulties and preserve the system which makes individual intiative possible. We have presented to us economic social patent medicines of one kind or another and, in fact, the great panacea of socialism is today in actual trial in its various forms. In Russia the attempt has been made to apply the most extreme form of complete communism. The Russian experiment is bankrupt in production. The populations of our modern states have been built up to numbers dependent upon an intensity of production that can be maintained only by stimulation of individual effort through the impulse of self-interest, and a departure from this primary incentive to production has now been demonstrated to lead only to famine and flame and anarchy. We have even had a gigantic experiment imposed upon the United States by the war in the necessity to operate a vast merchant marine at the hands of the Government, with a result that should offer little consolation to those who advocate even the mildest application of socialism.

*President, American Engineering Council.

We have built up our civilization, political, social and economic, on the foundation of individualism. We have found in the course of development of large industry upon this system that individual initiative can be destroyed by allowing the concentration of industry and service, and thus an economic domination of groups over the whole. We have therefore built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our mass of regulation of public utilities and of many other types of industry, aiming chiefly to prevent combinations in restraint of free enterprise, is a monument to our attempts to limit this economic domination to give a square deal. This regulation is itself also proof of the abandonment of the unrestricted capitalism of Adam Smith. While our present system of individualism under controlled capitalism may not be perfect, the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

GROWTH OF VOLUNTARY LOCAL AND NATIONAL ASSOCIATIONS

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose, and are quite apart from the great voluntary groups created solely for public service. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great bankers' associations, great labor associations—all economic groups striving by political agitation, propaganda and other measures to advance group interest. At times they come in sharp conflict with one another, and often enough charge one another with crimes against public interest. And to me one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations toward co-ordination with one another in the solution of national economic problems, or whether they shall grow into groups for more violent conflict. The latter can spell breakdown to our entire national life.

SERVICE SHOULD BE MOTTO OF ENGINEERS

This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service, to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate

experience in industrial life, can be of service in bringing about co-operation among these great economic groups of special interests they will have performed an extraordinary service. The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers or labor, of farmers or merchants or bankers. Their calling in life is to offer expert service in constructive solution of problems to the individuals in any of these groups. There is a wider vision of this expert service in giving the group service of engineers to group problems.

We have just passed through a period of unparalleled speculation, extravagance and waste. We shall now not only reap its inevitable harvest of unemployment and readjustment but we shall feel the real effect of four years of world destruction, and from it economic and social problems will stand out in vivid disputation. One of the greatest conflicts rumbling up in the distance is that between the employer on one side and organized labor on the other. We hear a great deal from extremists on one side about the domination of the employer, and on the other about the domination of organized labor. Probably the tendency to domination exists among the extremists on both sides. One of the most perplexing difficulties in all discussion and action in these problems is to eliminate this same extremist. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through co-operation, the field of common interest could be organized, then the area of conflict could be in the largest degree eliminated.

Labor Organizations Bulwark Against Socialism

In this connection the employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can expand the standard of living only by the steady increase of production and the creation of more goods for division over the same numbers.

The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chambers of Commerce.

Three Chief Wastes of Production

It is primary to mention the three chief wastes in production: First, from intermittent employment; second, from unemployment that arises in shifting of industrial currents, and third, from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive increase in production.

In the elimination of the great waste and misery of intermittent employment and unemployment we need at once co-ordination in economic groups. For example, our engineers have pointed out time and again to the bituminous coal industry where the bad economic functioning of that industry results in an average of but 180 days' employment per annum, where a great measure of solution could be had if a basis of co-operation could be found among the coal operators, the coal miners, the railways and the great consumers. The combined result would be a higher standard of living to the employees, a reduced risk to the operator, a fundamental expansion of economic life by cheaper fuel. With our necessary legislation against combination and the lack of any organizing force to bring about this co-operation the industry is helpless unless we can develop some method of governmental interest, not in governmental ownership but in stimulation of co-operation in better organization.

In help against the misery in the great field of seasonal and other unemployment we indeed need an expansion and better organization of our local and federal labor exchanges. We have a vast amount of industry, seasonal in character, which must shift its labor complement to other industries. The individual worker is helpless to find the contacts necessary to make this shift unless the machinery for this purpose is provided for him.

Collective Bargaining

In the questions of industrial conflict resulting in lockouts and strikes one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining, by which, whenever possible, the parties should settle their difficulties before they start a fight.

It is founded not only on the sense of prevention but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for years by organized labor, was agreed to by the employers' group in the First Industrial Conference. It has been supported in the platforms of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution. The conflict arises almost wholly over the question of representation and questions of enforcement. The employer in some industries denies the right of men other than his own employees to conduct the negotiations. Labor organizations insist that as such negotiations require skill, experience and bargaining freedom they are of more than local application and that thus only can they protect the body of workers by presenting the case on their behalf by skilled negotiators.

The Second Industrial Conference, of which I was a member, proposed a solution to this point by the provision that where there was a conflict over representation the determination should be left to a third and independent party. It also proposed that each party should have the right to summon skill and experience to its assistance. It further proposed that where one of the parties at dispute refuses to enter upon collective bargaining the entire question should be referred to an independent tribunal for investigation as to the right and wrong of the whole dispute—but only for investi-

gation and report. That conference, embracing both a great employer and a most distinguished representative of organized labor, was completely convinced that the illumination of the public mind as to the rights and wrongs of these contentions would in itself make for material progress in their solution, and that in public education and the condemnation by public opinion of wrong-doing lay the root of real progress. No group should be afraid of authoritative publicity in these matters, and I believe it would greatly advance an understanding of the cause of labor. 'The conference did not believe that industrial contention could be cured by compulsory arbitration or any other form of governmental repression which must in the end use the jails for enforcement. The principles formulated by that conference should have your consideration.

Questions Deserve Careful Study by Engineers

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected, the maximum production of the country should become the dominating purpose. The precise hours of labor should and will vary with the varying conditions of trades and establishments, but the proper determination of hours, based upon these factors, is an immediate field demanding attention of engineers. There is no greater economic fallacy than the doctrine that the decrease of hours below these primary considerations makes for employment of greater numbers, and it is an equal certainty that the 84-hr. week of some employments transgresses these fundamentals to a point of inhumanity.

Graded Added Compensation for Skill

There is a broad question bearing upon stimulation of self-interest and thus increase in production that revolves around the method of wage payment. I need not review to you the advantages, difficulties and weaknesses of bonus, piece work, profit- or saving-sharing plans that are in use as a remedy for the deadening results of the same wage payment to good and bad skill alike. The suggestion I wish to put for your consideration is the possible use of another device in encouragement of individual interest and effort by creating two or three levels of wage in agreements for each trade, the position of each man in such scale to be based upon comparative skill and character. This plan should be developed upon the principle of graded extra compensation for added skill and performance above an agreed basic wage. In order to give confidence the classification under such scales must be passed upon by representatives of the workers in such shop or department. This plan is now being successfully experimented with.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our people we cannot permit the dulling of these sensibilities. Indeed, we cannot accomplish increased production without their stimulation. Here again we cannot make an advance unless we can secure co-operation between the employer and the employee. In large industry this mutuality of interest that existed in small units cannot be restored without definite organization.

Shop Committees

There has been a great increase in shop committees as a method of such organization. Where they have been elected by free and secret ballot among the workers, where they are dominated by a genuine desire on both sides for mutual co-operation in the shop, they have resulted in great good. One of the most important phases of that good has been the tendency to turn the aspect of some foremen from that of slave-driving to leadership. And a great good has been possible by the encouragement of men to creative effort, in the stimulation of their minds as well as their hands to the solution of these problems. It makes for pride of craftsmanship and is a real effort to offer them an opportunity of self-expression. Organized labor has opposed some forms of these committees because of the fear that they may break down trade organization covering the area of many different shops. There is economic reason for this fear in certain cases, deeper than appears upon the surface.

One of the greatest accomplishments of organized labor has been the protection of the workers from the unfair employer, and it is worth the employer's notice that this is at the same time the protection of the fair employer from the unfair competition of the sweatshop. Again, I believe the engineers could assist in the erection of a bridge of co-operation if organized labor, which has already made a beginning, would extend more widely its adoption of the principles of a shop committee settling its problems of wage and conditions of labor in general agreement and applying its energies through shop committee organization to development of production as well as to the correction of incidental grievances. There would be little outcry against the closed shop if it were closed in order to secure unity of purpose in constructive increase of production by offering to the employer the full value of the worker's mind and effort as well as his hands.

Increased Production

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and in the meantime, when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to them that if the community is to benefit

by the cheapening costs, and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes. Nor can this be accomplished except by co-operation between groups. In fact, the whole problem of unemployment needs earnest consideration.

SUMMARY

In summary, the main point that I wish to make is this: that there is a great area of common interest between the employer and the employee through the reduction of the great waste of voluntary and involuntary unemployment and in the increase of production. If we are to secure increased production and an increased standard of living we must keep awake interest in creation, in craftsmanship and the contribution of the workers' intelligence to management. Battle and destruction are a poor solution of these problems. The growing strength of national organizations on both sides should not and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportsmanship and adopts the rules of barbarism. These organizations—if our society is to go forward instead of backward—should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of these questions. If we could secure this co-operation throughout all our economic groups we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative, that stimulates it through protection from domination. We should have given a priceless gift to the Twentieth Century.

I am not one of those who anticipates the solution of these things in a day. Durable human progress has not been founded on long strides. But in your position as a party of the third part to many of these conflicting economic groups, with your lifelong training in quantitative thought, with your sole mental aspect of construction, you, the engineers, should be able to make contribution of those safe steps that make for real progress.

Paper From Veneer Waste*

Raw material suitable for the manufacture of high grades of paper is found in wood wastes from veneer factories. The cores of many kinds of veneer logs, now used in large part for fuel, would make excellent pulpwood. In addition, a large part of the clippings and small veneer waste probably could be turned into pulp stock with profit.

Among the veneer woods whose waste has papermaking possibilities are red gum, yellow poplar, cottonwood, birch, tupelo, basswood and beech. Many veneer factories cutting these species are already within shipping distance of pulp mills: In certain other cases veneer factories are so grouped that they might furnish pulpwood enough to warrant the erection of a centrally-located mill. Other economic factors being favorable, such a mill could profitably operate on a daily supply of veneer waste equivalent to fifty cords of ordinary pulpwood. Of course, the construction of a mill should be undertaken only upon the advice of a competent mill engineer after a careful survey of local conditions.

*From *Technical Notes*, Forest Products Laboratory.

Cast-Iron Thermit Welds

Almost every day in various industries the question arises as to the feasibility of welding cast-iron sections of widely divergent sizes and shapes. The following explanation may therefore be of interest to those contemplating repairs of this nature:

In thermit welding the superheated steel produced by the reaction, when tapped into the mold surrounding the weld, fuses back into the fractured parts 2 or 3 in. on either side and the whole mass solidifying at one time effects the repair. The excess metal of the weld may then be removed or not, as the necessity indicates.

In cast-iron welding steel is the welding medium and the weld material will therefore necessarily consist of a mixture of this steel and the cast iron of the parts being welded. The graphitic carbon in the cast iron combines with the thermit steel, thus making a high-carbon steel which usually can be machined only by grinding. This material, however, is not so brittle as cast iron and is physically stronger.

In the second place, in considering thermit repairs of cast iron it should be borne in mind that the weld material is steel and therefore has double the shrinkage of the cast iron. This difference in shrinkage is of no importance where the section being welded is approximately square or equi-axed. Where, however, the length of the section at the fracture is four or five times its thickness this difference in shrinkage is evidenced by one or more minute cracks perpendicular to the line of the weld and extending through the weld material only. These cracks are naturally caused by the difference in shrinkage, the cast-iron parts tending to restrict the shrinkage of the steel along the length of the piece. Such hairline cracks will be found in the welding of sections such as, for instance, 12 x 24 in., but would not be found in sections 12 x 12 in. The cracks are often unimportant, as they are parallel to the line of strain.

The experience of the Metal & Thermit Corporation over a long term of years with literally thousands of cast-iron welds proves conclusively that where the length of a fracture is not more than four or five times its thickness and where the subsequent machining can be accomplished by grinding, a thermit weld can be made and will invariably be successful.

Foreign Trade of France for the First Nine Months of 1920

The total French foreign trade for the first nine months of 1920 amounted to 43,746,782,000 fr. (franc — $0.193 at the normal rate) against 31,271,637,000 fr. for the corresponding period of 1919, reports Consul General Thackara of Paris. The imports of food products for the January-September period of 1920 were valued at 6,727,751,000 fr., against 7,413,563,000 fr. for the first nine months of 1919; industrial materials, 12,618,645,000 fr. against 9,542,226,000 fr.; manufactures, 7,842,675,000 fr., against 7,611,631,000 fr. The exports of food products amounted to 1,529,501,000 fr. against 709,085,000 fr.; industrial materials, 3,661,821,000 fr., against 1,205,090,000 fr.; manufactures, 10,589,520,000 fr., against 4,174,361,000 fr.; and postal packages, 776,868,000 fr., against 615,681,000 fr. The adverse trade balance for the first nine months of 1920 was 10,631,360,000 fr., against 17,863,203,000 fr. for the corresponding period of 1919.

Some Deep-Etching Experiments on New Steel Rails

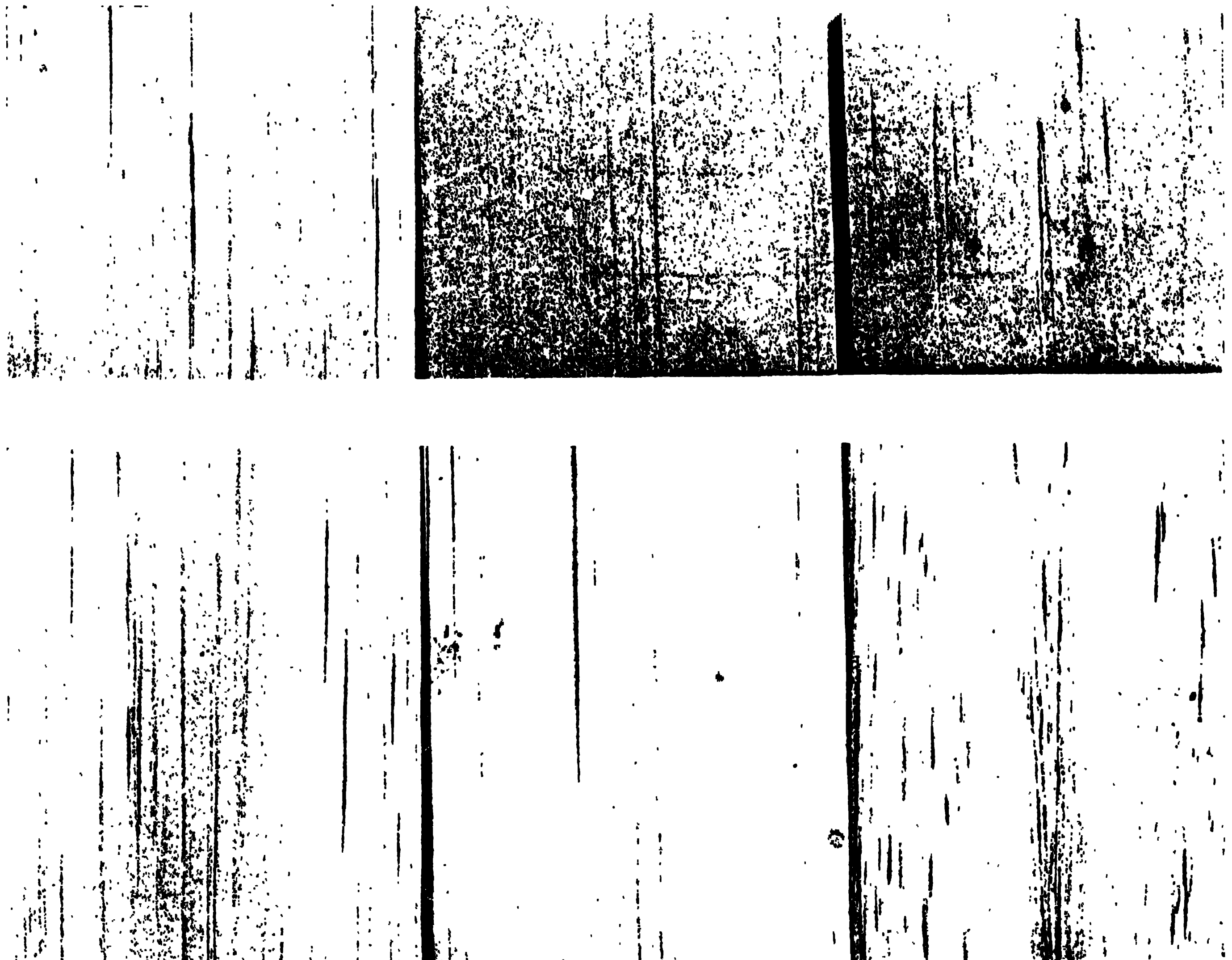
BY GEORGE F. COMSTOCK

IN VIEW of the interest that has been aroused recently in the subject of deep-etching of rails and the markings shown thereby, a few experiments were made with this method of etching on some of the large collection of new steel rails that have accumulated in this laboratory from previous work. Some facts were brought out by these experiments which, while possibly not of entirely general application, may nevertheless be worth publishing as affording an additional scrap of evidence on a point which has not received much attention in the numerous discussions of this etching method.

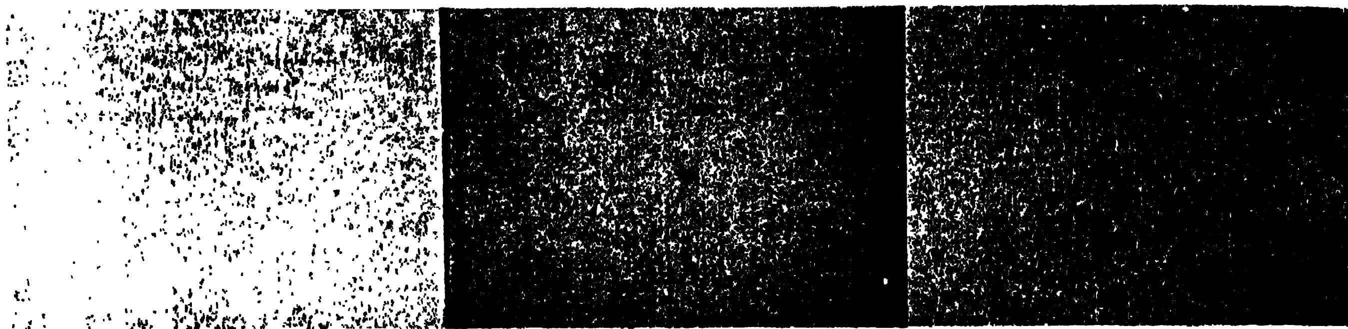
Most of the papers on this subject give the impression that the authors have considered all depressions, eaten out of a rail-section that was etched for several hours in strong hot acid, to be the result of pre-existing cracks or a shattered condition of the steel. Technologic Paper 156 of the Bureau of Standards, entitled "Metallographic Features Revealed by the Deep Etching of Steel," by H. S. Rawdon and S. Epstein, is an exception to the above statement, and a study of this comprehensive discussion of the subject shows that these authors appreciate the action of this etching on segregated streaks as well as its action on fissures or cracks. The statement has occurred several times in papers on this subject that the fissures or shattered condition have been found in new rails as well as in rails that had been in track, but no evidence has ever been seen by the writer as to the frequency with which this condition is met in new rails. It was decided, therefore, to examine some of the new rails in our large collection of samples, to see what we could find in them by deep etching.

The samples chosen were all hot-sawed sections of A-rails, half of them being rails made according to usual practice and more or less segregated, and half being titanium-treated rails having a uniform structure. Lengthwise sections 4 or 5 in. long were cut parallel to the base of the rail, and a little below the center of the head, and these were all boiled for several hours in strong hydrochloric acid, until their macrostructures were prominently developed. The etched sections were washed, dried carefully, and rubbed with a little oil to retard rusting, and were then photographed, with results as shown in the accompanying illustrations.

The homogeneous rails show sections free from any pits or markings except the lines due to the rolling out



Horizontal longitudinal sections cut a little below centers of heads ... l deeply etched. Each section from separate heat, and upper and lower rows from differe... pitted segregated streaks in all, and two small transverse cracks in small s...





Horizontal longitudinal sections cut a little below centers of heads of new titanium-treated open-hearth A-rails, and deeply etched. Each section from separate heat, and upper and lower rows from different mills. Etching shows rolled-out dendrites only.

of the original dendritic structure of the ingots. The ordinary segregated rails, however, show numerous deep streaks or elongated pits that are due not to any unsound or shattered condition of the steel, but merely to segregation of impurities, chiefly sulphur, which caused the metal in those streaks to dissolve faster. It is important that such segregated streaks should not be confused with cracks in the steel, yet the method of examination by deep etching gives the same indication for both kinds of defect.

The section illustrated in the upper right-hand corner of the photograph of the segregated rails shows two small transverse pits, one associated with a double segregated streak, and one apparently separated from any such streak. These could hardly be anything but enlarged cracks in the steel, so that we have here evidence of this condition occurring in a new rail that has not been in service. The twelve samples examined by deep etching do not probably constitute a sufficiently extensive test for a good determination of the frequency of occurrence of this defect in new rails, but we know at least that it was found in only one out of twelve subjected to deep etching, and indeed this is the only new rail in which such cracks were found out of about sixty new A-rails which have been exhaustively tested in this laboratory by various physical and metallographic methods. Thus it seems probable, from our work at least, that the shattered condition found so commonly in rails that developed transverse fissures in track is a very rare occurrence in new rails. Evidence on this point from those who have investigated it more extensively would be of considerable interest.

It might well be noted in this connection that since only one rail in a thousand develops transverse fissures, every transverse fissure might well be the result of shattered metal in a new rail, without any such defect being found in an investigation of only sixty representative rails. In other words, shattered metal in new rails may be quite a rare occurrence and still account for every case of transverse fissures.

Physical Testing Laboratory,
Titanium Alloy Mfg. Co.,
Niagara Falls, N. Y.

Europe's Sugar Production

In sugar production Germany has suffered perhaps more than any other country as a result of the war. Germany was the great sugar-producing area, but now she is unable to supply her own needs. Meanwhile Cuba has increased its output to still greater proportions, providing now about 90,000,000 hundredweight annually. The figures for sugar production in the principal European countries, as given in *The Review* of Oct. 15, 1920, are as follows:

Countries	1913-14 Cwt.	1919-20 Cwt.
Germany	54,766,000	15,000,000
Austria-Hungary	33,766,000	11,700,000
Netherlands	4,628,000	4,760,000
Sweden	2,744,000	2,900,000
Denmark	2,914,000	3,200,000
Belgium	4,580,000	2,540,000
France	15,620,000	3,500,000
Russia	33,760,000	7,000,000
Other countries	10.856 000	6.000 000

Wilmington and the Chemical Industry

Aside From the Well-Known Powder and Explosives Plants the Industrial Activities of Wilmington, Del., Include Such Chemically-Controlled Industries as: Cotton Goods Finishing; Glazed Kid Leather; Lithopone; Vulcanized Fiber; Pulp and Paper

MENTION of Wilmington, Del., invariably brings to mind the explosives industry, which is so highly developed in the district immediately surrounding the city. This instinctive association has become so strong that the extensive industrial enterprises in other lines are often lost sight of. Indeed, even many of the members of the Delaware Section of the American Chemical Society found at the conclusion of the regular meeting held Thursday evening, Nov. 18, that they had not fully appreciated the magnitude of the various chemically-controlled industries in the vicinity of Wilmington. The papers read at this meeting are given in abstract below.

The Finishing of Cotton Goods

Gray goods, as cotton goods are called as they come from the loom, must be finished to make them marketable. The cotton mills sell their product to merchants known as converters, who combine small orders so that the finishers are able to maintain quantity production. The operations involved in finishing cotton goods were outlined by D. S. Ashbrook, superintendent, Joseph Bancroft & Sons Co. This finishing plant is the largest single plant of its kind in this country, having a maximum production of 160,000,000 yd. per year.

After singeing and wetting out, the natural waxes and warp sizing are removed from the gray goods by boiling 9 to 12 hr. under 12 to 15 lb. steam pressure with a 3 to 4 deg. Tw. caustic soda solution in horizontal Mather & Platt kiers having a capacity of about 10,000 lb. of cloth per operation.

The cloth is then stretched on the mercerizing range—two parallel endless chains 75 ft. long made up of iron clips so arranged that the greater the tension the tighter the hold on the selvage of the cloth and impregnated with 30 per cent NaOH solution at 50 to 60 deg. F. After washing, bleaching with sodium hypochlorite, and dyeing by the process best adapted to the type of dye used, the cloth is ready for finishing. The speaker chose a lining sateen as illustrative of the more than two hundred finishes used by this company.

Finishing Process

In the case of a lining sateen the sizing depends on the weight of cloth desired and on the finish. High-grade cloths are merely oiled to produce a suitable softness. Low-grade cloths are sized with starch and oil. Each of the common starches has peculiar properties of its own and gives a distinctive feel to the cloth. Wheat flour, wheat, corn, cassava, potato, sago and rice starches, corn and potato dextrines are used. The cloth is now stretched, smoothed out on a seven-roll calender and satin finished on a hydraulic schreiner having a steel roll, engraved with fine diagonal lines (250 per in.), which is forced against the face of the cloth by a pressure of 30 to 45 tons at a temperature of 300 to 400 deg. F. The final operation consists in breaking up any hardness in the finish by steel blades or rollers set with brass-headed tacks.

Manufacture of Glazed Kid Leather

It is not ordinarily realized that with the exception of North America practically the whole world regards the goat as an important source of meat and milk. About 100,000,000 raw goatskins are obtained every year, chiefly from India, China, Europe, Africa, South America and Mexico. Of these about 50,000,000 are sent to the United States, a single company tanning 12,000,000 skins. The manufacture of glazed kid from these skins was described by F. J. Blatz, plant superintendent, Amalgamated Leather Co. Wilmington and Philadelphia produce 80 to 90 per cent of the glazed kid in this country.

Beam House Processes

The dry or salted skins are soaked in water, trimmed and treated with lime liquor from 8 to 12 days. The hair and flesh are removed on dehairing and fleshing machines and the excess lime is removed by bating with oropon. On slating machines dull revolving slates are brought into contact with the grain of the bated skins and pull out all dirt and fine hair, clearing the skins for tanning.

Tanning

In tanning goatskins the two-bath chrome process is used almost exclusively. The skins are placed in a solution of sodium bichromate acidified with hydrochloric acid. The next day the skins are bright yellow in color, but are not tanned, since the yellow color can be removed by washing in water. By immersing in a solution of sodium hyposulphite acidified with HCl the chromic compounds are reduced and combine with the skin to form leather. Only two days are required for this process. A portion of the free sulphur liberated from the sodium hyposulphite is apparently also taken up by the skin, since the results are superior to those obtained by using sodium bisulphite. About 1 lb. of sodium bichromate is required for 1 doz. skins. Water is now removed on striking-out machines and the skins are shaved on the flesh side. Unless this were done the backbone, which is thicker than the rest of the skin, would show as a black line on glazing.

Coloring

The skins are weighed and placed in revolving drums with suitable dyes and vegetable extracts, the majority being made into brown and black leather. After coloring the skins are given a bath of fat liquor, compounded of soap, oils and egg yolk. These substances give the leather its soft feel. This is followed by stretching on a putting-out machine, and oiling off with a thin coat of neatsfoot oil and glycerine, which holds the grain fine and silky. Drying brings the skins to the "crust" condition—that is, hard and stiff. They

are piled in cool rooms for a week, dampened with water and put through a staking machine which loosens all the fibers.

Finishing

The skins are now in a soft, pliable condition. They are given a coating of egg albumen, and gum, blood and nigrosine are usually added to brighten the gloss and blacken the grain. The glaze is produced on the dried skins by the friction of a moving agate cylinder and a stationary leather strap. Three coatings and glazings are usually required.

Measuring, sorting and bundling complete the process.

Lithopone

A paper on the manufacture and uses of lithopone, prepared by A. S. Krebs, treasurer, Krebs Pigment & Chemical Co., was read by Donald Ross, chief chemist.

The manufacture of lithopone is divided into three steps: The production of a pure barium sulphide solution; the preparation of a pure zinc sulphate solution; the manufacture of lithopone from these two solutions.

Barium Sulphide Solution

The most important raw material is barytes. This is now obtained chiefly from Georgia, although some has gone into the lithopone business from Tennessee and Missouri. The ore deposits of Georgia can be worked satisfactorily with a steam shovel, whereas most Tennessee and practically all Missouri deposits are so small that they are mined by pick and shovel.

Barytes as received at the factory is crushed, mixed with coal and burned at 1,200 to 1,300 deg. C. from 2 to 3 hr. in rotary kilns. The black ash formed is leached, giving a solution of barium sulphide.

Zinc Sulphate Solution

In the manufacture of zinc sulphate any form of zinc or zinc oxide such as skimmings, zinc ash from galvanizing kettles, impure oxides or zinc carbonate ores may be dissolved in sulphuric acid. Zinc sulphide or roasted zincblende may also be used. The resulting solution is purified by various oxidizing processes, depending on the nature of the liquor.

Lithopone

By mixing proper proportions of the zinc and barium liquors, lithopone is precipitated. Plate and frame presses or Oliver continuous filters are used in filtering the pigment and the cake is dried and fed into muffle furnaces heated to about 500 deg. C. When uniformly heated the material is raked out, quenched in water and ground to remove grit due to sand from the furnace walls or to the sintering of overheated particles of lithopone. The ground pulp is washed, filtered, dried, pulverized, sometimes air floated, and packed in barrels of 400 lb. or bags of 50 lb.

Uses of Lithopone

Lithopone is peculiarly well adapted to the manufacture of paints for interior work, such as flat wall paints with chinawood or soya bean oil vehicles and mill whites. In whiteness it is surpassed only by the finer grades of zinc oxide. It has a low oil figure—that is, there can be incorporated in a gallon of oil more pounds of lithopone than zinc oxide. Partly due to this reason and partly to its capacity, lithopone paints have excellent covering power. Indeed, in this respect it is probably the best pigment.

When lithopone is properly compounded with sublimed lead or zinc oxide and appropriate vehicles, an excellent outside paint results, the use of which is rapidly increasing.

Large quantities of lithopone are also used in the rubber industry, in the manufacture of linoleum, wall paper, window shades and printing inks. The lithopone industry has grown from 920 tons in 1900 to a production of 79,619 tons in 1919, and it is expected that the 100,000-ton mark will be reached in 1920 or 1921.

Vulcanized Fiber

The manufacture, properties and uses of vulcanized fiber were discussed by Jay Robinson, of the American Vulcanized Fibre Co. The annual production of vulcanized fiber in this country is about 20,000,000 lb., about 60 per cent of which is made within a radius of twelve miles of Wilmington.

Manufacture of Vulcanized Fiber

Cotton rags are the chief source of the fibrous materials used, although cotton hull, cotton linters and other materials are not uncommon. From these a special porous paper is made without sizing or loading. For best results, the fibers must be long and uniform. Consequently, cotton linters, which are short-fibered and knotty, do not make a satisfactory paper. While new rags are used largely in making writing paper, book-paper, etc., old rags are preferred in the manufacture of fiber paper, as they are softer than new rags. It seems that the older and dirtier the rags are when received at the mill, the better paper they make.

Rolls of the special paper are now made into vulcanized fiber by passing the paper sheet over heated cylinders, through a bath of zinc chloride maintained at about 70 deg. Bé. and 100 deg. F. It is then rolled up over large heated drums to the desired thickness. The zinc chloride hydrolyzes the cellulose and gelatinizes the surface to such an extent that the paper unites and forms an almost homogeneous mass.

The "green" fiber is then washed in zinc chloride baths of progressively diminishing concentration until it is commercially pure—that is, contains less than 0.15 per cent chlorine. This process is of necessity very slow and any attempts to expedite it are likely to result in an inferior grade of fiber, or in blisters due to increased osmotic pressure. Three to four weeks are required to wash ¼-in. fiber, while 2-in. fiber takes six to eight months. The wet, pure fiber is dried to 8 per cent moisture at 100 to 160 deg. F., pressed and calendered. Vulcanized fiber contains from 5 to 8 per cent ash.

Physical and Mechanical Properties

The finished product, which has shrunk to about one-half its original thickness, is a homogeneous material with a perfectly smooth, even surface that readily takes a high polish. No ordinary force will crush, break or split it. It can be turned, tapped, threaded, drilled, stamped, cut, sawed, riveted, embossed and bent, but it cannot be molded. The material is resilient, fire-resisting and has a low coefficient of friction. It does not rust, corrode or deteriorate with age like metal, does not scar like leather and does not have the weaknesses of wood.

Vulcanized fiber is not waterproof, but immersion in hot or cold water does no harm, as it resumes the original dimensions and properties on drying. By

pecial treatment, vulcanized fiber can be made sufficiently moisture-proof for ordinary use. Neutral salts, solvents and oils are without effect, but mineral acids cause disintegration in time.

It is possible to vary the mechanical and physical properties within fairly wide limits by proper manipulation of the chemical treatment or by varying the quality of the original paper. For this reason, care should be exercised in the selection of the proper grade to suit particular requirements. The two chief grades are hard and flexible. Pliability is secured in the latter grade by calcium chloride or glycerine treatment. Hard vulcanized fiber is most extensively used for mechanical purposes and as an insulator in dry places by manufacturers of electrical equipment.[1]

A comparison between some of the properties of vulcanized fiber and other materials is given in Table I.

TABLE I. SOME PROPERTIES OF VULCANIZED FIBER

Scleroscope Hardness	
Vulcanized fiber	25 to 50
Copper	15
Bessemer steel	26.6
Cast iron	33.3
Tool steel	37.8
High carbon steel	86.1

Tensile Strength	Lb. per Sq.in.
Vulcanized fiber	8,000 to 13,000
Zinc, cast	1,000 to 6,000
Tin	1,000 to 5,000
Porcelain	1,800
Aluminum, cast	11,000 to 16,500
Aluminum, rolled	16,500 to 22,100

Compressive Strength	Lb. per Sq.in.
Vulcanized fiber	33,000 to 13,000
Tin	6,400
Aluminum, cast	12,000
Granite	19,100
Marble	12,700
Paving brick	10,000
Porcelain	15,000
Copper, cast	39,000 to 18,000

Dielectric Strength	Volts per Mm.
Vulcanized fiber	6,000 to 16,000
Asbestos paper	4,000
Porcelain	9,000 to 16,350

The initial cost of vulcanized fiber is slightly more than that of mica, porcelain, glass, wood, leather, hard rubber and various metals, but on account of its longer life it is more economical in the end. Sheets are supplied from 0.005 to 2 in. thick, in widths and lengths up to 48 x 80 in.; rods and bars 3/16 to 2 in. thick by 72 in. long; tubes 1/4 to 6 in. inside diameter by 1/2 to 6 3/4 in. outside diameter by 30 in. long; rolls from 0.005 to 0.025 in. thick.

Uses of Vulcanized Fiber

As insulation, vulcanized fiber is found everywhere. It makes noiseless, oil- and current-proof gears and pinions. When meshed with metal, such gears will increase the life and efficiency of the whole gear train. Vulcanized fiber valves have given continuous service for over three years in feed water pumps, pumping hot water at 212 deg. F. against 150 lb. pressure. Because of its unusual wearing qualities, vulcanized fiber is being used for mechanical parts such as friction disks and washers, bushings, bearings, brake shoes, gaskets, packings, wheels, etc.

However, in spite of its wide usage, in practically every plant there are countless places where more expensive and less serviceable materials are still being used.

Paper Making in Wilmington

Some notes on paper making in Wilmington were presented by J. H. Plumstead, superintendent, Delaware Mills, Jessup & Moore Paper Co.

The first machine-made paper in the United States was manufactured during the early part of the nineteenth century in a small mill at or near the site of the present Augustine Mill of the Jessup & Moore Paper Co. on a cylinder machine invented by the owner of the mill. While this invention is the greatest single event in the history of paper making to which Wilmington can lay claim, it may be stated in a general way that this entire vicinity has been very closely identified with paper making from the time paper was entirely handmade down to the present day.

The more important grades of paper may be conveniently classified according to use as follows:

Grades of Paper

Newsprint is a mixture of unbleached ground wood and sulphate or sulphite process wood pulp with a small amount of china clay to give opacity and weight and some ultramarine to offset the yellow cast of the unbleached fiber. Newsprint stock receives little mechanical treatment or beating before going to the paper machine.

Book, magazine, litho and the cheaper writings are made from soda, sulphate or sulphite process wood pulp bleached, loaded with china clay to give weight, beaten more than newsprint, tinted or left natural as desired, and sized with glue, casein, rosin, starch, dextrine or parchmentizing chemicals to make the sheet impervious to ink. The paper may be calendered by passing it over heated rolls or surface coated and calendered.

Wrapping and tissues are usually made from wood fiber produced by chemically treating a long-fiber wood just enough to break down the cementatious materials. The fibers are not bleached and loading, sizing and coloring matters are not usually added.

High-grade writings, bonds, ledgers and all papers that are sold with the thought that they may be kept for many years are made from cotton fiber itself—that is, from selected rags and cuttings. The mechanical treatment is very similar to that used on book paper.

Future of Wilmington's Paper Industry

Mr. Plumstead outlined the sources of the raw material—cellulose—the operations involved in converting this into paper, and said in conclusion that some of the enormous plants built on sites where water power and timber abound were on the verge of shutting down because, having exhausted the raw material near at hand, they have neither navigable waters nor good railroad facilities to fall back on. Not so with Wilmington. A railroad center with a waterfront which is constantly being improved, raw material supply and markets linked in a way that cannot but make for growth and long industrial life, Wilmington's future in pulp and paper making bids fair to be brilliant.

Pacific Roofing Co. Experimenting on Wallboard

The Pacific Roofing Co. has developed a magnesite quarry on the Pacific Great Eastern Ry., erected an experimental plant for the manufacture of wallboard from sawdust, calcined magnesite and magnesium chloride, and has on exhibition in Vancouver a supply of the finished product, which has attracted considerable attention. The company will erect in the vicinity of Vancouver a magnesite calcining plant capable of treating 5,000 tons of magnesite and of producing 12,500,000 ft. of wallboard annually.

The new industry is somewhat in the nature of an experiment, but if there is a demand for the material the size of the plant will be increased.

[1] See "Vulcanized Fiber," by Charles Almy, Jr., MET. & CHEM. ENG., vol. 13, p. 716, Oct. 15, 1915, and "Electrical Properties of Vulvanized Fiber," by William Eves, 3d, *Electrical World*, vol. 71, p. 190, Jan. 26, 1918.

A. C. S. Intersectional Meeting of Chicago and Milwaukee Sections

ON INVITATION from the Milwaukee Section the members of the Chicago Section of the American Chemical Society visited Milwaukee the afternoon and evening of Nov. 20. The meeting was called at the Milwaukee Athletic Club.

Dinner was served in the club grill, followed by the evening program. This took the form of an industrial symposium under the direction of W. Lee Lewis, and John Arthur Wilson opened with the following paper:

Theory vs. Practice and Trade Secrets From the Viewpoint of the Industrial Chemist

Since the development of both science and industry is materially assisted by free discussion, it is rather disconcerting to a young enthusiast to find his fellow industrial chemists holding theory in mild contempt and refusing to discuss practice for fear of divulging trade secrets. Although this unwillingness on the part of the industrial chemist to discuss either his science or practice is gradually disappearing, it is still sufficiently widespread to warrant an investigation into the cause.

Often a young chemist leaves school to enter one of the more complicated chemical industries, say that of leather manufacture, where he finds his training in theoretical chemistry of very little immediate value because of its inadequacy to deal with the behavior of the several hide proteins under the conditions of liming, bating, pickling, tanning, fatliquoring and dyeing. If he does attempt to institute a change for the better in one of these operations, the probability is that the stock on which the change is made will be damaged, if not totally ruined. In contrast, he sees an army of unschooled men turning out an unexcelled product. Before he can become of any great value to his firm he must either greatly extend his knowledge of chemistry to cover the tanning operations, or else master the art as conducted in the plant. He really should do both, but he too often feels compelled to give up the pursuit of theoretical chemistry in order to get quicker results by devoting all of his time to plant operations. The advance of science soon leaves him behind and he becomes more and more reluctant to enter theoretical discussions because of the fear, perhaps only subconscious, that a display of ignorance will injure his reputation.

Having become a practical man, however, he can scarcely avoid being drawn into discussions of practice occasionally, and he can often add many facts to such a discussion as, for example, that increasing the salt content of a given liquor produces certain unexpected results. But when an explanation of the phenomenon is sought, involving theoretical chemistry, a most embarrassing situation would follow were it not for the invention of the magic words "trade secret." As soon as he feels himself getting into deep water, he has only to express regret at not feeling free to go more deeply into the discussion, and his reputation is saved. The term "trade secret" is doubly useful, for it not only hides one's ignorance, but actually tends to create a sensation of wonderment.

The remedy is to make it clear to young men leaving school that sound development of a chemical industry requires a knowledge of the basic principles underlying the several processes and that, while it is essential to master the practice of the industry, it is also essential to seek to explain every operation, and this requires the vigorous pursuit of theoretical chemistry far beyond anything learned at school. While the man who follows this advice may seem to make less headway during the first year than his more practical brother, in the long run he will probably reach a goal entirely out of reach of the man whose theoretical training stops with his graduation.

Industries differing widely in practical procedure are governed by the same physical and chemical laws and the derivation of fundamental principles furnishes a common ground for work and discussion by chemists in every walk of life. With the majority of industrial chemists keeping pace with theoretical chemistry, there would be little need to resort to subterfuges to avoid discussions and the term "trade secret" would become as rare as the thing which it signifies.

Discussion

Otto Eisenschiml described a meeting of foremen and superintendents he had attended some time ago where it was intended to interchange trade secrets of the linseed oil industry. Each one present was asked to write down his best secret and inclose it in a sealed envelope. When the envelopes were later opened fifty of the formulas were found to be identical. At a similar informal meeting of varnish makers the pertinent discovery was made that they were all familiar with the same procedure in manufacture.

Paul Van Cleef and Mr. Nash believed in the need for secrecy, not so much of chemical formulas, but in mechanical methods of preparation.

Dr. Leech, speaking from the viewpoint of the medical profession, said there was nothing of greater handicap to public health than the trade secret. Medical formulas surrounded by deep secrecy and mysticism used in patent medicines, and for which marvelous curative properties are claimed, work untold damage to the well being of the public.

Dr. Redman spoke for the new industries on the firing line of research, where industrial application of new discoveries involve trade secrets of immense money value. Such research findings as connot be patented must here be kept secret. Speaking of the established industries, we should break the ice, interchange information and do away with the autocratic foreman.

Other speakers, including Messrs. Kadish and Prentiss, were in favor of the general interchange of information between industrial chemists and managers.

Mr. Prentiss made the speech presenting, in behalf of the members, a gold A.C.S. pin to John Arthur Wilson, chairman of Milwaukee Section, for his competent leadership of the work during a most successful year. He touched briefly on the co-operation with the Mayor's office, the city library and the review of the report for the city on the new $5,000,000 water and sewage project.

While the foregoing paragraphs may cover the serious facts of the meeting in brief, the measure of high spirits and good comradeship cannot be expressed in the space available. Many hearty informal talks of good will and joint interests interspersed with the above made the occasion one of close communion. Close acquaintances, old and new, talked far into the night at the club quarters where the visiting members were entertained. Another intersectional meeting was promised at Chicago in the near future. Among the ladies present were Mrs. L. V. Redman, Mrs. W. Lee Lewis of Chicago and Mrs. S. E. Layman of Milwaukee.

Current Events
in the Chemical and Metallurgical Industries

Chemical Manufacturers to Meet Entomologists

Chemical features of boll weevil control are to be discussed at a series of meetings which will begin in New York, Dec. 6, of manufacturers of arsenates, entomologists and representatives of cotton growers. The conferences are under the auspices of the Crop Protection Institute. The organization of this institute is just being perfected by the National Research Council.

Dusting the cotton plant with arsenates has proved to be the most promising method of boll weevil control. One of the purposes of the conferences is to standardize the arsenates. The intention is to acquaint the manufacturing chemists with the machinery used in applying the arsenates. Attention also is to be given to standardization of the machinery.

This is the type of work to be undertaken by the newly formed Crop Protection Institute. Since chemists play an important part in the eradication and control of insect and fungus pests it is expected that they will have an important part in the work done by the new institute. In fact, G. R. Cushman, of the General Chemical Co., headed the committee which recommended the formation of the Crop Protection Institute. The trustees of the institute are chosen from entomologists, manufacturing chemists, phytopathologists, and a representative of the National Research Council. Mr. Cushman, F. O. Moburg of the Rex Chemical Co. and P. W. Pickard of the Bowker Insecticide Co. are the trustees representing the chemical industry.

Technical Men of Baltimore Organize Engineers' Club

For some time past the technical men of Baltimore and vicinity have felt the need of a central meeting house or club where meetings could be held and where it would be possible to combine the meeting place with the usual facilities of a club. The rapidly increasing number of engineers, chemists and other technical men employed in Baltimore has made it difficult for the various organizations to hold their meetings in quarters sufficiently large to take care of joint meetings of these societies, and much thought has been given to the question of improving the facilities of the city in this way. Therefore the various organizations have decided to back a new enterprise, to be known as the Engineers' Club of Baltimore. The club will be located in the new Merchants and Manufacturers' Building at the corner of Light and Redwood Sts.

The members of each of the technical associations and societies which have chapters or sections in Baltimore will have the privilege of becoming members of the club, and each organization will be able to hold its meetings in the lecture theater in the club building. The clubrooms, other than the lecture theater, will be a library, reading room, billiard room and dining room. In addition special arrangements have been made with one of the adjacent hotels to provide sleeping accommodations for members of the club or their guests.

Annual Meeting of the American Society of Mechanical Engineers

The American Society of Mechanical Engineers will hold its forty-first annual meeting Dec. 7 to 10, 1920, at the Engineering Societies Building, 29 West 39th St., New York City. The tentative program for the technical sessions is:

Tuesday Afternoon, Dec. 7.—Fuel, Forest and Machine Shop Sections.

Wednesday Afternoon, Dec. 8.—Management, Railroad, Design and Research Sections.

Thursday Forenoon and Afternoon, Dec. 9.—Keynote session on Transportation and second meeting of the Research Section.

Friday Forenoon, Dec. 10.—Design, Textile and Power Sections.

Among the many papers to be presented are:

Fuel Supply of the World, by L. P. Breckenridge.

Low-Temperature Distillation of Coal, by O. P. Hood.

Fuel Conservation, by D. M. Myers.

Processes and Equipment Used in Wood Preservation, by E. S. Park and J. M. Weber.

Principles of Industrial Philosophy, by W. N. Polakow.

The Heat-Insulating Properties of Cork and Lith Board, by A. A. Potter, J. P. Calderwood, A. S. Mack and L. S. Hobbs.

Effect of Fittings on Flow of Fluids Through Pipe Lines, by D. E. Foster.

Textile Fabrics for Mechanical Purposes, by J. W. Cox.

Papers on Future Power Development:

- The Policy of Future Power Development.
- Effect of Load Factors on Cost.
- Effect of Size of Plant on Cost.
- Financial and Legal Aspects of Future Power Development.

Mining and Metallurgical Society to Be Formed at Utah University

Plans for the formation of a mining and metallurgical society at the University of Utah have been completed, according to Prof. R. S. Lewis. Membership will be restricted to sophomores and upper class men taking mining, metallurgical, chemical and geological courses, as well as professors in those departments, and officials and employees of the United States Bureau of Mines located at the university. The society will petition the American Institute of Mining and Metallurgical Engineers for a student chapter.

Still Looking for Chemical Director for C.W.S.

The search for a chemical director for the Chemical Warfare Service is continuing, but as yet no one has been found who is willing to take the responsibilities of this position for the $10,000 salary which is offered. Chemists with the qualifications which General Fries deems requisite are being paid higher salaries in private employment. Pending the selection of a director, Captain D. B. Bradner of the chemical staff at Edgewood Arsenal is made acting chemical director.

Association of Official Agricultural Chemists Meets

The Association of Official Agricultural Chemists met in Washington Nov. 15 to 17, at which time numerous committee reports were received regarding methods for valuation of agricultural, fertilizer, drug and food materials. At this meeting it was announced that the publication has been completed of "Methods of Analysis," which is now available for sale by the secretary, box 744, Eleventh St. Station, Washington, D. C. The *Journal* of the association will present the proceedings of the meeting in full in the near future, as this publication is now appearing again regularly.

Officers for the coming year include: President, W. F. Hand, Agricultural College, Mississippi; vice-president, F. P. Veitch, Bureau of Chemistry, Washington, and secretary-treasurer, C. L. Alsberg.

Referees on subjects of industrial chemical interest are as follows: Insecticides and fungicides, J. J. T. Graham, Bureau of Chemistry, Washington; fertilizers, R. N. Brackett, Clemson College, South Carolina; borax in fertilizers, W. H. Ross, Bureau of Plant Industry, Washington; preparation of ammonium citrate, C. S. Robinson, East Lansing, Mich.; nitrogen in fertilizers, I. K. Phelps, Bureau of Chemistry, Washington; potash availability, A. G. McCall, College Park, Maryland.

Important committees appointed were as follows: Vegetation tests on the availability of phosphoric acid in basic slag—H. D. Haskins, Agricultural Experiment Station, Amherst, Mass., chairman; C. B. Williams, W. B. Eliott, B. L. Hartwell and J. A. Bizzell. Committee to co-operate with A.S.T.M. on standards for and methods of testing agricultural lime—W. H. McIntire, Knoxville, Tenn., chairman; William Frear and F. P. Veitch. Committee on quartz plate standardization and normal weight for sugar—F. J. Bates, Bureau of Standards, Washington, chairman; C. A. Browne and F. W. Zerban.

Objection to Official Methods for Phosphoric Acid Determination

H. P. Nelligan, of the American Glue Co., presented before the Association of Official Agricultural Chemists certain important objections to the present official methods of analysis for determination of phosphoric acid in commercial materials largely used as fertilizers. He stated his objections as follows:

> The American Glue Co. produces dicalcium phosphate as a byproduct in the manufacture of osseine. This product is sold and valued on the market for fertilizer purposes according to its content of citrate soluble phosphoric acid as determined by the method prescribed by the Association of Official Agricultural Chemists. This method is not applicable to our product, which is a comparatively pure dicalcium phosphate. The official method was undoubtedly designed for a mixed fertilizer, and in all probability never more than 500 lb. of our product would be used in a fertilizer mixture. Now, in such a case, the charge to be weighed out for the determination of insoluble phosporic acid would contain (in the mixture) only ½ g. of the dicalcium phosphate, which would no doubt give full credit for all of the available phosphoric acid present. It is the consensus of opinion of all chemists who have done any considerable amount of work on this product that the present method is manifestly unfair, for when the material is mixed with other fertilizers it gives a higher availability in proportion than does the raw material, yet no provision has been made by the association to take care of this condition. . . .
>
> We have always been under the impression that the object of the Association of Official Agricultural Chemists was to secure uniformity and accuracy in the methods of analysis, yet the official methods in this case inflict an unjust penalty upon the American Glue Co. These conditions were brought to the attention of the Association three years ago, and during this time the American Glue Co. has stood a considerable loss on this product.
>
> We produce each year about 2,500 tons of this material. It is safe to assume that if the official method of analysis for this product was amended so that a 1-g. charge was used with 100 c.c. of ammonium citrate instead of the official 2-g. charge, we would gain in the vicinity of 2 per cent available P_2O_5 on all our production. The dicalcium phosphate is sold at so much per unit citrate soluble P_2O_5. At the present market value, we stand a loss of between $5,000 and $6,000 a year on this discrepancy in the present method of analysis.

The referee of the association on available phosphoric acid in precipitated phosphates, H. D. Haskins, reported his investigations on this matter in the following language:

> Your referee is convinced that the present official method for the determination of available phosphoric acid does not give full justice to this class of material and he would, therefore, recommend:
>
> That the determination of insoluble phosphoric acid in precipitated phosphate be carried out according to the present official method for the determination of insoluble phosphoric acid in fertilizers with the exception that a 1-g. charge be employed and that a quality of filter paper corresponding to C.S. & S. No. 597 be used together with perforated platinum cone and gentle suction in the filtration of the citrate solution after treatment.

Neutral Ammonium Citrate Solution

The composition and preparation of a neutral solution of ammonium citrate was discussed by C. S. Robinson. He recommends as a solution for use in the determination of phosphoric acid one which contains NH_3 and $C_6H_8O_7$ in the ratio of 1 to 3.794. He also recommends certain methods for the preparation of this solution which are the result of investigation as to the significance with respect to hydrogen ion concentration of solutions prepared by different methods. It is evident that that measure of neutrality is very important as affecting the apparent phosphoric acid content of this type of fertilizer material.

The committees of the association will study this subject further in collaboration with the industries affected.

Wisconsin University Revises Chemistry Work

A revision of the courses of the chemistry department of the University of Wisconsin has just been completed with the purpose of meeting a need for greater specialization in this profession. A greater number of elective college subjects outside of chemistry are required under the new ruling, as a part of the special courses, in order to give the student more cultural training. In the freshman year mechanical drawing has been made a required subject and mathematical chemistry is required in the sophomore year. In the general course industrial chemistry is required of all students.

Another new ruling is that at least one industrial trip must be taken during the course. The department also urges that each student obtain summer employment in his particular branch of chemistry so that he can bring to his theoretical studies the appreciation of their practical application.

During the coming year a general course, a course for industrial chemist, a course for food and sanitary chemist and a course for agricultural chemist are to be offered by the chemistry department. The courses for physiological chemists and for soils chemists have been dropped because of insufficient demand.

Special Service by Chemists' Club Library

Some time ago the Chemists' Club asked the co-operation of industrial chemical concerns in the support of a special service in the Chemists' Club library. This request met with a generous response and the library committee now announces to all who co-operated with the club that the services of Dr. M. A. Graham have been secured for this work. Dr. Graham will give her time exclusively to the answering of requests for special information, compiling of special reports and bibliographies, and will be available to render every possible assistance to employees of our subscribers in searching the literature. Work of this kind requires very broad chemical training, which requirement is well fulfilled by Dr. Graham. All work of this kind done for subscribers will be treated entirely confidentially. No charge will be made for work of this kind except in special instances where considerable time is required, in which case merely a nominal charge will be made.

Important Rulings on Petroleum and Natural Gas Passed in Canada

Two important orders in council have been passed by the Canadian Government. One provides that petroleum and natural gas regulations applicable to dominion lands shall be extended to certain portions of the forest reserves in order that an opportunity may be given to test these lands with a view to discovery. The other provides that for a period of five years after the date upon which the Minister of Interior shall declare that oil in commercial quantities has been discovered on crown lands, acquired under regulations governing such lands, the royalty to be exacted by the crown shall not exceed 5 per cent of the output of the well on sale of the product of the locations, nor be less than 2½ per cent, and for the following five years it shall not be more than 10 per cent nor less than 5 per cent. After the ten-year period it shall be 10 per cent.

This applies only to the Provinces of Alberta, Manitoba and Saskatchewan, and the Yukon and Northwest territories. In the other provinces the oil rights are vested with the provincial governments.

Chemical and Fertilizer Tonnage

Chemicals and explosives to the extent of 2,038,223 tons were carried on the Class 1 railroads of the United States during the quarter ended June 30. This is shown by the statistical compilation just made public by the Interstate Commerce Commission. This compilation shows the tonnage of seventy commodities which were transported on the Class 1 roads—those having annual operating revenues above $1,000,000. These roads carry more than 90 per cent of all freight transported.

The tonnage of chemicals and explosives carried during the second quarter was somewhat greater than that during the first quarter, when it totaled 1,960,190 tons.

The fertilizer tonnage decreased decidedly during the second quarter. During that period 2,947,492 tons of fertilizer was handled by the principal railroads. During the first quarter the tonnage was 3,652,612.

The tonnage handled of some of the other commodities in which the chemical industry is interested is shown as follows in the report for the second quarter:

	Tons
Refined petroleum and its products	7,184,453
Vegetable oils	212,121
Sugar, sirup, glucose and molasses	1,485,118
Cotton seed and products, except oil	510,716
Crude petroleum	1,600,870
Pulp wood	1,396,186

Annual Meeting of the American Petroleum Institute

The convention of the American Petroleum Institute, which was held in Washington, Nov. 17 to 19, was significant principally because of the spirit of fraternity which was manifested. This was particularly striking to those acquainted with the antagonisms which have been assumed to exist between the independent operators and the representatives of the more highly organized companies. These interests now seem entirely disposed to work together to meet the common problems of their industry.

All of the officers and directors of the institute were reelected for the ensuing year. These officers are Thomas A. O'Donnell, president; S. Messer, vice-president; H. F. Sinclair, treasurer; R. L. Welsh, general secretary and counsel; C. C. Smith, assistant general secretary and treasurer.

Some of the important points brought out by the various speakers in their addresses were: That the demand for petroleum and its products is keeping pace with production and bears every promise of expanding in the future as rapidly as more crude can be supplied; the enormous demand for petroleum in America and the relatively smaller part our home production is going to play in the future necessitates going to foreign fields to supplement this demand; the necessity of foreign policy being changed so as to enable outside interests to help develop the oil resources for the good of all concerned instead of monopolizing the deposits for their own use; more freedom from governmental restrictions in the development of the oil industry by private individuals and corporations; the necessity of conservation of fuel oil as a means of power for our merchant marine and stimulation of further search for new sources of supply.

There was little of a chemical nature discussed. The group on Uniformity in Testing Methods, however, adopted the following resolutions:

> Resolved, That the Group Conference on "Uniformity in Testing Methods" recommend that the American Petroleum Institute call together and arrange to secure the co-operation and co-ordination of all existing agencies and petroleum associations working for or interested in uniformity in testing methods; to arrange for a central referee testing laboratory, the prompt dissemination of information concerning standard methods of tests and research work looking forward to improved methods of test.

Rennerfelt Electric Furnace Installed at the San Francisco Mint

In order to meet the increased demand for cents and nickels a ½-ton Rennerfelt electric-arc furnace has been installed at the San Francisco Mint. The electric furnace replaces oil-fired crucible furnaces for the melting of stock for cents, the copper-nickel alloy used for five-cent pieces and also for the tin-zinc alloy which, with copper, forms the cent alloy. The furnace is of the three-phase type using 2½-in. graphite electrodes, and is hand-operated. It is expected to produce a 1,000-lb. charge in three hours. A 1-ton and a 1,200-lb. Rennerfelt furnace have been operating at the Philadelphia Mint on the same alloys and have effected considerable saving in the cost of production.

It is only recently that the use of cents has become common in the West. The tax on theater tickets, 6c. and 7c. carfare and the cafeteria created the demand, and with a supply available the use of cents has become customary in stores.

Clayburn Co., Ltd., Reopens Kilgarde Plant

The Clayburn Co., Ltd., manufacturer of building brick, firebrick, tiles and drain pipes, has reopened its second plant at Kilgarde, B. C. Both of the plants at Kilgarde and those at Clayburn are now working at full capacity and more than 150 men are employed. The company is sending its products as far as Montreal in one direction and San Francisco in the other.

Canadian Electro Leather Industries Organized

The Canadian Electro Leather Industries has been organized in Vancouver, B. C., and will erect a plant at McKay Creek to treat 500 hides weekly. The cost of the plant will be between $30,000 and $40,000. Electricity is said to play an important part in the tanning process. A similar plant is said to be operating successfully at Singapore, and the McKay Creek plant is to be constructed on the same lines.

Carnegie Institute of Technology Has Elaborate Coal-Mining Laboratory

The Carnegie Institute of Technology of Pittsburgh is completing the most elaborate coal-mining laboratory in America. The laboratory, which will be finished by the opening of the fall term, is located beneath the building of the division of science and engineering of the institute. The equipment comprises a full-sized coal mine—a model mine, except that it yields no coal—a mine locomotive and a full set of coal and metal mine machinery, that has been furnished by manufacturers. In addition to the mining laboratories proper there will be a completely equipped ore-dressing and coal-washing plant. It is purposed to extend the mine during the practice work of the students along such a plan that it can be utilized for carrying some of the steam and water pipes of the institute.

Steel Co. to Be Established in British Columbia

Coast Range Steel, Ltd., has been incorporated, with a capitalization of $15,000,000, and head office at Vancouver, B. C. The provisional directors are H. J. Landahl, Fred T. Congdon, J. D. Kearns, John Steta and Montague Moore, all of Vancouver. The avowed object of the company is the establishment of an iron and steel plant in British Columbia. Arrangements have been made with the provincial government for a bounty of $3 per ton on all iron produced from British Columbia ore for a period of two years, with the probability of renewal, though possibly at a lower bounty. The concern is said to be backed by British capital, and there appears to be some evidence of this being so, as two British engineers, C. T. Williams and Francis Percy, have been in the province for the last two months investigating the iron-ore resources.

Paper Company of Dallas to Make Paper From Cotton Linters

The Trinity Paper Mills of Dallas, Tex., is to engage in the manufacture of pulp and paper from cotton linters, of which there is over 200,000 tons produced annually. There has been but small use for this product since the different governments suspended the immense production of nitro-cellulose in 1918. Large stores of this stock are accumulating while the cotton oil producers are forced to remove at least 75 lb. of lint per ton of seed in order to have a successful oil recovery, and the oil millers could profitably remove as much as 200 lb. per ton of seed, as the lint left on the seed absorbs oil. All of this 200 lb. of lint can be used profitably in paper making.

Briefly the treatment of cotton linters in making pulp suitable for high-grade paper is very similar to the treatment usually given rags. It is a soda process and the treatment of the stock offers no particular disadvantages over that of any other fiber now in use. It can be used successfully in the manufacture of several different grades of paper, such as book, writing, blotting, toweling, and in place of sulphite wood pulp in the manufacture of newsprint.

The company expects to have a pulp mill in operation at Commerce, Tex., in the near future.

Personal

FRANCIS L. ADAMS is now special inspector at the Jones & Laughlin Steel Co., South Side Works, Pittsburgh, Pa.

C. E. ALDEN is now with the Permutit Co., New York City, in its technical department.

Dr. GEORGE BORROWMAN, who recently returned from chemical investigations in Europe, has resigned from research work with Dr. J. E. Teeple, New York City, to enter independent practice in Chicago.

C. F. CARRIER, who has been taking a year's leave, has fully recovered his health and is now associated with the chemical department of J. Q. Dickinson & Co., Malden, W. Va.

EDWARD W. ENGELMANN, consulting research engineer of the Jackling porphyry properties, is in New York.

CLYDE L. FREAR has left the Merrell-Soule Co., where he had charge of the control laboratory, to accept a position with the U. S. Naval Experiment Station, Annapolis, Md.

JOHN M. HAYES, treasurer of the Utah Copper Co., Salt Lake City, has resigned and will remove to Los Angeles, Cal., at the end of the year.

J. H. MATTHEWS of Wisconsin University will address the Milwaukee Section of the American Chemical Society Dec. 3. His subject deals with photochemistry.

C. F. MILLSPAUGH, of the Field Columbian Museum, addressed the Chicago Chemists' Club on Tuesday, Nov. 23, on "Some Collections of Crude Materials and Their Relations to the Scientific Men of the West."

J. R. POWELL spoke before the Chicago Chemists' Club on Nov. 15 on colloidal clay, with special reference to the bentonite deposits in Wyoming.

Sir THOMAS KIRKE ROSE has been awarded the gold medal of the Institution of Mining and Metallurgy, the highest distinction in the power of the Council to bestow, "in recognition of his eminent service in the advancement of metallurgical science, with special reference to the metallurgy of gold."

FOREST RUTHERFORD, consulting metallurgist, New York City, has returned to New York after spending several months in Colorado on mine examinations and milling problems.

H. LIVINGSTON SULMAN has been awarded the Consolidated Gold Fields of South Africa, Ltd., gold medal and premium of forty guineas for his paper, "A Contribution to the Study of Flotation."

C. M. WELD, mining engineer, D. M. LIDDELL, chemical engineer and metallurgist, and P. H. LAZENBY, a civil engineer with wide experience in public utilities, have formed a partnership for practice as consulting engineers and economists under the firm name of Weld, Liddell & Lazenby, with offices at 2 Rector St., New York City.

JOHN ARTHUR WILSON, chairman of the Milwaukee Section, American Chemical Society, was in New York last week on business.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Nov. 29, 1920.

Tremendous resale pressure continued in evidence during the last week's activities and prices in several items suffered further recession. Inquiries, however, appear to be gaining more strength, but the differential is still wide enough between buyers and sellers to keep business quiet. Export orders were in evidence since the pronounced strengthening of foreign exchange. Consumers have adopted an ultra-conservative attitude even though producers are endeavoring to make prices attractive and real business is not passing.

In general the entire chemical movement was slow, with buyers content to operate only for actual wants. Sellers are still on the offensive so far as spot and near-by forwards are concerned, but the resistance is still relatively weak and the disposition seems to be to keep stocks as light as possible prior to the taking of inventory.

Solid caustic soda was offered in some directions at $3.75 @$4 per 100 lb., which is a new low record for this movement. Trading was not much in evidence and buyers are looking forward to further recessions. *Bleaching powder* broke down with keen competition and selling was reported as low as 3¾c. per lb. in small drums. Large drums at the works were quoted at 4c. per lb. *Bicarbonate of soda* producers report a steady movement against outstanding contracts to consuming trade and are quoting 2¾c. per lb. f.o.b. works. Factors in *chlorate of soda* are holding the market at 10c. per lb. works and are readily working off their output through standing contract channels. Spot supplies are not heavy, although odd lots could be obtained at a fraction under producers' figures. *Cream of tartar* has shown no evidence of life in the past few weeks and spot supplies are heard as low as 43c. per lb., with very little trading at this figure. Spot material of *oxalic acid* was heard on the market at 19c. per lb., with buyers showing relatively no interest. The range was up to 22c. per lb., depending on quantity, brand and seller. Improvement to the extent of inquiries was noted in *cyanide of soda* and indications gave promise of some better business developing. Supplies seem to be well scattered among dealers. German cyanide was held at 23@25c. per lb., French at 24@26c. and American at 29@30c. per lb.

Potash Salts

The potash industry has developed into one of the leading factors in the chemical market as American producers, confronted with a severe shortage and an incessant demand for potash products previously imported, set about to solve this difficult problem.

Like all other chemicals, potash has seen some abnormally high prices and producers have reaped a tremendous harvest in the last few years. Gunpowder manufacturers and foreign merchants were flooding the American market with a continuous volume of orders and prices soared far above the normal mark. In the past few months, however, with the general depression in business circles and recent German importations, potash has been on a sharp decline. Germany has once more come into the domestic market as a competitor, but the consensus of opinion in chemical circles is that it will be some years before any real imports can be expected to reach pre-war figures or before prices will be materially lowered to affect American producers. At present, however, America is looking forward to a fair supply from Europe, since it has not yet become able to meet the increased consuming demand. It is also certain that the new Administration will provide methods in the form of a new protective tariff to safeguard domestic producers from any strong foreign competition. In short, it seems probable that it will be many years before our European neighbors will be in a position to produce enough permanent surplus stock for the American market. In the meantime America will continue developing her own resources with the hope of becoming a self-sustaining industry.

The beginning of 1920 saw *bichromate of potash* the leading factor in the potash group. A shortage of chrome ore, transportation difficulties and strong foreign demand brought the price from 27c. per lb. in January to 42c. per lb. in May. During April leading producers announced a temporary discontinuance of production owing to inability to obtain raw materials. Speculators saw an opportunity to work the market and shot prices up from 30c. to 40c. per lb. Since June, however, a rapid decline has been noticed and material is now available at 21c. per lb. *Caustic potash* demand during the past year was accentuated in sympathy with all other leading chemicals. A wide demand was noted from soft-soap makers, who reported a large volume of orders on hand for all parts of Europe. Prices were on a sharp advance for this commodity during the first five months of the year, climbing from 25c. per lb. to 33c. per lb. Material can be obtained at present at 16c. per lb. The call for *chlorate of potash* from the match and fireworks trades kept the price very steady until the past few weeks. Large importations have weakened the spot market considerably, and even though dealers quote 15c. per lb., no real interest was shown by the consuming trade.

Coal-Tar Products

The coal-tar products market has taken the attitude of a secondary factor in the chemical industry. It seems that readjustments will have to be completed in all allied trades before anything can be satisfactorily undertaken in this branch. On the face of things it might seem that the proper thing to do would be to start at the crude end of the game and state plainly that any revisions downward are practically impossible or else make them at once and relieve further uncertainty. On the other hand, it is argued that nothing would be gained until the position of the ultimate consumer becomes better understood as to the extent of his probable needs. Reports show that large numbers of buyers are in town, but what purchasing is being done seems to be limited to small quantities to fill in for the holiday trade only, and until demand and prices become more stabilized in the allied lines, factors in the crude and intermediate markets contend that readjustment in prices would fail to stimulate buying. Trading during the week followed the regular routine that has prevailed during the past few weeks. Small quantities of *H acid* are reported moving at $1.60 per lb. *Benzylchloride* producers report the general market requirements as rather light, while the supply is of usual fair volume with prices quoted at 25@35c. per lb. Supplies of *dinitrobenzene* retain their steady tendency with the output generally held by first hands, and show the usual range of prices from 32c. to 35c. per lb. Demand for *aniline salts* is light and available supplies are free enough to keep the market easy and dealers offer spot supplies at 32@33c. per lb. Sales of *aniline oil* are limited only to small quantities, and while producers are still quoting 30c. per lb. resale material is held at 27c. per lb., with very little business even at the outside figure.

Waxes

The wax market has been quiet and featureless for the last few weeks. Export orders, that have been so common in this commodity, have entirely disappeared of late and hand to mouth business to domestic consumers is about the only business noted.

Beeswax continued dull, with offerings fairly liberal, especially in the lower grades. *Crude African beeswax* was offered at 20c. per lb. and it was intimated that round lots for shipment might have brought concession. *Brazilian beeswax* was quoted nominally at 28@30c. per lb. The higher grades of *Carnauba wax* are holding up well considering the routine nature of business. Brazilian markets were unsettled according to advices received in local circles, causing dealers to hold aloof. *Carnauba No. 1* was held around the 85c. per lb. level. *No. 3 North Country* was unchanged and closed at 25@27c. per lb. Scattered business is noted in *Japan wax* for immediate delivery at 19@19½c. per lb., indicating that the market is fairly steady. The

export movement that has characterized the *paraffine wax* market has taken a great slump and dealers are inclined, therefore, to offer their merchandise at surprising concessions. *Crude 124-126 m.p.* was quoted at 7½c. per lb., with very little response from consumers.

POTASH SALTS

	Jan April	May July	Aug Sept	Oct	Nov.
Bichromate Potash....	27 37c	42 37c.	36 30c	30 26c	25 20c
Caustic Potash					
88-92 per cent.. ..	25 30c.	31 33c	32 26c	25 20	19 16c
Muriate Potash, ton...	$150	$110	$125	$110	$100
Nitrate Potash .	13c	13c	14c	13c	11½c
Permanganate Potash	60 85c	85 80c	75 70c	65c	60c
Prussiate Potash, yellow	35 37c	35c	36 38c	38c	34c
Chlorate Potash..	17 19c.	20c.	18c	18c	15c

The Chicago Market

Chicago, Nov. 26, 1920.

Without exception, every line of trade in the chemical industry reports continued inactivity and further depression of prices. Most advisers to the trade recommend extreme caution in buying, and this advice is being followed to such an extent that no factors are making engagements for supplies in excess of thirty days' requirements. Undoubtedly those concerns which have been existing on week-to-week supplies of chemicals will, when they figure the bottom has been reached, come into the market with some real buying.

Coal-tar products seem to occupy the weakest position as the result of heavy imports. Total importations of coal-tar products for the first nine months of this year is $7,865,-000, against $4,710,000 for the same portion of last year. The Department of Commerce reports imports of chemicals, drugs, dyes, etc., for the period from Jan. 1 to Oct. 1, 1920, of $165,527,000, compared with $81,846,000 in 1919.

Heavy Chemicals

Plentiful supplies of all commodities are in evidence, but buyers are content to look on. Price recessions seem to excite no interest, and it is doubtful if even radical and unjustifiable cuts would induce any heavy buying, as all chemical users seem committed to a policy of day-to-day buying. *Bleaching powder* of various grades and at various prices is offered in plenty. Quotations on spots cover a wide range, figures from $3.85 to $5.25 per 100 lb. being heard. *Soda ash* also is getting no rapid action even when offered at below 2c. per lb. It can be purchased as low as 1.90c. Spot *caustic soda* is offered from warehouse at $4. Some sales are mentioned at as low as $3.90. *Sal soda*, quoted about $2 per 100 lb., is also weak.

Soda nitrite, under pressure of plentiful supply, is offered at $7.35, but not much business is being done at any figure. Holders of stock show every disposition to shade prices. *Soda cyanide*, affected by importations, is freely offered at 22@23c. per lb. *Nickel salts*, with a dull market catching heavy supplies in second hands, is offered on the spot at 14c. for the single salts. Manufacturers' price is about 2c. higher on the pound

Trade in *alcohol* is very quiet, producers being reported as holding large stocks of all grades. The only price change of moment has been in *denatured*, which is now offered at 82@85c. per gal. for 96 per cent. *Glycerine* quotations of 20c. per lb. for c.p. grade, drums extra, are ruling, with but light buying resulting. Dynamite grade is 17½c. or 19c., depending on whether you are a buyer or a seller.

Acids are equally dull, with only small transactions noted; 60 per cent pure *acetic* is offered at $10 per 100 lb., *nitric* at $8.25 per 100 lb. for 42 deg., *sulphuric* at $21 per ton for 66 deg. and *pyrogallic* at $1.92 in crystal form.

Coal-Tar Products

Overstocked domestic markets, combined with heavy imports, are forcing price levels down, in spite of which but little interest is shown by buyers. *Phenol* has taken a slump to 10½c. per lb. for spot offerings and it appears that real money would shade this from ½c. to ¾c. *Naphthalene* has suffered from large offerings of German goods and either balls or flakes can be had for 10c. per lb. or less. *Toluene* is weak and uncertain, quotations ranging in the neighborhood of 32c. per gal. *Benzene* alone is remaining fairly firm at 37c. per gal. for the pure. Demand on this item is well maintained.

Intermediates in the hands of makers are firmly held, but second hands are plainly worried at the stagnant market and are eager to shade prices. *Aniline oil*, offered at 25c. per lb., faces few takers, and the *salts*, at 33c. are even in less demand. *Benzaldehyde* is down to 55c. per lb. for technical grade and *beta naphthol* is offered at 40c. or even less. *Phosgene* is in good supply and fair demand at 45c. per lb.

Vegetable Oils

The downward trend of the market is proceeding without interruption, and temperatures above the average for the season are helping it along. *Linseed oil* is offered in tanks at 80c. and in small lots from jobbers' stocks at $1 per gal. Prime summer yellow *cottonseed oil* is quoted at 8c. per lb. in sellers' tanks. *Corn oil*, at 8½c. per lb. in tanks f.o.b. Chicago, excites no interest, and but little business is being done in *coconut oil* at 16c. per lb. in barrels out of stock. *Red oil*, in tanks, is quoted locally at about 9½c. per lb.

Naval Stores

Conservative buying is the rule locally, both buyers and sellers apparently feeling their way with caution. Reports of reduced activity in the various consuming industries offset to a certain extent the effect of the reported smaller available supply. Withdrawal of foreign buyers from Eastern markets has effected price reductions, but a study of conditions shows that a reaction would not be a surprise. Producers show no great desire to get rid of stocks. Local quotation on *turpentine* is $1.29 per gal. in barrels, $1.22 per gal. in tanks. *Rosin* is held at $11.50@$11.65 for all grades.

The St. Louis Market

St. Louis, Mo., Nov. 26, 1920.

A further slowing up of spot business is the only change to be noted in this market during the past two weeks. In this way the depression in other lines is making itself felt in heavy chemical demand, but producers state that their shipments on contract are practically normal and that they are renewing contracts satisfactorily. Evidently fears of the necessity of cutting production have been allayed as one of the largest heavy chemical producers is planning an increase in output. The prices which were established around the beginning of November are holding firmly and producers feel that they have them under their control and are able to keep them on a sound basis. The decline in spot business seems to indicate that buyers are staying as close as possible to their day-to-day needs and producers do not look for this situation to be relieved until the depression in other lines ends.

The demand for 66 deg. *sulphuric acid* remains slow but fairly steady and prices are being maintained at $22 per ton, carload lots. Oil refinery demand is at a satisfactory level and little decline in the demand from this quarter is expected. Quietness also marks the 98 per cent sulphuric acid market. It is quoted at $25 per ton f.o.b. works. The quotation on the 60 deg. sulphuric acid is $16.50 per ton and 1½c. per lb. in carboys, with demand slow. *Oleum* is holding at $28.50 per ton.

Demand for *muriatic acid* is dull, but producers have not very large supplies on hand and have the situation well in hand. The price is holding at 1¾@2c. per lb. in carboys and $25 per ton in bulk.

The demand for *sodium bisulphate* (niter cake) is steady and the advanced quotations noted two weeks ago are still holding. The quotations are $7@$8 per ton.

The *nitric acid* market is slightly more active and prices of two weeks ago hold good. Quotations are $7 per 100 lb. for the 36 deg. test and $10 per 100 lb. for the 42 deg. test. Standard mixed acid is quoted at 1½c. per lb. of sulphuric content and 11½c. per lb. of nitric acid. Inquiries show no decrease but orders have fallen off slightly.

No further advance has been noted on *zinc chloride*, for which demand is fairly strong. It is quoted at $4.50 per 100 lb. There has been no change in the market for U. S. Government supplies of *phenol*.

The Iron and Steel Market

Pittsburgh, Pa., Nov. 26, 1920.

Steel production by the independents continues to decrease rapidly, while the Steel Corporation maintains its production rate, the divergence being due of course to the difference in order books, as to volume of business and price involved. Some estimates place the rate of independent mill operation at an average of less than 50 per cent of capacity, and many mills are operating much below that as regards ingots.

Chairman Gary of the United States Steel Corporation late last week issued another of the periodical statements that the corporation has no intention at this time of changing its prices. The Industrial Board prices were promulgated March 21, 1919, and at intervals since then expectations have arisen that the corporation would advance above that schedule, making it desirable for Judge Gary to issue a statement indicating that the expectations were unfounded. The latest statement, however, may be viewed also as a statement that the corporation will not reduce its prices.

Probably as a result of Judge Gary's statement the independent steel producers generally began today to quote the Steel Corporation prices on bars, shapes and plates, these prices being 2.35c. on bars, 2.45c. on shapes and 2.65c. on plates. On Wednesday a canvass of at least half a dozen large independents showed that they were quoting bars, shapes and plates all at 3c., so that the reductions today on the part of these independents are $13 per net ton on bars, $11 on shapes and $7 on plates. Several independents, however, have for several weeks past been quoting prices at or near the Steel Corporation level on particularly attractive inquiries.

As to rails, however, the interpretation of the Steel Corporation statement is clear in the minds of the trade, that there had been no thought of a reduction, but instead some thought of an advance. The Industrial Board prices were $45 per gross ton for bessemer and $47 for open-hearth rails, and of late some independents have quoted as much as $16 over these prices. The Steel Corporation had made large reservations for 1921, prices to be named not later than Jan. 1. It is related that the railroads fully expected to pay the corporation at least $50 for open-hearth rails.

Steel Prices

In sheets the market continues to decline. Blue annealed sheets have been offered in all gages on the basis of 4.50c. for 10 gage, or $19 a ton above the Steel Corporation price. Black sheets have been offered down to 5.50c., or $13 a ton above the corporation price. Galvanized sheets are offered by one mill at 6.70c., or $20 over the corporation price, although that independent may be alone in quoting under 7c.

The first sale of any semi-finished steel by an independent at the Steel Corporation price has just occurred, 6,000 tons for December, January and February being sold at $48.40 delivered to a mill which has a freight rate of $1.40 from Pittsburgh, this being equivalent to the Steel Corporation price of $47 Pittsburgh. The trade has not ascertained who made the sale. Quotations on the inquiry ran up to $60, one mill quoting $60 Youngstown, equal to $62.10 delivered, and another $60 Pittsburgh, or $61.40 delivered. As to sheet bars, however, it is predicted in some quarters that the Steel Corporation will recede to the Industrial Board price of $42, its advance in September to $47 having applied merely to certain contracts that involve a quarterly fixing of price.

Pig Iron

Bessemer and basic pig iron have receded $2.50 in the week, being now available at $37.50 valley for bessemer and at $35 valley for basic. There was little temptation by way of inquiry to induce the declines. The basic decline appears to have been prompted chiefly by the offering of iron by steel works that normally consume their entire product themselves. Foundry iron remains nominally quotable at $39 valley. The recession from the top prices reached late last August, while perfectly natural in a way, has been phenomenally rapid. The total recessions to date are $11 in bessemer, $13.50 in basic and $11 in foundry. There is no doubt that iron will go below $30, but the rest of the decline may be slower.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	....–...	$0.65 – $0.75
Acetone	lb.	$0.15¾–$0.16½	.16½ – .17
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	7.25 – 7.50	7.75 – 8.00
Acetic, glacial, 99½ per cent, carboys	100 lbs.	11.50 – 12.00	12.50
Boric, crystals	lb.	.15½ – .16	.16½ – .17½
Boric, powder	lb.	.15½ – .16½	.17 – .20
Citric	lb.		.52 – .54
Hydrochloric (nominal)	100 lb.	1.85 – 2.25	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04¾ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		....	....
Nitric, 40 deg.	lb.	.07 – .07½	.08 – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.20 – .20½	.21 – .21½
Phosphoric, Ortho, 50 per cent solution	lb.	.19 – .19½	.19¾ – .21
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	....	....–....
Sulphuric, 60 deg., drums	ton	....–....	11.00 – 12.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	–
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton		–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –....
Tannic, U. S. P.	lb.	....–....	1.35 – 1.45
Tannic (tech)	lb.	.50 – .55	.56 – .60
Tartaric, crystals	lb.		.49 – .52
Tungstic, per lb. of WO	lb.	....–....	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	....–....	5.50 – 5.75
Alcohol, Methyl (see methanol)		–	–.
Alcohol, denatured, 188 proof (nominal)	gal.	....–......	.83 – .85
Alcohol, denatured, 190 proof (nominal)	gal.	....–......	.88 – .90
Alum, ammonia lump	lb.	.04½ – .04¾	.05 – .05½
Alum, potash lump	lb.	.05½ – .06	.06½ – .07
Alum, chrome lump	lb.	.14½ – .15	.16 – .17
Aluminum sulphate, commercial	lb.	.02¾ – .03	.03¼ – .03½
Aluminum sulphate, iron free	lb.	.03¾ – .04	.04¼ – .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .09½	.09½ – .10½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.36 – .38
Ammonium carbonate, powder	lb.	.14 – .14¾	.14½ – .15
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.12½ – .13	.13¼ – .13½
Ammonium chloride, granular (gray salammoniac)	lb.	.11 – .12	.12½ – .13
Ammonium nitrate	lb.	. – .10	.11 – .14
Ammonium sulphate	lb.	.04½ – .04½	.04¾ – .05
Amylacetate	gal.	...–......	4.50 – 5.00
Amylacetate tech	gal.	....–......	4.00 – 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	.12½ – .13	.13½ – .13½
Arsenic, sulphide, powdered (red arsenic)	lb.	.16 – .16½	.16¾ – .17½
Barium chloride	ton	90.00 – 95.00	100.00 – 105.00
Barium dioxide (peroxide)	lb.	.24 – .25	.26 – .27
Barium nitrate	lb.	.12 – .12½	.13 – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		.....–......	......–.......
Blue vitriol (see copper sulphate)		.....–......	......–.......
Borax (see sodium borate)		.....–......	......–.......
Brimstone (see sulphur, roll)		.....–......	......–.......
Bromine	lb.	.70 – .80	.85 – .90
Calcium acetate	100 lbs.	3.50 – 3.55	.....–.....
Calcium carbide	lb.	.04½ – .05	.05¼ – .05½
Calcium chloride, fused, lump	ton	30.00 – 32.00	33.00 – 35.00
Calcium chloride, granulated	lb.	.02 – .02½	.03 – .03½
Calcium hypochlorite (bleaching powder)	lb.	.03¾ – .04	.04½ – .05
Calcium peroxide	lb.	....–....	1.50 – 1.70
Calcium phosphate, monobasic	lb.	....–....	.75 – .80
Calcium sulphate, pure	lb.	....–......	.25 – .30
Camphor	lb.	....–....	1.05 – 1.10
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.13 – .13½	.14 – .14½
Carbonyl chloride (phosgene)	lb.	.....–......	.60 – .75
Caustic potash (see potassium hydroxide)		.....–......	......–.......
Caustic soda (see sodium hydroxide)		.....–......	......–.......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	....–....	.43 – .50
Cobalt oxide	lb.	....–....	3.90 – 4.00
Copperas (see iron sulphate)		.....–......	......–.......
Copper carbonate, green precipitate	lb.	.23 – .24	.24½ – .25½
Copper cyanide	lb.	....–....	.65 – .70
Copper sulphate, crystals	lb.	.07 – .07½	.07¾ – .08½
Cream of tartar (see potassium bitartrate)		....–..	....
Epsom salt (see magnesium sulphate)		.....–......	....
Ethyl Acetate Com. 85%	gal.	....–......	1.05 – 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		....–....	–....
Formaldehyde, 40 per cent (nominal)	lb.	.18 – .18½	.19 – .20
Fusel oil, ref	gal.	. –	3.60 – 3.75
Fusel oil, crude (nominal)	gal.	......–......	3.25 – 3.50
Glauber's salt (see sodium sulphate)		......–......	......–...
Glycerine, C. P. drums extra	lb.	......–......	.21 – .22
Iodine, resublimed	lb.	......–....	3.75 – 4.00
Iron oxide, red	lb.	......–......	.15 – .25
Iron sulphate (copperas)	100 lbs.	2.25 – 2.50	2.75 – 3.00
Lead acetate, normal	lb.	......–......	.13½ – .16
Lead arsenate (paste)	lb.	.13 – .14	.14½ – .15
Lead nitrate, crystals	lb.	......–......	.90 – 1.00
Litharge	lb.	.12 – .12½	.13 – .13½
Lithium carbonate	lb.	......–......	1.50 –....
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .12
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 4.00	..–...
Magnesium sulphate, commercial	100 lb.	......–......	3.00 – 3.25
Methanol, 95%	gal.	....–......	1.85 – 1.90
Methanol, pure	gal.	....–......	2.30 – 2.35
Nickel salt, double	lb.	......–......	.12 – .12½
Nickel salt, single	lb.	......–......	.13 – .13½
Phosgene (see carbonyl chloride)		......–......	......–......
Phosphorus, red	lb.	.50 – .52	.53 – .55
Phosphorus, yellow	lb.	....–......	.35 – .37
Potassium bichromate	lb.	.20 – .21	.21½ – .22½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$0.45 – $0.47	$0.48 – $0.49
Potassium bromide, granular	lb.	... – ...	.45 – .50
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.13 – .13½	.13½ – .14
Potassium chlorate, crystals	lb.	.14 – .14½	.15 – .15½
Potassium hydroxide (caustic potash)	lb.	.16 – .16½	.16 – .17
Potassium iodide	lb.	... – ...	3.00 – 3.20
Potassium nitrate	lb.	.14 – .16	.16½ – .17
Potassium permanganate	lb.	.60 – .63	.65 – .70
Potassium prussiate, red	lb.	.55 – .57	.58 – .60
Potassium prussiate, yellow	lb.	.34 – .35	.35½ – .36
Potassium sulphate (powdered)	ton	$240.00 – 255.00	... – ...
Rochelle salts (see sodium potas. tartrate)		... – ...	... – ...
Salammoniac (see ammonium chloride)		... – ...	... – ...
Sal soda (see sodium carbonate)		... – ...	... – ...
Salt cake	ton	... – ...	52.00 – 55.00
Silver cyanide (nominal)	oz	... – ...	1.25 – ...
Silver nitrate (nominal)	oz	... – ...	.55 – .57
Soda ash, light	100 lb.	1.90 – 2.00	2.10 – 2.30
Soda ash, dense	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium acetate	lb.	.08 – .08½	.08½ – .09
Sodium bicarbonate	100 lb.	2.90 – 3.00	3.25 – 3.50
Sodium bichromate	lb.	.09 – .09½	.09½ – .10
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ – .07	.07½ – .08
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.85 – 2.00	2.15 – 2.25
Sodium chlorate	lb.	.10 – .10½	.10½ – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .28
Sodium fluoride	lb.	.17 – .17½	.17½ – .18½
Sodium hydroxide (caustic soda)	100 lb.	4.00 – 4.10	4.30 – 4.50
Sodium hyposulphite	lb.	...	.04 – .04½
Sodium molybdate	lb.	2.50 ...	3.25 – ...
Sodium nitrate	100 lb.	3.00 ...	3.25 – ...
Sodium nitrite	lb.	.07½ – .07¾	.07¾ – .08
Sodium peroxide, powdered	lb.	.35 – .40	.42 – .45
Sodium phosphate, dibasic	lb.	.03¾ – .04¼	.04¼ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.33 – .35
Sodium prussiate, yellow	lb.	.18 – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01¼ – .01¾	.02 – .02¼
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½ – .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	2.15 – 2.50	2.60 – 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.07 – .07¼	.07¼ – .08
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.20 – .20½	.21 – .22
Sulphur chloride, red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	... – ...
Sulphur dioxide, liquid, cylinders	lb.	.09 – ...	.10 – .12
Sulphur (sublimed), flour	100 lb.	... – ...	3.70 – 4.35
Sulphur, roll (brimstone)	100 lb.	... – ...	3.40 – 3.90
Tin bichloride, 50 per cent	lb.	.18 – .19	...
Tin oxide	lb.	... – ...	.50 – .51
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.12 – .13	.13½ – .14
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, XX	lb.	.10 – .10½	.11 – .11½
Zinc sulphate	lb.	.03¼ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.44 — .46
Aniline oil, drums extra	lb.	.26 — .27
Aniline salts	lb.	.32 — .35
Anthracene, 80%, in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.15 — 1.20
Benzidine sulphate	lb.	1.10 — 1.15
Benzoic acid, U.S.P.	lb.	.80 — .85
Benzoate of soda, U.S.P.	lb.	.80 — .90
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35 — .40
Benzene, 90%, in drums (100 gal.)	gal.	.32 — .35
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech.	lb.	.25 — .35
Beta-naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta-naphthol, sublimed (nominal)	lb.	.75 — .80
Beta-naphthol, tech. (nominal)	lb.	.40 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U.S.P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 — 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 — 1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzene	lb.	.07 — .10
Diethylaniline	lb.	1.45 — 1.50
Dimethylaniline	lb.	.75 — .80
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.27 — .32
Dinitronaphthalene	lb.	.4[illegible] — .45
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.30 — .32
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.75 — .77
H-acid (nominal)	lb.	1.60 — 1.65
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.17 — .18
Monoethylaniline	lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09 — .09½
Naphthalene, flake	lb.	.09 — .09½
Naphthalene, balls	lb.	.09½ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.30 — .32
Para-amidophenol, base	lb.	2.35 — 2.40
Para-amidophenol, HCl	lb.	2.25 — 2.30
Para-dichlorbenzene	lb.	.10 — .15
Paranitroaniline	lb.	1.10 — 1.15
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.20 — 2.35
Para-toluidine	lb.	1.85 — 2.00
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.08 — .10
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	2.90 — 3.00
Resorcinol, pure	lb.	3.75 — 4.15
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35 — .38
Salicylic acid, U. S. P.	lb.	.40 — .45
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 — .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .22
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.45 — 1.50
Toluidine, mixed	lb.	.45 — .55
Toluene, in tank cars	gal.	.35 — .....
Toluene, in drums	gal.	.38 — .40
Xylidines, drums, 100 gal.	lb.	.45 — .50
Xylene, pure, in drums	gal.	.45 — .47
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.37 — .38
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.26 — $0.27
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.35 — .40
Carnauba, No. 1 (nominal)	lb.	.80 — .90
Carnauba, No. 2, regular (nominal)	lb.	.70 — .80
Carnauba, No. 3, North Country	lb.	.25 — .26
Japan	lb.	.19 — .20
Montan, crude	lb.	.12 — .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07½ — .08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07½ — .07¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 — .09½
Paraffine waxes, refined, 125 m.p.	lb.	.09½ — .09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10½ — .11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13½ — .14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.14½ — .15½
Stearic acid, single pressed	lb.	.17½ — .17¾
Stearic acid, double pressed	lb.	.18½ — .19
Stearic acid, triple pressed	lb.	.22½ — .23

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$11.25 — .....
Rosin E-I	280 lb.	11.25 — ....
Rosin K-N	280 lb.	11.25 — ....
Rosin W. G.-W. W.	280 lb.	11.50 — 11.75
Wood rosin, bbl.	280 lb.	11.00 — .
Spirits of turpentine	gal.	1.02 — ..
Wood turpentine, steam dist.	gal.	1.00 — ...
Wood turpentine, dest. dist.	gal.	1.00 — ..
Pine tar pitch, bbl.	200 lb.	..... — 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... — 15.00
Retort tar, bbl.	500 lb.	15.00 — 15.50
Rosin oil, first run	gal.	.70 — .....
Rosin oil, second run	gal.	.73 — ....
Rosin oil, third run	gal.	.90 — .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.22 —$0.23
Upriver coarse (nominal)	lb.	.15 — .16
Upriver caucho ball (nominal)	lb.	.16½ — .17½
Plantation—First latex crepe	lb.	.19 — .....
Ribbed smoked sheets	lb.	.18 — .....
Brown crepe, thin, clean	lb.	.16 — .....
Amber crepe No. 1	lb.	.17 — .....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.14½ — $0.15
Castor oil, AA, in bbls.	lb.	.15¾ — .16½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12¼ — .12½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.14 — .14½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.15½ — .16½
Corn oil, crude, in bbls.	lb.	.10 — .10½
Cottonseed oil, crude (f.o.b. mill)	lb.	.06 — .07
Cottonseed oil, summer yellow	lb.	.09½ — .10
Cottonseed oil, winter yellow	lb.	.11 — .12
Linseed oil, raw, car lots (domestic)	gal.	.83
Linseed oil, raw, tank cars (domestic)	gal.	.80
Linseed oil, boiled, car lots (domestic)	gal.	.85

Olive oil, commercial	gal.	2.75	— 3 00
Palm, Lagos	lb.	.09½	— .09¾
Palm, Niger	lb.	.09	— .09½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¾	— .09
Peanut oil, refined, in bbls	lb.	.15	— .15½
Rapeseed oil, refined in bbls	gal.	1.15	— 1 20
Rapeseed oil, blown, in bbls	gal.	1.25	- 1.35
Soya bean oil (Manchurian), in bbls N. Y.	lb.	.09¾	— .10
Soya bean oil, tank cars, f.o b., Pacific coast	lb.	.07	- .07½

FISH

Light pressed Menhaden	gal.	$0 65	— $0 70
Yellow bleached Menhaden	gal.	.67	— .70
White bleached Menhaden	gal.	.72	- 75
Blown Menhaden	gal.	1.05	-- 1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—$30 00
Barytes, ground, off color, f o b. Kings Creek	net ton	22.00	— 26 00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	-- 12.00
Barytes, floated, f o.b St. Louis	net ton	26 50	- 28 00
Barytes, crude, first grade, Missouri	net ton	10 00	— ..
Blanc fixe, dry	lb.	05	— .05½
Blanc fixe, pulp	net ton	60 00	— 65.00
Caseine	lb	.14	— .18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	--- .05½
Chalk, domestic, heavy	lb.	.04	- .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb	04½	-- 05
China clay, (Kaolin) crude, f o b mines, Georgia	net ton	8 00	-- 10 00
China clay (Kaolin) washed, f o b Georgia	net ton	12 00	15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	12 00
China clay (Kaolin) ground, f.o b. Virginia points.	net ton	15 00	-- 40 00
China clay (Kaolin), imported, lump	net ton	25 00	— 35 00
China clay (Kaolin), imported, powdered	net ton	30.00	35.00
Feldspar, crude, f.o b. Maryland and North Carolina points	gross ton	8.00	— 14 00
Feldspar, crude, f.o b. Maine	net ton	7 50	-- 10 00
Feldspar, ground, f o b Maine	net ton	21 00	--- 23 00
Feldspar, ground, f.o b. North Carolina	net ton	17 00	— 21 00
Feldspar, ground, f.o b. N Y. State	net ton	17 00	- 21.00
Feldspar, ground. f o b Baltimore	net ton	27.00	30 00
Fuller's Earth, f.o.b. New York	net ton		18.00
Fuller's earth, granular, f.o.b. Fla.,	net ton	25 00	—
Fuller's earth, powdered, f.o b. Fla,	net ton	18.00	--
Fuller's earth, imported, powdered	net ton	35.00	40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	. .	- .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07	- .09
Graphite, higher lubricating grades	lb	.11	— .40
Pumice stone, imported, lump	lb	.04	.50
Pumice stone, domestic, lump	lb.	.06	--- .
Pumice stone, ground	lb.	.04	— 07
Quartz (acid tower) fist to head, f o b Baltimore	net ton	.. .	10 00
Quartz (acid tower) 1½@ 2 in, f.o b Baltimore	net ton	......	-- 14 00
Quartz (acid tower) rice, f o b Baltimore	net ton	...	— 17 00
Quartz, lump, f o b North Carolina	net ton	5.00	-- 7 50
Shellac, orange fine	lb.	1.00	. 1.05
Shellac, orange superfine	lb.	1 05	1.10
Shellac, A. C garnet	lb.	.90	95
Shellac, T. N	lb.	.85	. 95
Soapstone	ton	15.00	— 25 00
Sodium Chloride	long ton	. .	-- 17.50
Talc, paper making grades, f.o.b. Vermont	ton	12 00	— 22 00
Talc, roofing grades, f o b. Vermont	ton	9.50	-- 15 00
Talc, rubber grades, f.o b. Vermont	ton	12 00	18 00
Talc, powdered, Southern, f o b. cars	ton	12 00	- 15 00
Talc, imported	ton	60 00	-- 70 00
Talc, California Talcum Powder grade	ton	20 00	-- 45 00

Refractories

Bauxite brick, 56% Al, f o.b. Pittsburgh	1,000	160
Chrome brick, f.o b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	45 50
Magnesite brick, 9 in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f o b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	--$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17	— .18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	16	17
Ferro-manganese, 76-80% Mn, domestic	gross ton	155 00	- 160 00
Ferro-manganese, 76-80% Mn, English	gross ton	150 00	-- 155 00
Spiegeleisen, 18-22% Mn	gross ton	60 00	— 70 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb	2.00	— 2.50
Ferro-silicon, 10-15%	gross ton	60.00	— 65.00
Ferro-silicon, 50%	gross ton	80.00	— 85.00
Ferro-silicon, 75%	gross ton	.....	-- 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.75	— .90
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	-- .....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	— 7.50

Ores and Semi-finished Products

All f.o b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 11% moisture	gross ton	$10 00	$11 00
Chrome ore, Calif concentrates, 50% min Cr_2O_3	unit	. 65	70
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	60	.65
Coke, foundry, f o b. ovens	net ton	9 00 --	11 00
Coke, furnace, f o b ovens	net ton	7 00	9 00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	26.00
Fluorspar, lump, f o b Tonuco, New Mexico	net ton	17 00	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22 50	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb	01½ --	.01½
Manganese Ore, 50% Mn, c i f Atlantic seaport	unit		45
Manganese ore, chemical (MnO_2)	gross ton	55 00	60 00
Molybdenite, 85% MoS_2, per lb of MoS_2, N. Y.	lb.	55	60
Monazite, per unit of ThO_2, c i f, Atlantic seaport	unit	35 00 -	..
Pyrites, Spanish, fines, c i f, Atlantic seaport	unit	.12	.
Pyrites, Spanish, furnace size, c i f, Atlantic seaport	unit	.17 —	
Pyrites, domestic, fines, f o b mines, Ga	unit	.12	.14
Rutile, 95% TiO_2 per lb. ore	lb	.15 --	. .
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	6.00	..
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50 -	5 00
Uranium Ore (Carnotite) per lb of U_3O_8	lb.	2 75 -	3 00
Uranium oxide, 96%, per lb. contained U_3O_8	lb.	2 75 —	3 00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	2.00 —	.
Zircon, washed, iron free	lb.	.05 -	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	15 75
Aluminum, 98 to 99 per cent	32 00
Antimony, wholesale lots, Chinese and Japanese	6 00
Nickel, ordinary (ingot)	43 00
Nickel, electrolytic	45 00
Tin, 5 ton lots	39 01
Lead, New York, spot	7 25
Lead, E. St Louis, spot	7 05
Zinc, spot, New York	7.00
Zinc, spot, E St Louis	6 60

OTHER METALS

Silver (commercial)	oz	$0 91½
Cadmium	lb.	1 40@1.50
Bismuth (500 lb lots)	lb.	2 55
Cobalt	lb	6 00
Magnesium (f o b Niagara Falls)	lb	1.75
Platinum	oz.	85.00@ 90 00
Iridium	oz	350.00@ 400 00
Palladium	oz	85.00
Mercury	75 lb	58.00@ 60.50

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	23 50
Copper bottoms	34 00
Copper rods	29.00
High brass wire and sheets	27 50
High brass rods	19 00
Low brass wire and sheets	30.50
Low brass rods	24.00
Brazed brass tubing	36 25
Brazed bronze tubing	41.50
Seamless copper tubing	28.00
Seamless high brass tubing	27 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 50	17 00	12 00	13 50
Copper, heavy and wire	12 00	16 00	11 75	12 50
Copper, light and bottoms	10 00	14 00	10 00	11 00
Lead, heavy	5 50	4 75	5 50	6 00
Lead, tea	4 50	3 75	3 75	5 00
Brass, heavy	7 00	10 50	8 00	12 50
Brass, light	5 50	7 50	5 00	6 50
No. 1 yellow brass turnings	7 00	10 00	6 00	6 75
Zinc	4 50	5 00	3 75	5 00

Structural Material

The following base prices per 100 lb are for structural shapes 3 in by ¼ in and larger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named.

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4 15	$4 47	$3 47	$3 44	$3 37	$4 08	$3 47
Soft steel bars	4 15	4 62	3 37	3 84	3 27	3 98	3 37
Soft steel bar shapes	4 15	4.62	3 37	3 84	3 27	3.98	3.37
Soft steel bands	5 50	6 32	4 07	6 25	. .	..	.
Plates, ¼ to 1 in thick	4 15	4 67	3 67	3 64	3 57	4 28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

SOUTH GLASTONBURY—The Wasue Mills Co. plans to build a paper plant to replace the one recently destroyed by fire. Estimated cost, $50,000.

VERSAILLES—The Federal Paper Bd. Co. has awarded the contract for altering and building a 2-story addition to its paper factory to H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $250,000.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., has awarded the contract for the construction of laboratory buildings, etc., at the Naval Experimental and Research Laboratory at Bellevue, to Boyle and Robertson, Evans Bldg., at $652,411.

Florida

PALATKA—The United Sugar Corp., 1512 Walnut St., Philadelphia, Pa., will soon award the contract for the construction of a sugar refinery, including mill, etc. Estimated cost, $1,000,000. G. P. Anderson, engr.

Indiana

COLUMBUS—The Indiana Oil Refinery Co. plans to build an oil refinery to have a capacity of 1,000 bbl. O. L. Bartlett, pres.

Iowa

CEDAR RAPIDS—The Bd. Educ. will soon receive bids for the construction of 4 high schools. A chemical laboratory will be installed in each. Estimated cost, $1,200,000. K. Mategill, secy. Frank Tustison and Hugh & Zalesky, 811 Securities Bldg., Des Moines, engrs. and archts.

CORYDON—The Bd. Educ. will receive bids about Dec. 15 for the construction of a 3-story, 67x121-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $160,000. W. Gordon, Hubbell Bldg., Des Moines, archt.

FORT MADISON—Hinde & Dauche Co. plans to build a paper mill. Estimated cost, $100,000.

Louisiana

NEW ORLEANS—The Apex Paper Co., Paris Ave. and the New Orleans Terminal R.R., plans to build a 1-story, 10x90-ft. building addition to its plant. Estimated cost, $50,000. H. W. Schlosser, secy.

NEW ORLEANS—The Linde Air Products Co., 30 East 42nd St., New York City, will build a 1-story, 125x125-ft. oxygen factory. Estimated cost, $300,000. Work will be done by day labor.

Maine

HOULTON—P. J. Sullivan, 74 Broad St., Boston, plans to build a 1-story, 80x300-ft. fertilizer plant.

Massachusetts

DEDHAM—The Third Natl. Film Co., 61 Milk St., Boston, plans to build a large moving picture laboratory here in the spring.

EAST WALPOLE—Bird & Son, Inc., plans to build a 1-story, 50x200 ft. plant for the manufacture of roofing materials, etc. Charles Main, 201 Devonshire St., Boston, engr.

NEWTON—Boston College, Chestnut Hill, plans to build a 3-story science building on College Rd. Estimated cost, $375,000. Maginnis & Walsh, 100 Royston St., Boston, archts.

SANDWICH—The Sagamore Co., 53 State St., Boston, has awarded the contract for the construction of a 1-story pulp mill, to T. Kellher. Estimated cost, $100,000.

Maryland

BALTIMORE—The Red "C" Oil Mfg. Co., 110 Keyser Bldg., is having plans prepared for the construction of tanks and probably a refinery, on Key Highway. Estimated cost, $250,000. W. W. Pagon, Lexington Bldg., engr.

Michigan

SAGINAW—The Bd. Educ. plans to build a 3-story, 173x282-ft. school on Weadock and Park Sts. A chemical laboratory will be installed in same. Estimated cost, $1,000,000. Cowles & Mutscheller, Chase Blk., archts.

Minnesota

ANNANDALE—The Bd. Educ. is having plans prepared for the construction of a 2-story, 110x151-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $250,000. C. H. Parsons, 600 Builders Exch., Minneapolis, archt.

EVELETH—The Bd. Educ. will receive bids about January for the construction of a 3-story, 110x200-ft. vocational high school. A chemical laboratory will be installed in same. Estimated cost, $750,000. J. M. Stearns, clk. W. T. Bray, 817 Torrey Bldg., Duluth, archt.

LONG PRAIRIE—The Bd. Educ. has awarded the contract for the construction of a 2-story, 75x160-ft. high school to the Carlsted Bros., 512 Builders Exch. Bldg., Minneapolis. A chemical laboratory will be installed in same. Estimated cost, $86,692.

Nebraska

NORFOLK—The Bd. Educ. had plans prepared for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. J. C. Stitt, archt.

New Jersey

GLEN ROCK (Ridgewood P. O.)—The city will receive bids in March for the construction of a sewage disposal plant, etc. Estimated cost, $300,000. H. J. Harder, engr.

PASSAIC—The Newport Chemical Wks., Inc., 168 River Drive, plans to build a warehouse. R. W. Wiliner, secy.

New York

OSWEGO—The Bd. Educ. plans to build a 3-story, 200x264-ft. high school on Utica St. Laboratory equipment will be installed in same. Estimated cost, $150,000. J. A. Randall, S. A. & K. Bldg., Syracuse, archt. and engr.

SHEEPSHEAD BAY—C. A. Benoit, Jerome Ave., has awarded the contract for the construction of a factory on Jerome Ave., to the Gretsch Eng. Corp., 103 Park Ave., New York City. Estimated cost, $150,000.

Ohio

DAYTON—The Bd. Educ. plans to build a 3-story high school on Summit St. A chemical laboratory will be installed in same. Estimated cost, $750,000. Schenk & William, Mutual Bldg., archts.

Oklahoma

MIAMI—The city has awarded the contract for the construction of a sewage disposal plant, etc., to Jame & Shoe, City Hall. Estimated cost, $111,000.

Pennsylvania

HAZLETON—The United Filters Corp. is building a plant, including several buildings. Filters for chemical food and mining industries will be installed in same. C. M. Stanley, chief engr.

West Virginia

HUNTINGTON—The Fordlette Engine Co. plans to build a plant for the manufacture of gas engines. Plans will probably include a foundry for castings, machine shop and assembling plant. Estimated cost, $100,000.

Quebec

THREE RIVERS—The Three Rivers Pulp & Paper Co. has awarded the contract for the construction of a pulp and paper plant to William I. Bishop Co., 10 Cathcart St., Montreal. Estimated cost, $500,000.

QUEBEC CITY—P. A. Beaulie, 37 Bourlargue St., will soon receive bids for the construction of a brass foundry including equipment. Estimated cost, $69,000.

New Publications

MECHANICAL ORE SAMPLING IN MONTANA, by H. B. Pulsifer. Published by the State School of Mines, Butte, Mont.

RECENT INCREASES IN THE PRICES OF PETROLEUM AND ITS PRODUCTS, published by the American Petroleum Institute, 15 West 44th St., New York City.

ANNUAL REPORT FOR THE YEAR 1919, published by the Bureau of Mines, State of Colorado, Denver, Col.

THE CHICAGO GEOGRAPHIC SOCIETY, Harry P. Pearson, president, is making plans for the founding of a geographic magazine defined as "an organ of discovery and interpretation disclosing man to man and unifying his family in the exchanges of commerce." The trade and banking interests of Chicago are in favor of this movement because of its value to commerce.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deshler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hôtel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS 1920 annual meeting will be held in the Engineering Societies Building from Dec. 7 to 10 inclusive.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

TAYLOR SOCIETY will hold its annual meeting Dec. 2, 3 and 4 in the Engineering Societies Bldg., New York City. The meeting of Dec. 3 at 8 p.m. will be of special interest to metallurgists. The subject will the "The Long Day in the Steel Industry."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

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In the Interest of Education in Mathematics

IT IS PROFITABLE in more ways than one to study the reports of the Rockefeller Foundation and the General Educational Board. The literary style of President VINCENT of the Foundation, whereby, in the simplicity of consummate art, he tells, in the fewest possible words, of their herculean efforts in battle against disease and for health all over the world, is an inspiration in itself. And again, to know that while so large a part of the world seems to have lost its ideals and to have gone loose in thinking and in character, there are those who are diligent in well-doing without trying to make a fuss about it is a still greater inspiration. In his report of the General Educational Board Dr. BUTTERICK explains their activities with the greatest praise for the generosity of others, but with such modesty for the Board's own immense disbursements as to give the impression that they really had to do it and that he hoped you would excuse them for having to acknowledge it.

One item in explanation of an appropriation for a committee of the Mathematical Association of America deserves mention here. A great many of our chemists and chemical as well as other engineers are short in their mathematics. Even among those who have studied and have passed their examinations, the understanding and the philosophy of mathematics is often lacking. Mathematics is too often taken like Latin to be studied "to train the mind" and then forgotten. By far too much is known by formula only. Now this committee composed of professors and instructors from colleges and secondary schools present a report which is reprinted in full in the report of the General Educational Board, and it is well worth reading. They believe that both in colleges and secondary schools the mathematical curriculum is in need of reformation. It should be adapted to the needs of the world of today and tomorrow instead of the world of yesterday. It is held that secondary school mathematics may prepare the student for his life work as well as for college courses without lowering the standard of scholarship. In regard to algebra, for instance, they say: "Our elementary algebra is, in theory and symbolism, substantially what it was in the seventeenth century. The present standards of drill work, largely on non-essentials, were set up about fifty years ago. The few lines of application of algebra to nominally practical questions found in our college entrance examinations are mere variants of problems that are centuries old and often represent only remotely any real conditions of today. A considerable number of teachers, both in the secondary schools and in the colleges, believe that the amount of time spent by pupils on abstract work in difficult problems in division, factoring, fractions, simultaneous equations, radicals, etc., is excessive; that such work leads to nothing important in the science, and adds but little to facility in the manipulation of algebraic forms." They believe that the more difficult and abstract portions of such work could be replaced by work of a much more profitable nature, such as the real uses of algebra, the applications of intuitive geometry, modern methods of computation, and the significance of trigonometry. Among specific elementary topics which have of recent years been suggested and whose availability in this connection should receive careful and open-minded consideration may be mentioned the mathematics of business and finance, the graphic representation of facts, mechanical drawing and perspective, elementary notions of statistics, the use of logarithms (and of tables in general), the slide rule, elementary principles of surveying with field work, etc. It is also felt by many that, just as the mathematical work in the schools has in the past been enriched by the continual introduction of principles previously regarded as too advanced, the time has come to give careful consideration to the question whether in the more advanced secondary school courses the work could not be made more valuable, more vital and more significant by the introduction of the elementary principles of analytic geometry and calculus, and of projective geometry. It is urged that the elementary ideas and processes of these subjects are less difficult than some of those now included in our courses in advanced algebra and solid geometry, and much more interesting and significant.

"It is urged by many friendly critics that, instead of giving a student a good all-round idea of what mathematics means and of its general range of application, our present secondary school courses are too abstract, often uninteresting except to the mathematically inclined, and not as valuable as they might be as an aid to college work in general or to life work for those who enter at once into their careers. These are not the opinions of the extremists in the schools of education; they are the opinions that are held by a large number of college professors and secondary school teachers. They are not the opinions of destructionists, but of those who have well-defined ideas of a modern, living, scholarly course in mathematics to replace what they believe is rapidly becoming obsolete."

There is still more to the same effect, and we wish we had space for it. Suffice to say that the enlightened teachers believe that they can begin mathematics in secondary schools as a live study, and by extending it into the first two years of college courses, give the subject that reality and vitality to which it is entitled.

We congratulate the teachers on the support that they are receiving in this good work and we congratulate the General Educational Board on its wisdom. It looks like light ahead.

Patents Viewed As Contracts

SOME months ago, in our issue for Sept. 22, 1920, we published an article by CHESLA C. SHERLOCK on "The Value of Patents." The author made an admirable presentation of the position of the patentee as far as his monopolistic powers are concerned. He quoted one court as saying, "Within his domain he [the patentee] is czar." There is, however, another important phase of the matter which should not be overlooked—namely, the contract relation of the patentee to the public. By very reason of the fact that the patentee is czar within his domain, and because of the monopolistic powers conferred upon him, "the acts of legislatures which prescribe the limit and conditions of the patent privilege and the decisions of the courts in interpreting and applying such legislative acts relate to its contract character alone." Our authority is found in section 41 of Robinson on Patents.

In other words, a patent is primarily a contract between an inventor and the public, a contract by the terms of which the patentee is obliged distinctly to state and clearly point out in exact terms just wherein his invention lies and of what it consists. This duty to the state is explicitly imposed upon the patentee. Curtis says: "The truth is, a patent should be construed as what it really is, in substance—namely, a contract or bargain between the patentee and the public upon those points which involve the rights and interests of either party. These points relate to the extent of the claim and to the intelligibility of the description for the purposes of practice."

Courts and legal writers in treating this subject have consistently recognized the principle that patent law rests upon a contract basis. Hence, because of the broad—not to say monopolistic—character of the grant to the patentee, he is held by the courts strictly to the scope of his patent as distinctly claimed and clearly pointed out in the claims.

Doctor, Teacher, Chemist, Preacher

IN THE *Transactions* of the Institution of Mining and Metallurgy of Great Britain for the years 1917-18 there is a necrological note of interest. It refers to one of their members born in Canada in 1837, the son of a Canadian surgeon. As a young man the late member planned to follow his father's footsteps, studied medicine in Canada and Germany, but on returning to Quebec he became professor of chemistry at Morrin College, Quebec, instead of practicing his avowed profession. In the end neither medicine nor chemistry could hold his attention against what seemed a greater call, for he returned to Europe, this time to Scotland, where he matriculated and took the course in theology at the University of Edinburgh. In 1875, when he was thirty-eight years of age, he received his license to preach in the Presbyterian Church. He was not ordained in any pastorate, however, because just at that time his father's affairs, owing to unfortunate investments, called for his immediate presence in Canada again. He therefore returned and addressed himself to the problem of saving his father's property, but in order to provide for his own sustenance he became superintendent of an insane asylum, thus reverting in part to the practice of medicine again. Now, among the old doctor's investments that had gone wrong was the Harvey Hill copper mine in Quebec, which could never be developed into a great success—but it gave the junior doctor-clergyman both interest in and experience on the subject of copper mining and the treatment of copper ores. His work along this line led to his engagement, as a man of forty, to become superintendent of a chemical copper extraction plant in Pennsylvania where Western matte was treated. In 1880, being then forty-three years of age, he went West to pay a visit to a recently opened mine in Arizona, where he recognized a great future for the industry. Then he returned East and interested some of the partners of a leading metal firm in the enterprise, but endured four or five years of great uncertainty and anxiety before the tide turned. After this there followed nearly forty years of immense personal and professional success in the development of the American copper mining and smelting industry, in which he was recognized as a great leader. The metal firm to which we refer was PHELPS, DODGE & CO., and the man whose history we have been sketching was none other than the late Dr. JAMES DOUGLAS.

An Appropriate Time For Investigations

WHEN times are good and material costs are low, it is easy to make money in industry. The real test of operating efficiency comes only when the operating margin is small or when costs advance sharply with reference to market demands for products. During the war period (and no economic discussion can fail to mention the war) chemical industry grew like Jack's beanstalk of fairy-tale fame. In many cases expansion at any cost or even with very poor efficiency represented a gain; but in normal times these low efficiencies are, of course, not at all acceptable.

With increasing complexity of industrial conditions during readjustment, the management of chemical industry is watching much more closely every detail of plant performance. It is a fine time to get out all the old operating records and analyze them in a way that the rush of production even beyond plant capacity forbade during the several years of war-time stress. These records, which perhaps were kept in a more or less perfunctory manner, now take on increased importance; from them in many cases it will be feasible to determine the relation between operating conditions and plant efficiency. Formerly, capacity output governed; now, plant efficiency is the determining factor in success. Even though in the past the chemical staff or the engineer of tests has largely been regarded as a necessary evil set by the management to spy upon the operating force, it will be worth while to see what this chemist or engineer of tests has to show.

Perhaps some of the research-laboratory recommendations for "improvements" in process can also be tried out most successfully at a time like this. Such trials frequently result in temporary interruptions of process, small amounts of material spoilage, or temporary reduction in output. The possibility of such losses or reduced speed of operation cannot be risked during times of large demand for output. But when there is a tendency to reduce stocks and to slow up operation to permit this, the time is particularly appropriate for these trials; and if the trials result in improved efficiency, in increase of output, or in decrease of costs, there is no time when such fortunate result is more welcome.

Engineering Reports Partisan and Impartial

"IDEAL engineering reports are in effect minature court decisions. The evidence is first arranged, the arguments are presented, and finally an engineering judgment is rendered." Thus one of the well-known consulting engineers of Chicago writes in his contribution to a discussion of the function and make-up of engineering consultants' reports. The same communication goes on to discuss how material should be treated by the engineer who makes the report, giving splendid suggestions on many points. But one point is not raised in this discussion—as to the attitude of the executive or board of directors for whom the report is prepared.

Facts are often uncomfortable things and judicially minded decisions and advice sometimes are disappointing. Nevertheless, when a consultant is engaged great pains should be taken that he is given full opportunity to get the facts and render to the best of his ability an absolutely impartial report or finding. To insure this is a part of the responsibility of the executive or board for whom the report is being prepared.

An outside investigator or adviser, unless unusually tactful or of unusual fame and ability, is likely to be received in anything but a friendly way by the operating staff whose work is under scrutiny. The lot of a consultant who is to advise as between two recommendations of the staff is particularly unhappy because of these factors. However, much of the possible good from expert assistance is lost unless some executive means be found to give the whole truth as a basis for recommendations. The executive should not be satisfied with a report based upon an investigation which has been in any way hampered to prevent such judicial consideration of all important pertinent factors.

There are, of course, many occasions upon which a consultant is engaged to assist in controversial matters as between a company and the authorities, or a company and some other commercial agency with which it happens to have legal or commercial difficulties. A report prepared by a consultant or with his assistance for public use and partisan purposes is, of course, proper in such circumstances. The consultant does not expect to emphasize both sides of the question, but will limit himself to the presentation of the points favorable to his client, which he will set forth honestly and as effectively as circumstances permit. For such work the consultant becomes in effect an advocate and takes on himself all of the responsibility and privileges of the attorney advocate, except that he usually limits his effort to the technical field.

This same attitude cannot successfully be assumed in reports prepared for the assistance of executive officers. For such latter purposes a discussion of both sides of any case, setting forth the strong points for and against the decision finally reached, is most satisfactory. The executive is entitled to know the evidence on both sides. Indeed, the final recommendation of the expert is strengthened by a frank presentation of the best arguments which may be advanced against his findings, even though the final recommendation be a definite judgment. The executive who receives such report is fortunate, for he can feel sure that his adviser has taken into account both sides of the question and has not simply undertaken to present convincing arguments in support of preconceived ideas.

The Regulation Of Immigration

THE Welty immigration bill introduced in the House of Representatives May 22, 1920, receives strong support in various quarters and is likely to constitute a live issue in Congress. Very briefly stated, its object is to regulate immigration from time to time by a flexible system administered by a board to be composed of an appointed member, who shall be chairman, and the Secretaries of State, Labor, Commerce, Agriculture and Interior. Immigration is to be considered by ethnic groups and the volume of each regulated according to assimilibility and the industrial needs of the country.

It is not calling labor a "commodity" to say that the scheme is of the same order with a tariff system which seeks to encourage the importation of materials we need to import and aims to exclude materials not needed. With this fact in mind, and noting the widely divergent interests that have been represented in tariff discussions, it becomes obvious that a tremendous responsibility would have to be borne by the contemplated Immigration Board. The proponents of the bill undertake to depict the admirable results that would follow its enactment. The bill certainly aims to handle the matter of immigration in a scientific and practical manner and thus it is wholly novel by comparison with immigration legislation of the past.

The bill is naturally to be considered on the premise that there are certain objections to immigration. Those workers who object to immigration do so on the ground that they do not wish to be diluted, and do not wish the standard of employment to be reduced. The bill provides that the Immigration Board shall base its actions upon "the maintenance of American standards of living and wages," and in this respect again it becomes merely a question of whether the board functions perfectly. As to dilution, it is plainly the purpose of the proposed scheme to encourage the immigration of classes of workers we particularly need. It has been made quite plain by developments in recent years that the workers we have do not gravitate toward the various employments in the proportions that the public as a whole desires. The people in the cities insist that too many boys leave the farms. The consumers of coal insist that not enough men want to make coal mining their work, and so on and so on.

One can hardly doubt that the employment preferences of the people are not distributed in the proportion that would be best for us as a whole. If we can improve the analysis by increasing the percentages in certain lines, we should do so. If there are objections to the Welty plan on the part of groups of workers whose percentage has been tending to diminish below the proper level for the good of all, such objections should not be considered. For years there has been much preachment that we should make one occupation or another more comfortable and attractive whereby men would be moved to change their minds and take up that class of work. There has been very little success along this line. The main thing we have done is to bribe men, and that does not work well. The men are dissatisfied and seek constantly to have the bribe increased. If an ethnic group can be found that like the kind of work we do not like, it certainly would be a good plan to encourage people of that group to come and do the work. Would that not be much better than bribing an unwilling worker?

British Chemical Industry

(From Our London Correspondent)

London, Nov. 13, 1920.

WITH the passing of the coal strike the demand for chemicals has improved, particularly from the textile and other industries of prime importance. Nevertheless, prices remain steady, partly owing to the unsatisfactory condition of an export trade suffering from adverse exchange conditions, but mainly because the recent "shake-out" has done much to stabilize markets and to bring market prices within reasonable distance of actual manufacturing costs. The question of transport generally and the alleged unfair discrimination of the railway companies against the products of the chemical industry are receiving considerable attention and a new trade paper is to deal solely with this subject and with that of "freight exchange," which aims at the reduction of wasted "return empty" journeys. Distances being relatively small in this country, chemical manufacturers are increasingly adopting road transportation, and this tendency has been accentuated by the policy of the railway companies.

Government Delays Restrictions on Imported Dyestuffs

For some time past the daily and technical press have been innundated with articles, often apparently inspired by those chiefly affected, emphasizing the importance of maintaining the dyestuff industry on an adequate scale, and explaining *ad nauseam* its relation to chemical warfare. From the national point of view the importance of being prepared in a military sense is admitted, but the average business man has realized that compared, for instance, with the maintenance of supremacy in the cotton and piece goods trade, the value of the home dyestuffs industry *per se* is almost negligible. At the same time the government definitely committed itself, when the prospectus of the British Dyestuffs Corporation was issued, to protect the industry from German aggression, and it will be remembered that the proclamation prohibiting importation except under license was vitiated by the "Sankey judgment." A year having elapsed during which German dyes have been entering freely in ever-increasing quantities, pressure is being applied on the government to redeem its pledge by immediate legislation. It was intended to include dyestuffs in the so-called "dumping bill" which was to protect other "key" industries such as glass, etc., but as the measure is a highly contentious one as far as the other key industries are concerned, immediate and separate legislation in regard to dyestuffs seems essential if the British dyestuffs industry and the interests of its shareholders are not to be seriously jeopardized. It seems probable that the government will agree, but there is grave misgiving in regard to the matter in the cotton trade, which will naturally be the loser. It is rumored that the Board of Trade will now summon a conference representative of all interests concerned in order to enable an agreed measure to be laid before Parliament, and such a course would probably solve the difficulty.

Dyestuff Merchants Demand Export Facilities

The question of dyestuff exports and re-exports is closely bound up with this matter, because, as previously mentioned in these articles, there is a growing tendency among manufacturers, and dyestuff manufacturers are a good example, to appoint their own distributors and to eliminate the merchants wherever possible by restricting supplies to them for the export trade. Merchants are now demanding price facilities for the export trade at least equal to those of manufacturers' agents and a scheme has also been drawn up to facilitate re-export of foreign dyestuffs from bond (with reasonable customs safeguards). As regards export, it is pointed out that rather than lose the valuable foreign and particularly Eastern trade connections secured in the past, the merchants would sell German, Swiss or U.S.A. dyestuffs in foreign markets in competition with the British products, which under present conditions would probably lead to reduced exports and to unemployment in the industry. Now that the merchants have at last formed a really representative association, there is a better prospect of their interests being safeguarded and of a compromise fair to all parties being agreed upon.

Prof. Soddy Condemns Government Research Policy and Chemical Warfare Scheme

Much valuable knowledge has admittedly been accumulated during the war and since by government departments and research associations subsidized by the government. It has been agreed that discoveries made with the aid of public funds should be made available, under proper conditions, for the public advantage, but it is notorious that in many cases these results and data have been sold or transferred to the great business interests, and where publication was made, it was only on a restricted scale. This is characterized by Prof. Soddy as unfair competition. At the same time he advocates increased use of the scientific and technical faculties of the universities to supplement the work of the research associations. Writing to *Nature*, Prof. Soddy complains that the committee to be constituted for chemical warfare and research is to submit in advance to the official secrets act and protests that scientific workers should not be called upon to prostitute science in times of peace to develop a mode of warfare which has not been legalized by civilized nations.

Prospects of Electrolytic Iron

The experimental manufacture of articles by electrodeposition of pure iron has been proceeding for some time at Grenoble, France, and simultaneously by other interests in this country. The difficulties due among other things to the occlusion of hydrogen seem now to have been overcome, and important developments are foreshadowed in regard to the use of electrolytic iron in the electrical industry, the manufacture of heating coils and radiators (sometimes coated with cadmium) and the economical substitution of iron for brass and the like in one-piece containers. This industry should be of special interest to American users, as cheap power is of importance for its successful development.

Personal

Prof. C. S. Sherrington, of the University of Oxford, is to be the new president of the Royal Society.

Sir James Dobbie has retired from the post of Government Chemist.

Dr. O. Kamm, of Illinois University, has been appointed director of the chemical research department of Parke, Davis & Co., manufacturing chemists, of Hounslow and London.

Readers' Views and Comments

Engineers in Governmental Functions

To the Editor of Chemical & Metallurgical Engineering

SIR:—The war has thrown a new light upon several phases of the nation's political, social and economic life, emphasizing the need for readjustment of traditional administrative practices in public affairs in the interest of economy and conservation of resources. Long before the war there was a growing consciousness of the inadequate functioning of state and federal departments which in their nature were largely, or wholly, technical and therefore should be under the direction of trained and experienced engineers in order to obtain the most beneficial results in the interest of the public and for the money expended. Up to date the idea prevailed with the appointing power that lawyers and politicians had a prior claim upon administrative ability of whatever kind.

Of late the engineering fraternity has called attention to the inadequacy of lawyers and politicians assuming directive functions in matters for which they were not trained, with consequent wasteful use of public money, however honest the administration may otherwise be. The generally accepted reason for excluding the engineer from higher administrative functions in public service is that lawyers and politicians are by training and occupation better fitted to understand and to deal with the larger social needs of the public and to make public sentiment amenable to the requirements of governmental control. These broader, what might be called popular, qualifications are, it is claimed, not possessed by the engineer, who, however valuable as a professional man, is not trained to deal with the people and their social adjustments.

In the United States several factors have combined to give plausibility for preference of considering laymen better fitted even for technical administrative functions than professional engineers and technical men.

First, the engineer is only a comparatively recent arrival in the family of social and economic forces controlling the welfare of the public. Time is not so far distant when the surveyor was recognized as the engineer of his day and he performed the functions of an engineer in pioneer days. During all the evolutionary period there were only three socially and economically recognized professional classes—the lawyer, the doctor and the minister. What wonder then if the lawyer, as the representative of property right and law regulating the daily activities of the public, should be considered the natural incumbent of public administrative office?

Second, in a democracy the politician naturally occupies an exalted popular position in the community and is therefore considered suitable for administrative functions.

Third, the engineer represents the essentially economic side of public affairs, and the great wealth of natural resources in the United States has helped to produce wasteful, careless habits with the people, producing a natural antipathy and lack of understanding of the teachings of economy and conservation by the engineer.

The discoveries of science are enabling mankind to make generous use of the forces of nature for its own benefit, and the engineer is the learned and trained interpreter of these natural forces. If it is the lawyer's business to uphold positive law and to cultivate jurisprudence in order to maintain a state of public justice, just so is it the business of the engineer to cultivate the natural sciences in order to maintain a state of mental and physical welfare by means of scientific sewering, lighting, water supply, sanitation, bridging, road building, transportation safety appliances, etc., without which the people could not live in a state to make them receptive for the benefits of legal, medical and spiritual ministration according to the modern standard of civilization. Why then should the engineer not be considered competent at the present time and in the future, without interference by the lawyer or politician, to be at the head of the administration of those departments of public business which are engineering functions primarily and subjects of legal interpretation only secondarily?

When it comes to the application of social justice in public affairs the engineer is certainly equal to the lawyer and politician in that respect. Every well-educated engineer, of sufficient breadth of mind and experience in the management of private enterprises, should and would be competent to direct state or federal undertakings of a similar nature with greater advantage to the public interest than non-technical men who, because of their lack of technical training and experience, are frequently guided by the bureaucratic traditions of their office, with consequent waste of time and money.

If it is the purpose of social economy to make use of the mental and material resources of the country to best advantage in order to create a maximum of happiness, contentment and confidence in public institutions among the population, it is the modern engineer more than any other professional man who comes nearest to fostering and promoting this desirable purpose.

While the immediate results of the engineer's activities are of a tangible economic and commercial nature, in a larger sense these activities involve the ethical, the moral and the æsthetic life of the people because the conscientious execution of his activities by the engineer involve the ethical qualities of his sense of duty and responsibility to himself, to his client and to the community and the public at large.

On the other hand, to the degree this ethical sense of duty and responsibility toward his fellow citizens and to his country is developed among the people the more the conscientious and scientific work of the engineer will be appreciated and insisted upon for the material and moral benefit of the individual as well as of the public.

PAUL KREUTZPOINTNER.

Altoona, Pa.

Although there has been increasing recognition recently, especially in the federal departments, of the importance of technical specialists as administrative chiefs in technical work, there still is opportunity for increasing this tendency. There probably is only one need for limitation of the tendency to appointment of

technical men to administrative work for which they are particularly fitted. This is the result of the very limited number of such men who are available in comparison with the large demand for strictly technical service at the present time. An undue tendency to place technical workers in administrative function would, therefore, perhaps be an unfortunate factor, serving only to increase the shortage already acute of experienced, capable scientific and engineering investigators and consultants.

Changes in Cyanamide When Mixed With Fertilizer Materials

To the Editor of Chemical & Metallugical Engineering

SIR:- In your issue of Oct. 6 there appears a report on the program of the Fertilizer Division of the American Chemical Society as carried out at the recent Chicago meeting. The great industrial significance you attached to the paper of R. N. Harger, of the United States Department of Agriculture, has created considerable interest among fertilizer manufacturers, a viewpoint which Mr. Harger did not take in the actual paper as officially published.

The title of the paper in its official form is not "The Changes Taking Place in Cyanamide When Used in Mixed Fertilizers," but instead "The Change Taking Place in Cyanamide When Mixed With Fertilizer Materials."

Mr. Harger dealt only with laboratory mixtures of certain fertilizer materials and not with the commercial fertilizers as found on the market, as he distinctly emphasizes, and his conclusions were most carefully drawn and limited to the exact conditions surrounding his laboratory work. Since these conditions are different from those existing in the ordinary fertilizer plant, Mr. Harger in his official publication was careful to limit his conclusions to apply only to his laboratory work and not to the mixing plant.

Mr. Harger further did not carry out his work following the recommendations made by the manufacturers of cyanamide for the guidance of fertilizer mixers and as represented in the practice of the fertilizer plants, and since your report did not closely follow the details of Mr. Harger's procedure but rather implied the reverse, there has arisen in the minds of the mixers a natural question of doubt after reading your report.

I am certain you are desirous of correcting this erroneous impression created by the article in your journal and of presenting to your readers the true facts in the case as officially published by Mr. Harger. At the same time I believe you would be interested in calling the attention of your readers to the fact that the reactions described by Mr. Harger do not take place in ordinary commercial fertilizers when proceeding under recommendations for the use of cyanamide, as published by this company, and that such fertilizer mixers need not concern themselves about the presence of dicyandiamide in their mixtures, as such does not occur. Cyanamide is an extremely reactive substance, which on mixing with acid phosphate in the prescribed quantities is for a very large part converted into various ureas and in smaller part to ammonia and ammonia salts. When mixed with the ordinary ammoniated base which forms the bulk of the mixed fertilizer tonnage cyanamide reacts with the animo acids to form complex organic compounds, which so far as they have been isolated and studied are of excellent fertilizer value. Dicyandiamide cannot be produced in the presence of these ammoniated base compounds. In the ordinary acid phosphate mixture it can be produced only in extremely small quantity by a direct violation of the prescribed rules for mixing, and even then it rapidly disappears by conversion into more complex compounds of good fertilizer value.

E. J. PRANKE.

American Cyanamid Co.,
New York, N. Y.

The Paint and Varnish Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I wish to call your attention to an article by Dr. Maximilian Toch in CHEMICAL & METALLURGICAL ENGINEERING, vol. 23, No. 10, Sept. 8, 1920, pp. 469 and 470, entitled "Putting the Paint and Varnish Industry on a Scientific Basis." The statements therein made are so at variance with the facts that it is unfair to the paint and varnish industry and to chemists long engaged in this industry to allow them to remain uncorrected.

Early in the article he states: "Prior to 1906 the most impossible and worthless mixtures paraded under the name of paint." This was doubtless as true then as it is today. He fails to state the noteworthy fact that in 1906 a considerable number of thoroughly reliable, well-equipped paint manufacturing concerns were and for many years prior thereto had been turning out large quantities of paint of a quality which has never been surpassed.

His statement, "There was at that time no literature on the subject," is entirely erroneous. He names five men who "were the only chemists in the United States who had at that time any knowledge of the chemistry of paints." In addition to these, he states, "There were perhaps three or four more like" (two names mentioned) "and others who did private work."

As a matter of fact, Dr. Toch in 1906 was listed in the membership of the American Society for Testing Materials as a paint manufacturer, and in the membership of the Society of Chemical Industry as a chemist. Within these two societies in 1906 there was a goodly number of men who had knowledge of paint chemistry.

At least twelve varnish companies were represented in the membership of the American Society for Testing Materials or the Society of Chemical Industry, or both, and of these twelve at least eight employed chemists. Other companies not so represented employed chemists. At least eighteen paint companies were represented by membership in these societies, either directly or indirectly, and of these eighteen at least ten employed chemists. Other companies not so represented employed chemists. At least fifteen great railway systems were represented by membership in these societies and all of these employed chemists, many of them engaged in work similar to that of Dr. C. B. Dudley.

The membership list also discloses (in addition to the two mentioned by Dr. Toch) at least five in New York City, one in Boston, one in Baltimore, one in Philadelphia, one in Pittsburgh and one in Chicago, engaged in private work. The membership list discloses at least one expert in paint and varnish chemistry in the federal service.

The following list is certainly not a complete roster of all the chemists who in 1906 had "any knowledge of the chemistry of paints." It is a partial list of those found in the societies mentioned, and also includes a few holding official position who may not have been

chemists. Membership in the American Society for Testing Materials is indicated by (a) and in the Society of Chemical Industry by (b):

(a) Alcott, F. L., engineer of tests, Chicago, Milwaukee & St. Paul Ry.
(b) Andrews, W. H., manager varnish works.
(a) (b) Austen, Peter T., consulting chemist.
(a) (b) Bailey, R. W., chemist, Stillwell & Gladding.
(a) (b) Baringer, F. J., chemist, Eagle White Lead Works.
(a) (b) Bjerregaard, A. P., varnish chemist, Emil Calman Co.
(a) Blanch, J. C., superintendent Blanchite Process Paint Co.
(a) (b) Browne, Arthur I., consulting and analytical chemist.
(a) Bunnell, F. O., engineer of tests, Chicago, Rock Island & Pacific Ry.
(a) (b) Burleigh, William F., technical chemist, Murphy Varnish Co.
(a) (b) Cheeseman, Frank P., paint manufacturer.
(b) Clark, Homer, chemical manufacturer, Vacuum Varnish & Chemical Co.
(a) Dabbs, Harold M., L. J. McCloskey & Co.
(a) Davidson, George M., engineer of tests, Chicago & Northwestern R.R.
(b) Dreyfus, L. A., chemist, the Muralo Co.
(a) (b) Dudley, C. B., chemist, Pennsylvania R.R.
(a) (b) Edgerly, D. W., chemist, Chilton Paint Co.
(a) (b) Forrest, C. N., chemist, New York Testing Laboratory.
(a) (b) Frank, Jerome W., chemist, Standard Varnish Works.
(a) Gibboney, James H., chief chemist, Norfolk & Western Ry.
(a) (b) Gill, A. H., assistant professor of technical analysis, Massachusetts Institute of Technology.
(b) Gladding, T. S., chemist.
(a) (b) Handy, J. O., chemist, Pittsburgh Testing Laboratory.
(a) (b) Harriman, N. F., chemist and engineer of tests, Union Pacific Ry.
(a) (b) Holton, E. C., chemist, Sherwin-Williams Co.
(a) (b) Hooker, A. H., chief chemist, Heath & Milligan Co.
(a) Hunt, Robert W., Co. Laboratory.
(a) Ingalls, F. P., chemist, John W. Masury & Sons.
(a) (b) Job, Robert, chemist, Booth, Garrett & Blair.
(a) (b) Kittredge, H. G., chemist, Kay & Ess Co.
(a) Kohr, D. A., chemist, Lowe Bros.
(a) Knapp, A. C., manager, railway department, Parrott Varnish Co.
(a) (b) Little, Arthur D., consulting chemist.
(a) Lord, Richard C., engineer of tests, Louisville & Nashville R.R.
(a) (b) Lowe, Huston, paint and varnish maker.
(a) Lucas & Co.
(a) McFarland, J. A., chemist, Missouri Pacific Ry.
(a) (b) McIlhiney, Parker C., chemist.
(a) (b) McKenna, Charles F., chemist.
(a) (b) Mahon, R. W., chemist, New York Central & Hudson River R.R.
(b) Mannhardt, Hans, chemist, Heath & Milligan Co.
(a) Marshall, William, president, Anglo-American Varnish Co.
(a) Minwax Coatings Co.
(a) Patterson Sargent Co.
(a) Patton, Ludington, secretary-treasurer Patton Paint Co.
(b) Perry, R. S., president, Harrison Bros. & Co.
(a) Phlegar, A. A., Jr., chemist, Norfolk & Western R.R.
(a) Picher Lead Co.
(a) Powers, W. A., chief chemist, Atchison, Topeka & Santa Fe R.R.
(a) Riddle, Walter V., president Sterling Varnish Co.
(a) (b) Sabin, A. H., chemist, varnish works.
(a) Scott, W. G., chemist, J. I. Case Co.
(a) (b) Smith, H. E., chemist, Lake Shore & Michigan Southern Ry.
(b) Stillwell, A. G., chemist.
(a) Suydam, Richard S., president, M. B. Suydam Paint Co.
(a) (b) Thompson, G. W., chemist, National Lead Co.
(a) (b) Toch, Maximilian, paint manufacturer, chemist.
(a) (b) Van Gundy, C. P., chief chemist, Baltimore & Ohio R.R.
(a) Von Marle, C. M., chemist, Pratt & Lambert.
(a) (b) Voorhees, S. S., engineer of tests, Treasury Department, Washington, D. C.
(b) Worstall, Robert A., chemist, Chicago Varnish Co.
(a) Wickhorst, Max H., engineer of tests, Chicago, Burlington & Quincy Ry.
(a) Wilhelm Co., The.
(a) Woods, R. W., chief chemist, Northern Pacific Ry.

Of the thirty-eight listed as members of the Society of Chemical Industry in 1906 thirteen had been in the society for ten or more years. E. C. HOLTON.

Cleveland, Ohio.

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to Dr. Holton's letter, let me say that when I mentioned that there were only three or four more chemists in 1906 who did real work on the chemistry of paint, I should have mentioned him because undoubtedly he was one of the pioneers and entitled to a niche in the hall of fame in the chemistry of paints. His list marked "a" and "b" of members of the American Society for Testing Materials and members of the Society of Chemical Industry means very little, however, for in looking over these lists I notice the names of some who are no longer living; also many who know nothing about the chemistry of paints today. A man may be an excellent chemist in general chemistry and yet know nothing about the chemistry of our particular line. I hope Dr. Holton will realize that no discourtesy was intended by omitting his name; but I am unable to agree with his imposing list which, while it contains the names of many good chemists, lists only a few who have within the past fourteen years come sufficiently to the front to be classed as paint chemists.

New York City. MAXIMILIAN TOCH.

Important Leather Factory in Alsace Changes Hands

The announcement is made in the French press that the German firm of Adler & Oppenheimer, located at Lingolsheim, a suburb of Strasburg, and considered the largest leather factory in Europe, has been sold to a group of French and Alsatian interests for 32,000,000 fr. The group includes important financiers and business men. The new organization is constituted under the name of Les Tanneries de France, with a capital of 50,000,000 fr. divided into 500,000 shares of 100 fr. each. The plant is capable of realizing an annual turnover of from 200,000,000 to 250,000,000 fr. It is intimated that special attention will be given to exporting the products of the factory. When the Adler & Oppenheimer plant was placed under sequestration by the French considerable fear existed among French tanneries regarding the possibility of serious competition from the newly acquired factory. It is very well situated for the purpose of export to foreign countries.

Porous Plates Hard to Get

Numerous complaints having reached the chief chemist of the Bureau of Mines as to the difficulty of securing porous plates for laboratory use, the bureau is inquiring into the situation in the hope that it may be helpful in making possible a more adequate supply of these utensils.

Gas Analysis by Absorption and Titration

The Method of Gas Analysis by Absorption and Titration Has Been Simplified by the Use of a Gas Volume Compensometer for Measuring the Volume of Residual Gas, and an Alignment Chart for Calculating the Results

BY R. S. TOUR

FOR more accurate determination of certain constituents in gases—e.g., NH_3, CO_2, SO_2, H_2S—it is best to absorb the constituent in a suitable reagent, the volume of residual gas being measured, and the absorbing solution titrated. The accuracy then is that of the standard solutions of the titration or of the measurement of the gas. Assuming the standardization and titration within the limits of accuracy desired, it becomes necessary to measure the volume of gas with the same accuracy and correct it to some known standard condition e.g., 760 mm., 0 deg. C., dry. There then remains merely the calculation of the content of the absorbed constituent in the original gas.

The measurement of the gas and its volume correction may be greatly simplified by the use of a "compensometer," while the final calculation may be accomplished graphically with the aid of a nomograph.

GAS VOLUME COMPENSOMETER

The gas volume compensometer here described may be used to measure gas at room temperatures and pressures and to give at the same time a factor for converting this volume to standard conditions (760 mm., 0 deg. C., dry) or to read directly the corrected standard volume. The apparatus as shown in Fig. 1 is designed for an accuracy of ±0.5 per cent, although with some modifications an apparatus of much greater accuracy could be obtained.

Manipulation of the apparatus is simple. The gas to be measured is drawn through the double inlet stopcock and displaces the water in the gas flask. This can be accomplished by lowering the leveling bottle connected to the water exit of the flask, or more simply by using slight pressure on the gas to raise the water into the bottle. The gas flask is marked for some definite or convenient volumetric displacement. When water has been discharged to this point, the water exit is closed by the stopcock in that line or by pinching the rubber tube and the double inlet gas stopcock is turned to communicate with the manometer. The scale on the manometer reads either the correction factor or the corrected volume (at 760 mm., 0 deg. C., dry) of the gas within the flask.

The apparatus consists essentially of a measuring gas flask completely inclosing a compensator which connects to one leg of a manometer, the other leg of which can be opened to the gas within the measuring flask. The compensator pressure on one leg of the manometer indicates the temperature correction and if a drop of water has been inclosed within the compensator the correction includes that for water vapor pressure. The pressure of the gas in the flask acting on the other leg of the manometer tends to balance the compensator pressure and the manometer actually indicates the net correction to be applied.

Let P, p = total pressures in mm. Hg.
" T, t = temperature in deg. C. abs.
" V, v = volumes in c.c.
" A, a = water vapor pressures.

Let capitals above represent gas flask conditions and let small letters represent compensator conditions.

Let B = barometric pressure in mm. Hg.
" D = gas flask displacement in c.c.
" m = compensator manometer pressure in mm. Hg.
" K = compensator constant.
" C = conversion factor to standard conditions.

Let subscript s be used for standard conditions.
Let subscript r be used for compensator conditions at time of sealing.
Let subscript c be used for calibrating conditions.
Let subscript x be used for any operating condition.

The manometer is sealed with mercury under such compensator conditions as to give approximately no pressure differential at the average operating conditions of the apparatus. All pressure readings (m) on the manometer are to be measured from a true zero pressure point which includes a correction for capillarity.

FIG. 1. GAS VOLUME COMPENSOMETER

Contribution from the Fixed Nitrogen Laboratory. Published by permission of the Chief of Ordnance.

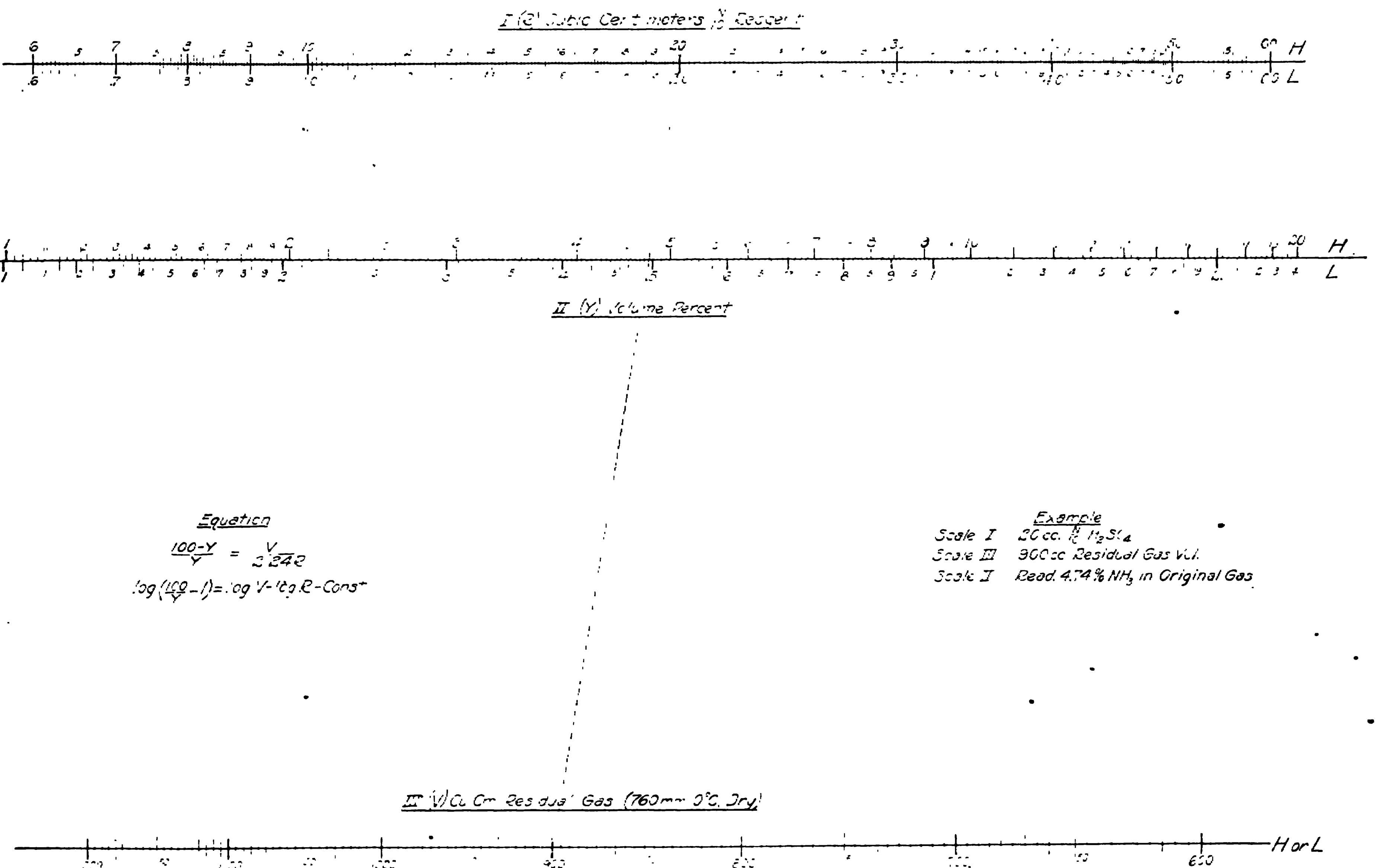


FIG. 2. NOMOGRAPH FOR CALCULATING RESULTS OF GAS ANALYSIS BY ABSORPTION AND TITRATION

For calibrating the apparatus it is necessary to determine the compensator constant (K) which is based on the conditions (p_r, t_r, a_r) at which the compensator was sealed. To do this, place water of known temperature within the flask about the compensator, leaving the flask leg of the manometer open to the atmosphere. For our purposes, the compensator volume is constant and independent of the manometer reading if the manometer tube be capillary.

$$\text{Then } \frac{p_r - a_r}{t_r} = \frac{p_c - a_c}{t_c} = \frac{B_c + m_c - a_c}{t_c}$$

The temperature of calibrating determines t_c, as well as a_c, which may be read from vapor pressure tables, and p_c is equal to the barometric pressure (B_c) plus any small manometer pressure (m_c). The value of the term $\frac{p_r - a_r}{t_r}$ is thus determined and may be known as the compensator constant (K).

For graduating the manometric scale to read in terms of the conversion factor (C) to standard conditions (760 mm., 0 deg. C., dry), note that

$$T_x = t_x,\ A_x = a_x,\ P_x = p_r - m_x,\ \frac{p_x - a_x}{t_x} = K$$

Hence

$$C_x = \frac{V_s}{V_x} = \frac{T_s}{P_s - A_s} \times \frac{P_x - A_x}{T_x} = \frac{273}{760 - 4.6} \times \frac{p_x - a_x - m_x}{t_x}$$

or

$$C_x = 0.361 \left| K - \frac{m_x}{t_x} \right|$$

The term $\frac{m_x}{t_x}$ is the correction term for the variation from the average operating conditions represented in K.

In ordinary practice the value of $\frac{m_x}{t_x}$ at its maximum will be under 10 per cent of K and the value of t_x is subject to a maximum variation of ±5 per cent. Hence the average value of t_x can be assumed.

If the average value of t_x be taken at 298, or 25 deg. C., then $C_x = (0.361K) - \frac{m_x}{825}$. This represents a variation of 0.010 in the numerical value of C for each 8.25 mm. pressure on the manometric scale. The scale can then be graduated to read C directly, and for ordinary operation the range 0.800 to 1.000 covering 165 mm. is ample. If the average value of t_x be 289 (16 deg. C.), then each 8 mm. of the scale represents a variation of 0.010 in the value of C. If it is desired that the reading be directly in corrected volume, the scale is graduated according to C_xD. It is suggested that one point of the scale (e.g., $C = 0.90$) be permanently etched on the manometer tube.

Calculations

Having obtained the necessary data, there remains the calculation for the percentage content of the constituent to be determined in the original gas.

Let Q = c.c. of reagent used for titration.
" N = normality of reagent.
" R = c.c. of 0.10 normal reagent used.
" V = c.c. volume of residual gas corrected to standard conditions.
" J = valence of absorbed constituent.
" Y = per cent of absorbed constituent in original gas.

Then $22.4 \frac{NQ}{J}$ c.c. of constituent absorbed.

$$\text{And } V + \left(22.4\frac{NQ}{J}\right) = \frac{100}{Y}\left(22.4\frac{NQ}{J}\right)$$

$$\text{Or } \frac{100 - Y}{Y} = \frac{VJ}{22.4NQ}$$

Taking J at unity and the normality of the standard solution at 0.100 (which solution is in general very satisfactory) then $\frac{10NQ}{J} = R$

Constitution of Nomograph

A nomograph for the graphical solution of the above equation is shown in Fig. 2. It has been of great help in routine laboratory analyses. For use a rule is laid across the three scales so that it cuts the R scale at the number of c.c. of 0.10 N reagent used and cuts the V scale at the number of c.c. residual gas measured in the compensometer. The intersection of the rule on the Y scale then reads directly the per cent of absorbed constituent in the original gas.

For plotting the nomograph with the same proportional accuracy throughout its scale, the logarithmic form of the equation was used:

$$\log \frac{100 - Y}{Y} - \log V - \log R - \text{constant}$$

The nomograph shown has an accuracy greater than ±0.5 per cent with scales and ranges as follows:

	R Scale $\frac{10NQ}{J}$ C.c. Reagent 0.10 Normal	V Scale C_xD C.c. Residual Vol. 760 Mm. 0 Deg. C. Dry	Y Scale Per Cent Composition by Volume
I. Range	0.6 to 6.0	600 to 1,200	0.1 to 2.0
II Range	6 to 60	600 to 1,200	1 to 20

In this case $\frac{10NQ}{J}$ has been taken equal to R. If any other conditions than $J = 1.0$ and $N = 0.10$ apply for using the nomograph, the actual titration value Q as obtained can be corrected. For special absorption determinations where V may be very large, R may be proportioned so as to reduce V within the nomograph range.

For the determination of NH_3 in gas mixtures, for which particular analysis the compensometer and nomograph have been devised, the compensometer draws 800 to 1,000 c.c. of gas and reads the corrected volume directly on the manometer scale, the value of J is 1.0, 0.10 N acid is very satisfactory, and the nomograph reads directly the per cent volume of absorbed constituent.

Apothesin as a Local Anæsthetic

A pharmaceutical compound about which little has appeared in the literature and which has earned a place among the prominent local anæsthetics bodies because of its merits is apothesin. The cinnamic ester of gamma-diethylamino propyl alcohol is made as follows: Thirteen parts, by weight, of gamma-diethylamino propyl alcohol are dissolved in eighty parts, by weight, of benzene, and to this solution sixteen parts, by weight, of cinnamoyl chloride are gradually added. The solution deposits the hydrochloride of gamma-diethylamino propyl cinnamate in the form of white crystals, readily soluble in water, and having a melting point of 137 deg. C. This body is recrystallized from a mixture of alcohol and ether and is then ready for use. The alcohol is prepared from trimethylene glycol, a byproduct in the manufacture of soap.

Some Notes on the Effect of Nitrogen on Steel

Work Showing at Least Five Definite Layers Are Produced on the Surface of Low-Carbon Steel When It Is Exposed to Ammonia at 650 Deg. C.—Excessive Brittleness in the Outer Zones Responsible in Part for Gun Erosion

BY O. A. KNIGHT AND H. B. NORTHRUP*

IT HAS long been known that nascent nitrogen formed by the decomposition of ammonia at elevated temperatures has a deleterious effect upon a number of metals and alloys. In this connection a number of papers have been published covering the pioneer work on the subject, as well as some later ones covering the progress of further research. A few of the more important references are given below.[1]

The need of further investigation of this subject was brought to the attention of each of the authors of this paper, working severally as metallographist at the Watertown Aresnal, Watertown, Mass., and metallurgist for the Engineering Division, Ordnance Department, attached to the Bridgeport District Ordnance Office.

EXPERIMENTAL EQUIPMENT

The present investigation was carried out in order to determine the effect of ammonia on the microstructure and physical properties of steel and its possible relation to the erosion of guns, corrosion, deterioration of nitrating cylinders, etc. The effect of ammonia on a number of other alloys was also studied in an attempt to find a metal or an alloy which would not appreciably deteriorate under the influence of ammonia at elevated temperatures, and this paper consists of notes of observation which the writers have recently made and which they believe will be of value to add to the already existing data. It is with this object in mind that these notes are published.

Owing to the fact that the deterioration noticed by the writers was always accompanied by marked changes of microstructure it was believed that a study of the effect of ammonia on the microstructure would give direct evidence of its effect on the physical properties. Therefore the preliminary work consisted of a search for a metal or alloy whose structure would not be materially affected by ammonia at elevated temperatures.

In view of the fact that the deleterious effects above mentioned took place at a low red heat, and also that several industrial processes (the Haber process for producing ammonia, and others) involve the use of ammonia near this temperature, it was decided that the present experiments be conducted at a temperature of 650 deg. C.

The specimens in question were treated in a furnace of the electric resistance type. The resistor was wound upon an alundum core through which was inserted a glazed silica tube 1½ in. in diameter, inside of which the specimens were placed for the nitrogenizing treatment. Ammonia gas was generated by heating c.p. aqua ammonia in a flask, the gas being passed through a condenser, over lime, and thence through the silica tube. The temperature was accurately controlled by the use of a platinum thermocouple checked against a couple of the same type carrying a Bureau of Standards certificate. The emf. generated was measured by a Leeds & Northrup portable potentiometer.

This work has consisted in the investigation of many grades of iron, steel and other alloys, having been under way for approximately two years. Since this work was begun an article by H. E. Wheeler, entitled "Nitrogen in Steel in the Erosion of Guns," has appeared in Bulletin 160, of the A.I.M.E.,[2] in which article a great many of the metals investigated by the present writers and several others are described with reference to the effect of nitrogen on them under similar conditions. Therefore, since the appearance of this paper, the contents of which in many instances check the results of the present experiment, the major portion of the writers' work will not be reproduced. In phases of the work where the results of Wheeler do not check the observations of the writers discussion will follow later on.

An early part of the investigation consisted in heating ⅛-in. (3-mm.) diameter steel wire tensile specimens in an atmosphere of ammonia at 650 deg. C. for varying lengths of time at a pressure of about 840 mm. mercury, and the subsequent heating of some of these specimens in hydrogen. Tensile tests and microscopic examination were carried out. Pressure of about 840 mm. of mercury was maintained on the ammonia gas, as previously mentioned, by means of an open-arm manometer.

HEATING IN AMMONIA AND HYDROGEN

Nine specimens of annealed steel wire ⅛ in. in diameter, 10 in. in length (3 x 254 mm.) and containing C 0.81 per cent, Mn 0.56, Si 0.17, S and P less than 0.04 were selected for treatment. Three were pulled in the annealed, untreated condition. The six others were treated in ammonia gas for eight hours at 650 deg. C. and furnace-cooled in ammonia gas. Three of these were tested in the tensile machine, and the other three were heated in hydrogen for eight hours at 650 deg. C. and furnace-cooled. They were then tested in the tensile-testing machine. Hydrogen was generated by the action of sulphuric acid on pure zinc; it was dried before passing through the furnace by bubbling through pure sulphuric acid.

The average results of these tests are given in Table I.[3]

As will be seen from this table, the effect of heating in ammonia diminished the tensile strength and greatly reduced the elongation, while the reduction of area was rendered zero. This low value of the tensile strength

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[1]Traite de Chemie, 1834, p. 434; Savart, *Pogg. Ann.*, 1865; Despretz, *Ann. Chem. Phys.*, 1829, vol. 42, p. 122; Fremy, *Compt rend.*, 1861, vol. 52, p. 322; *J. Chem. Soc.*, 1901, p. 285; *J. Chem. Soc.*, 1891; *Iron Age*, Feb. 17, 1916; *Revue de Metallurgie*, 1905, vol. 2, pp. 497-507; Braun, *J. Chem. Soc.*, 1905; *Bull.* A. I. M. E., May, 1919; CHEM. & MET. ENG., Mar. 3, 1920, vol. 22, p. 399; *Mining & Metallurgy*, No. 160, April, 1920.

[2]Abstracted in CHEM. & MET. ENG., vol. 23, p. 366; Sept. 1, 1920.

[3]Taken from thesis work of E. K. Mull and W. I. Pottelger, 1919.

can easily be accounted for by the extreme brittleness of the outside hard surface, which developed circular cracks extending completely around the specimen upon the application of a few thousand pounds per square inch. This cracking effect not only decreases the area of cross-section remaining but opens up a path of fracture which will continue through the interior, though no doubt more ductile, portion. It will be noticed that heating in hydrogen partly restored the normal physical properties, and no doubt prolonged heating in this manner would completely restore the original physical properties. Microscopic examination showed the irregular *white layer* (so frequently discussed by other investigators and mentioned later) to be all removed by hydrogen treatment and the structure back of it partly restored to normal. Heating in hydrogen did not remove the effects of the ammonia treatment as fast as they were induced.

TABLE I.

Condition of Steel	Tensile Strength — Lb per Sq In	Tensile Strength — Kg per Sq Mm	Elongation in 2 In., per Cent	Reduction of Area, per Cent
Annealed, not treated	98,500	69 2	13 6	22.1
Annealed, heated in NH_3 for 8 hr at 650° C.	79,500	55 9	2 0	0.0
Annealed, heated 8 hr in NH_3 at 650° C., followed by heating 8 hr in H at 650° C.	89,000	62.6	4 5	6.6

Search for Metal Unaffected by Ammonia

A series of experiments were next carried out with the object of finding, if possible, a metal which would stand up under the action of NH at elevated temperatures. In this series no physical tests were attempted; microscopic examination alone was relied upon as a means of testing, since it has been found that the deterioration is accompanied by very distinct changes in microstructure. Therefore the object was to find a metal whose structure would be little (if any) affected by ammonia gas at 650 deg. C. and under a pressure slightly greater than atmospheric. The results of these tests may be briefly summed up as follows:

Pure tungsten does not seem to be affected by the ammonia treatment. All other pure metals tested were affected. Wrought iron and low-carbon steels are readily attacked. High-carbon steels are much more resistant than wrought iron and low-carbon steel. White cast iron is affected on the surface, but not deeply. Chromium-vanadium steels are in general the best class for resisting this action so far studied by the writers. Stellite is practically unaffected, and the alloy nichrome is also little affected; monel metal is slightly attacked.

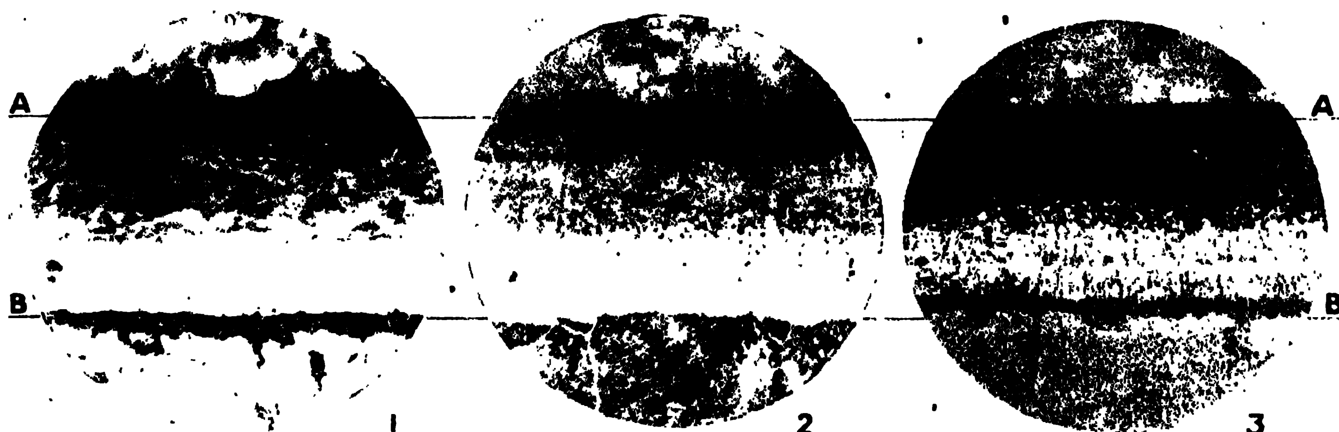
Those metals which were only slightly attacked are either impractical to apply as containers for NH_3 at elevated temperatures and pressures on account of their price or on account of undesirable physical properties, such as brittleness, hardness too great to permit machining, etc. Therefore this series of experiments seems to be of value only in a negative way.

Effect of Ammonia on Carbon Steels

It was then decided to study carefully the effect of ammonia on all the different grades of plain carbon steel, keeping all elements constant except the carbon and varying it from practically pure iron to hypereutectoid steels. This was carried out as follows: A piece of 0.07 per cent C steel, other elements normal, ½ x ½ x 1 in. (13 x 13 x 26 mm.) was casehardened by heating to and holding at a temperature of 950 deg. C. in a packing of Rodman Chemical Co.'s "Carbo S" casehardening compound for three hours and furnace-cooled. After this the specimen was removed and cut in two in the central part of its longest dimension, the surface cut being normal to the greatest axis. The surface thus exposed on the freshly-cut face varied in carbon from 0.07 per cent near the central portion to about 1 per cent on the outside (hypereutectoid distinctly), with the other elements remaining constant, unless a change took place in the percentage due to impurities in the carbonizing material.

Careful microscopic examination was made of one-half of the casehardened specimen; the other was ground to a smooth surface and heated to 650 deg. C. in ammonia for twelve hours and furnace-cooled. After this treatment the specimen was removed from the furnace and cut in two on a plane normal to the surface previously exposed by cutting in two the first time. This then presented for study a surface whose carbon content ranged from 0.07 to about 1 per cent, increasing gradually, and which had been exposed alike to the action of ammonia at 650 deg. C. The specimen was then carefully mounted, as usual, in a low fusing point ductile alloy, the melting point of which was about 95 deg. C., after which it was polished for micro-examination.

Nothing unusual was noticed in the unetched condition, so the specimen was etched five seconds in 4 per cent nitric acid in absolute alcohol. It was examined along the entire edge from high-carbon to low. A very uniform layer was found all along and its average depth was 0.0073 in. (0.19 mm.), with only very slight variations from that figure. The nature of this layer was the same in the high-carbon area as in the low. The accompanying photomicrographs are arranged with the edge, or extreme outside of the steel, up and the interior portion down i.e., below it on the page. Lines have been drawn to make clear the location of the areas under discussion. Fig. 1 shows this layer between the lines *A-A* and *B-B* taken on the low-carbon area. The structure above the line *A-A*, out of focus, is that of the alloy used for mounting, and which holds the hard brittle layer firmly in place. This layer, between lines *A-A* and *B-B*, etches differently on the outside three-fifths (approximately) than on the inner two-fifths. The outer portion is darkened and a sort of granular or finely pitted effect is revealed, while the inner two-fifths is unaffected or only slightly so by five seconds' etching. The discussion of the structure which lies deeper in—i.e., below line *B-B*—will be left till later on, but it is now desired to confine attention to this outside layer. Fig. 2 between the lines *A-A* and *B-B* shows this same layer in the region of highest carbon content. It (the normal steel) is hypereutectoid, as seen by the excess cementite around the large grains in the lower left of the picture. The thickness of this outside layer, or "case" as it will be termed in this paper, is practically the same for all the different carbon concentrations and its nature seems likewise the same. The high-carbon portion seems to etch a trifle faster, if any. Longer etching has the effect of simply intensifying the corrosive action on the outer three-fifths of the layer, making it darker, as etching progresses, until black. An entirely different effect is observed on the inner two-fifths of the case, which remains comparatively bright and structureless after etching five seconds in 4 per cent nitric acid in alcohol. Longer etching develops an interesting structure in this area. There is a definite crystalline structure and



FIGS. 1 TO 3—STRUCTURE OF NITROGENIZED LAYER ON CEMENTED STEEL. 125 DIA. HNO_3 ETCHING
Fig. 1. Low-carbon region Fig. 2. High-carbon region Fig. 3. Layer after long etching

the crystals are of a columnar nature with their major axis normal to the outside surface. This is shown in Fig. 3 at 125 diameters after etching with 4 per cent HNO_3 for twenty-five seconds. Between the dark outside and the light columnar crystalline structure will also be seen several fine lines, having the appearance of cracks.

Further study of this portion of the case containing the columnar crystals was made at higher magnification and after longer etching.

Structure of Case Produced by Ammonia

The photomicrograph shown in Fig. 4 shows the structure of the area containing the columnar crystals as revealed by etching thirty-six seconds in 4 per cent nitric acid in alcohol and at a magnification of 400 diameters. The columnar crystals are shown distinctly as well as the fine hair cracks previously mentioned. Each one of these columnar crystals has striations crossing it in some direction and all the striations are parallel in the same crystal but extend in different directions in different crystals. The base of these crystals forms practically a straight line, and a sharp line of demarcation separates this structure from the pearlitic structure just beneath it.

The hardness of the outside layer or case is greater than any other portion. This was determined by drawing a needle point over the surface at a uniform pressure. A deep impression (microscopically) was cut in the metal by the needle point up to the case, but there very little effect was produced. The specimen was scratched after etching and the marks could be seen under the microscope to be very slight on the outside layer in comparison to the effect on the metal back of it. Rubbing the specimen gently on the rouge pad removed all traces of the scratches on the case but left deep markings on the rest of the metal. The case was much harder than the high-carbon portion of the steel, and so far as could be determined by this simple method of testing its hardness is more clearly equal that of cementite than any other constituent.

Before leaving the discussion of this outside "case" —i.e., the layer extending from the extreme outside to the base of the columnar crystals—the writers wish to emphasize more strongly its extreme brittleness. Attention is again invited to the cracks shown so vividly in the photomicrograph reproduced in Fig. 4 somewhat above and parallel to the base of the columnar crystals. The specimen was taken out of the fusible alloy and in order first to determine if these cracks were a result of sudden heating when the specimen was mounted in this alloy the specimen was heated very quickly on the edge by plunging in a bunsen flame. Examination after this treatment showed no further development of cracks. After this the edge was gently struck with the edge of a spatula at different places and again examined microscopically. The extreme outside of the case was found to have fractured along the hair cracks shown in the photomicrograph reproduced in Fig. 4. This occurred at every place the specimen was struck, and the line of fracture was always the same—i.e., near the tops (exterior ends) of the columnar crystals, consequently within the light portion of the case.

Necessity of Mounting Before Polishing

It was noticed that in all specimens not mounted a *distinct but irregular white layer* was present. This was because the exterior portion, which etches dark, has been lost during the polishing operation due to its extreme brittleness. Losses of this sort occurred after polishing early in the present investigation, until it was observed that a very constant increase in weight was obtained by giving like gas annealing to like specimens.



FIG. 4—COLUMNAR CRYSTALS IN NITROGENIZED LAYER. ETCHED 36 SEC. IN 4 PER CENT ALCOHOLIC NITRIC ACID. × 400

With the possibility that spalling could be giving the erratic misroscopic results, mounting was resorted to. When this was done examination showed very regular depths of case when like specimens were treated in the same way. This is somewhat contrary to Wheeler's views, which he expresses on page 30 of his paper (*Mining and Metallurgy*, No. 160, April, 1920) as follows:

"The object of treating a number of alloy steels twenty hours in NH at 650 deg. C. and in some cases at 750 deg. C. was to observe the depth of the case formed and gather an idea of the effect of the added element in retarding or accelerating this reaction. The method is far from quantitative. For instance, two steels, each of 0.40 per cent carbon and 1 per cent chromium, one of 0.20 per cent vanadium and the other of 0.25 per cent vanadium, would not give in half a dozen experiments consistent results as regards the depth of penetration. Such fine distinctions are beyond the scope of this method."

While Mr. Wheeler does not mention whether or not his specimens were mounted before polishing, nor does he mention the extreme brittleness of the outer surface exposed to NH_3, the present writers fear, in case his specimens were not mounted, the spalling of the edge led him to conclusions which are not quite correct.

Let us examine a few photomicrographs, in this connection, prepared by the writers of specimens mounted and not mounted. The photomicrograph shown in Fig. 5 shows the type of case produced by treating a plain low-carbon steel in NH_3 twelve hours, followed by furnace-cooling and polishing with great care in the ordinary way—i.e., not mounted. The case is seen to be very irregular. Other views at the same magnification and nearly the same location on the same specimen give white cases from one-third to one-fifth the thickness. Another steel of eutectoid composition showed such irregular and jagged edges as are revealed in Fig. 6.

As soon as such gross irregularities as this appeared as a result of microscopic examination and in view of what would be expected from the gain in weight observed on many treated specimens it was decided at once that mounting was necessary to make an accurate study of this case.

Table II gives the weight before and after treatment in NH_3, together with the actual and percentage increase in weight, of isx specimens of steel wire ¼ in. in diameter and cut approximately to the same length.

One can see at a glance that a greater degree of regularity exists in weight gain than would be expected from such an irregular surface. Consequently the specimens from this time on were mounted in the low melting point alloy previously mentioned. This resulted in uniform cases, as was expected. The photomicrograph

TABLE II. GAIN IN WEIGHT OF ¼-IN. WIRE AFTER AMMONIA ANNEALING

Specimen No.	Weight Before NH_3 Treatment	Weight After NH_3 Treatment	Gain in Weight	Per Cent Gain
1	3.5822	3 6104	0 0282	0 79
2	3 9745	4 0045	0.0300	0 75
3	4 1864	4 2166	0 0302	0 72
4	4.3250	4 3550	0 0300	0 70
5	3 9836	4 0128	0 0292	0 73
6	3 9621	3 9909	0 0288	0 73

reproduced in Fig. 8 shows the same steel as shown in Fig. 5 (at 125 diameters instead of 200, because all the case could not be conveniently shown at high power).

This degree of uniformity was found on all specimens mounted, though in some instances the case would be cracked, but held in place by the low melting point alloy.

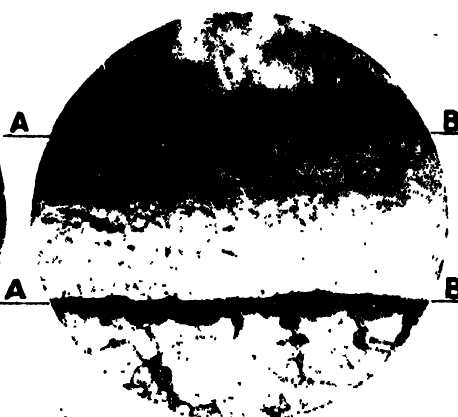
Inspection of all of Mr. Wheeler's photomicrographs shown in his excellent paper noted above, taken on the edge of specimens to show the depth of case, shows that none were mounted. On account of this the present writers are very skeptical regarding the accuracy of some of the conclusions to which he has been led.

Pearlitic Layer Under Brittle Surface

Let us turn now to the rest of the microstructure produced by the ammonia treatment. Referring again to Fig. 1, taken in the region of low-carbon content, a thin dark layer, appearing to be high in carbon, is seen at the inside of and immediately next to the white layer—that is, at the base of the columnar crystals. Examination of this layer at higher magnification reveals a pearlitic structure, as shown clearly in Fig. 4, at 400 diameters. This layer was scrutinized microscopically from the low- to the high-carbon region, and it had the same appearance all along. In the high-carbon area it was in the form of pearlite grains, each grain surrounded by a thin film of excess cementite, seemingly the same as the normal structure, so that nitrogenization in this region produced the so-called "case" previously described, beneath which there was no evidence of a change in microstructure.







FIGS 5 TO VARIATION IN SURFACE LAYERS CAUSED BY POLISHING METHODS, HNO_3 ETCHING

Fig. 5. Low-carbon steel, polished without mounting. × 200.

Fig. 6. Eutectoid steel, polished without mounting. × 200.

Fig. 7. Same steel as Fig. 5, polished after mounting. × 125.



FIG. 8. SO-CALLED NITROGEN NEEDLES BENEATH THE SURFACE. × 125. HNO_3 ETCHING

In the low-carbon region something entirely different is observed. First, a thin layer (approximately 0.0007 in. or 0.017 mm. in thickness) pearlitic in appearance is found just beneath the columnar crystals; then comes a layer whose thickness equals about the width of two rows of ferrite grains, in which the structure of these two rows of ferrite grains appears normal. Just beneath this is found a layer of considerable thickness (not measured, but of greater thickness than all the other layers combined), in which the ferrite grains are found to contain a great number of the (so called by other investigators) nitrogen needles. This is shown in Fig. 8, at 125 diameters. Below this the normal structure of the low-carbon steel prevailed.

Restating conditions, we may say that in the high-carbon region there is a very brittle "case," which on its outer three-fifths etches dark and on its inner two-fifths light at first but depicts columnar crystals on further etching, beneath which case no change of structure was observed, whereas in the low-carbon area the same type and depth of "case" was observed, beneath which was a thin layer pearlitic in structure or pearlitic containing some sorbite, beneath which in turn was a layer about two grains in width which appeared unaffected; then follows the area containing nitrogen needles, and then the true normal structure. It is clear from this that in so far as microscopic examination of a sample etched with HNO_3 is able to show the nitrogen liberated by decomposing ammonia under the conditions stated has a far greater penetrating power on low-carbon than on high-carbon steel. It is recognized that nitrogen needles may be effectively masked by pearlite normally existing in high-carbon steels.

An explanation as to the reasons for the formation and existence of the different types of structure here shown will be left until more data are accumulated.

Specimens were etched with Stead's reagent, iodine, and boiling sodium picrate. Stead's reagent blackened the outside three-fifths of the case very quickly with a heavy copper deposit, while the nitrogen needles were light in a dark background. The columnar crystallization was vividly shown and the thin layer immediately beneath it was darkened. Boiling sodium picrate developed a most interesting structure, but the writers wish to withhold a discussion of these results until further study can be made, when a slightly higher melting point alloy will be used for mounting the specimens so they will not become loosened during the etching. Iodine gave no results that were not better shown by some other reagent.

Corrosion and Casehardening

A series of experiments were carried out to determine if the case produced by ammonia was of any value in resisting corrosion. Several specimens of 0.80 carbon steel were subjected to the action of ammonia at 650 deg. C. for twelve hours, after which they were given accelerated corrosion tests. As compared to the same steel not treated in ammonia the specimens thus treated were much more resistant to corrosion *provided* the specimen, after nitrogenization, was not subjected to stresses which would develop cracks in the brittle case. Specimens were tested which had the case intentionally cracked by light stresses, and these gave very poor corrosion tests. Since the case fractures so easily it is hardly possible that it can be useful in this way. As to casehardening, the writers firmly believe that cyanogen compounds used for casehardening give more brittle cases than compounds which do not contain cyanogen and that this brittleness is due to nitrogen. This was suggested earlier by Le Chatelier, and Braune reports needles similar to "nitrogen needles" in *Revue de Metallurgie*, 1905, vol. 2, p. 497, in his report on baths containing cyanide and ferrocyanide of potassium.[*]

Nitrogen (or Chemical) Theory of the Erosion of Guns

Early in 1917, when the first of the present writers was studying the erosion of two 10-in. rifles at the Watertown Arsenal, Watertown, Mass., a report of which will be found on page 245 of "Tests of Metals and Other Materials at the Watertown Arsenal During the Fiscal Year Ended June 30, 1917," he was led to believe that nitrogen liberated by the chemical changes taking place during the burning of the powder reacted with the metal lining of the gun and formed compounds which play a considerable part in the erosion of the bore, and it was at that time that he first offered this theory to his immediate superiors at that place. While this supposition was rejected at the time, the work of the past three years has done more to prove than disprove this point. In view of the extreme brittleness and fragility of the surface of steel after exposing it to the action of nascent nitrogen at elevated temperatures it has been and is the firm belief of the writer that this action goes on within the bore of guns and that the fragile substance formed, be it iron nitride or not, is, owing to its nature, readily swept away by the physical forces so well known. It therefore is believed that when attempts are made to reduce erosion to a minimum this point should not be overlooked and if at all possible a steel should be specified which has as high a resistance to the action of nascent nitrogen as is possible and at the same time meet the necessary physical requirements. The later work of Wheeler, previously referred to, adds a great deal to the strength of this theory. Erosion is therefore believed to be caused by chemical as well as physical and thermal changes.

[*]See also Brophy and Leiter on "Cyanide Hardening Due to Nitrogen," CHEM. & MET. ENG., vol. 23, p. 568, Sept. 29, 1920.

Determination of Nitrogen Oxides in Processess for Nitrogen Fixation

By Guy B. Taylor

Many investigators in the field of electrical discharges through gases have need for an accurate method of analyzing gases for nitric oxide. In many cases these investigators are not trained chemists, but may be physicists or electrical experts. In casting about for a method suited to their purpose, they naturally seize upon the obvious one of absorbing the nitrogen oxides in an excess of standard sodium hydroxide solution and titrating the excess alkali with standard acid after absorption. This method in the hands of an inexperienced analyst will unquestionably yield inaccurate results. The purpose of this note is to describe a simpler method, one not so likely to lead to errors as the alkaline absorption method.

Ehrlich and Russ[1] showed that nitrogen peroxide is quantitatively converted to nitric acid by hydrogen peroxide solutions. This reaction serves as the basis of the proposed method which is carried out as follows:

The gas is sampled by allowing it to fill an evacuated glass bottle provided with a glass stopcock. For arc-furnace gases a two-liter bottle is convenient. The volume of the bottle must be known as well as the previous degree of evacuation. If an excess of oxygen is not normally present in the gas to be sampled, oxygen gas must be added to the sample to convert nitric oxide to nitrogen peroxide. After filling the bottle to atmospheric or some other exactly known pressure and ascertaining the filling temperature, introduce 25 to 50 c.c. of 1.5 per cent hydrogen peroxide solution and shake until the reddish color of NO_2 disappears. Let stand at least five minutes and shake again. Then titrate the acid solution in the bottle with N/10 sodium hydroxide, using methyl orange as the indicator.

Practically all hydrogen peroxide solutions are acid in reaction. To prepare the reagent for the analysis, dilute the commercial 3 per cent peroxide with an equal volume of water and neutralize with N/10 sodium hydroxide, using methyl orange indicator.

To calculate to per cent nitric oxide, let

a = c.c. N/10 alkali used.

v = volume of bottle in c.c.

b = barometer in millimeters of mercury, corrected.

p = pressure in bottle before sampling, millimeters of mercury.

t = temperature of gas sample, deg. C.

Then

$$\frac{2.24a}{v\left(\frac{b-p}{760}\right)\left(\frac{273}{273+t}\right)} \times 100 = \text{per cent NO}$$

This formula holds for low concentrations of nitric oxide, say up to 3 per cent NO, where the volume change due to formation of nitrogen peroxide may be neglected. To convert per cent NO to grams HNO_3 per cubic meter of gas at standard temperature and pressure (0 deg. C., 760 mm.) multiply by 28.

In many cases the temperature of the gas at the point of sampling is considerably higher than room temperature, in which case it is not practicable to determine the temperature of the gas in the bottle at the moment of closing the stopcock. In such cases proceed as follows: First, introduce the peroxide reagent with a rubber tipped pipette so that no air enters. After absorbing the nitrogen oxides, allow a measured volume of water to enter the bottle until the residual gas is at atmospheric pressure. Titrate as described above. In addition to the previous notation, let

w = vapor pressure of water at t deg. C.

v' = volume of peroxide plus water introduced into the bottle. Then

$$\frac{2.24a}{\left[(v-v')\left(\frac{b-p-w}{760}\right)\left(\frac{273}{273+t}\right)\right]+2.24a} \times 100$$

gives the percentage of NO.

The advantage of the above-described method lies mainly in the fact that only one standard solution is required and there is no trouble from bleaching of indicators by nitrous acid. Most indicators suitable for titrating in the presence of nitrites are sensitive to CO_2. This means that in the alkaline absorption method the standard sodium hydroxide solution must be prepared free from carbonates and carefully protected from the air after its preparation. Another serious source of error that an inexperienced investigator is likely to encounter is a mathematical one. The tendency is to use five or six or even ten times as much alkali for absorption as is neutralized by the gas, with the result that burette errors and errors in the factors of solutions are magnified. There is no possible advantage in any excess alkali above that required to keep the absorbing solution barely alkaline. Such excesses of alkali may lead to serious misintepretations of results, when, as is often the case, conclusions are based on a difference of 2 or 3 c.c. of the standards.

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[1]*Monatsh.*, vol. 32 (1911), p. 917.

France the Richest European Country in Iron Ore

It may not be generally known that France is the richest country in iron ore in Europe, and that the United States is the only country in a position to challenge her for the leading position of the world. With the restoration of Alsace-Lorraine, it is estimated that the French output will be 45,000,000 tons of iron ore a year, of which 17,000,000 tons will be exportable.

The successful organization of the export trade has now been brought about by the Comptoir Sidérurgique de France, which has absorbed the Comptoir des Poultrelles and the Comptoir d'Exportation des Produits Sidérurgiques. The large forges or steel works, by means of a combination known as the Committee of Forges, are securing increasing interests in iron mines, waterpower, coke ovens and mechanical engineering shops. In order to obtain the best results in foreign trade there has been created an industrial unity comprising the mine, the forge, the workshop and the bank. The opportunity has been taken by important French firms to secure in the markets of the world the position formerly occupied by organizations of a semi-industrial and semi-trading character, such as the Metall-Gesellschaft.

Engineering undertakings of all kinds have for many years been chief factors in French expansion abroad—particularly in Asia Minor, Russia and South America. A great many South American ports are under the management of French enterprises. The Maison Fougerolle Frères and the Société Générale d'Entreprises have between them executed contracts of a total value of 950,000,000 fr. and are now making elaborate plans for the extension of their foreign business.

Need of Professional Solidarity Among Chemists*

A Succinct Review of the Status of the Chemists as Related to the General Welfare of Their Profession, and as to Their Duty to the Community and the Nation

BY H. C. PARMELEE

THE United States needs a consciousness of chemistry as a factor in its national welfare, and the only man who can create that consciousness is the chemist. The war laid the foundation for this achievement. It remains for the chemist to build the superstructure, not only in the public interest but also for the advantage of professional solidarity. The immediate aim thus seems to be twofold, but the ultimate accomplishment is single in its purpose -the reaction of chemical thinking on the life and activities of the people.

It is safe to say that the part played by the chemist in the World War brought him into public prominence as did none of his previous scientific and technologic achievements. The reason is that his services touched directly the great mass of the people. He came out of the seclusion of his laboratory and stood forth as a fellow citizen, specially trained to meet a need that was insistent, sudden and unexpected. His performance commanded the respect of soldier and civilian alike. He "arrived" with almost unprecedented efficiency and became a factor of prime importance. His work stood out as eminently practical and was shorn of much of the mystery that had previously surrounded him in the public mind. In fact the public suddenly became conscious of the chemist, just as it was conscious of the surgeon as a necessary adjunct to the army.

But the public had long been conscious of the surgeon in its civil life as a necessary adjunct to peaceful pursuits. Why had it not so recognized the chemist? It was not because he had not played an important part in the daily life of the nation, for he had. For years he had been controlling important industries the manufacture of steel, the production of foodstuffs, the winning of gold and silver from their ores, the manufacture of medicines, the purification of municipal water supplies, the making of paper and ink, the application of fertilizers, the production of dyes, the preparation of salt, soap, starch and sugar. For years he had been thus close to the public interest and yet had failed to gain the recognition that was accorded to other professionals.

A Needed Public Consciousness Relating to Chemists Wrought by the War

The nature and importance of the chemist's work were comparatively unknown to the great mass of the people, for whom his queer apparatus and strange solutions and smelly laboratory were shrouded in mystery.

The war wrought a sudden change. The chemist became a marked man; and while he was drafted, it was not into the infantry, but into the laboratory and plant for the production of munitions. Much of his work was the same as it had been in times of peace -the production of steel, food, medicine, metals, fertilizers, soap. The principal difference lay in the channels to which the products of his ability were diverted. He gained more publicity and greater recognition; there was no longer quite so much mystery about the nature of his services.

It is safe to say that before the war the average citizen, on discovering that his neighbor was a chemist, would say, "Oh, yes," in a hazy sort of way, and then either change the subject or inquire, "Well, just what do you do?" And if the reply indicated, for example, that the chemist worked in the laboratory of a railroad company or a packing house, the mystery would only be deepened. But let the same man casually learn that his neighbor was a lawyer or a doctor, and immediately he would understand that man's place in society and his relation to the community; and it would matter not whether the lawyer or doctor were employed at a smelting works or a sugar factory, the average citizen would understand the nature and value of his services. And this because there was a public consciousness relating to doctors and lawyers which had not yet developed regarding chemists and chemistry.

Professional Solidarity Fostered by Self-Consciousness

Granting that the chemist is no longer an unknown quantity in the public mind and that the importance of his part in the general scheme of things is recognized and admitted if not fully understood, the next step is the creation of professional solidarity among chemists by fostering a modest self-consciousness of their relation to society and their duty to the community and the nation. The chemist may not again retire to the obscurity of his laboratory and plant. He has certain abilities and ways of thinking that can be turned to good account in public affairs. He possesses knowledge of incalculable and practical value and benefit to the public, and the public is entitled to it. And more: if the chemist is to be satisfied with the conduct of business and government, he must apply thereto his qualities of precision, accuracy, efficiency, integrity and all other mental products of his education and training, or else refrain from criticism of those who lack his knowledge and point of view. Like the engineer, his preparation for professional work "makes him exact, precise, honest, efficient, unshackled by tradition, aggressive in attacking a problem, sound in analysis and judgment, and fearless in execution."[1] These qualities are quite as useful for citizenship and government as for scientific pursuits, and those who possess them are obligated

*Excerpt of an address delivered before the New York alumni of Alpha Chi Sigma, and published in *The Hexagon*, September, 1920.

[1] "The Engineer and His Thinking," CHEM. & MET. ENG., Aug. 18, 1920, p. 265.

to exercise them in the public interest. And so it is now incumbent on the chemist to develop a consciousness of his duties and obligations to society. That self-consciousness will draw the members of the profession together and ultimately give them a sense of power that comes with unity. Solidarity, community of interest, will not be achieved if the chemist attempts to remain in "splendid isolation." In fact, neither he nor his profession will flourish, nor will he gain public recognition as a member of a great profession if he remains in isolated independence. The chemist must change his way of thinking of himself as an individual and look upon himself as a member of an important profession.

What Professional Solidarity Can Accomplish

We may take a lesson in ways and means to accomplish this from another profession of marked solidarity. Lawyers are organized in bar associations everywhere, and through these associations the voice of the profession becomes articulate. The public recognizes a pronouncement by a bar association on any subject of public welfare as a professional expression of opinion from a group of men qualified to pass technical judgment. Influence is thus exerted which would be impossible for any individual to put forth. The effect is cumulative: a sense of professional solidarity leads the bar association to speak with authority; the public is impressed by the weight of organized opinion and learns to respect it. This gives the association a new sense of power and responsibility and encourages it to assume leadership which the community, in turn, finally accepts as a matter of course. The relations become mutually advantageous. But the point to be observed is that the entire development had its inception in the consciousness of a group or class of men, due to similar training and habits of thought. So it must be with the chemist. To borrow a phrase from our labor friends, he must acquire "class consciousness," or, as it is better phrased, professional solidarity.

The Chemist Must Impress the Public With His Own Worth

It has often been humorously remarked that the lawyer has gained his position of professional prominence in the public mind by simply assuming it—by talking himself into it. There is quite as much truth as humor in the statement. Oratory is part of his stock in trade and he uses it for advertising purposes. And advertising may not be neglected, especially when promoting a new venture. If the chemist is to rise to a position of professional prominence and recognition he must, to use a modern commercial phrase, "sell himself" to the public. Publicity begins at home. If the chemist does not impress the public with his own worth, nobody will do it for him, at least not to the extent of creating that chemical consciousness which we want to see in the public and that sense of solidarity which we want to create among the chemists themselves. Advertising is essential. A man in the dark may know where he is, but nobody else does. He needs an illuminated sign. Likewise the chemist is a worthy citizen, but if he carefully refrains from collective action and expression nobody will be cognizant of his importance or gain the benefit of his knowledge. Lawyers assume leadership in government, acquire places on the directorates of large corporations, and otherwise gain distinction in public and private life. They and their opinions find favor with financiers and industrial leaders. The same road to distinction is open to the chemist if he first gains that sense of professional fellowship and community of interest, and then impresses the public with his ability for leadership. There is no inherent reason why he cannot be recognized by bankers and business men as a professional necessity equally with the lawyer.

An Appropriate Machinery for the Realization of the Chemists' Professional Solidarity

There remains, then, the consideration of the machinery for accomplishing this professional solidarity. Some form of organization or association immediately suggests itself, but a new addition to our already long list of societies does not make a favorable appeal. True, the engineers, who have been confronted with this same problem of crystallizing a professional sense out of the prominence and importance which the engineer gained in the war, have deemed it advisable to organize new societies; but it is doubtful if this is necessary for the chemists. Their technical society already is functioning in this respect to a certain degree, and that activity can be increased. In the meantime Alpha Chi Sigma offers a fertile field for the cultivation of the ideas herein expressed. Composed of men who presumably have a lively sense of fellowship as well as exceptional technical ability in chemistry, it affords a culture medium for the propagation of the thoughts that are beginning to find expression. Through its publication, *The Hexagon*, it should be possible to disseminate that particular kind of advertising which will demonstrate the importance of the chemist as a citizen and his relation to society, thereby fostering the professional sense and gaining public recognition. The fraternity should have some definite activity, for without it there can be no binding force to hold it together and make it useful. In helping to create this professional solidarity it would be doing the very thing that would make the fraternity flourish as a graduate or alumni organization—and that is where most alumni organizations fail, in a lack of common interest. If the alumni of Alpha Chi Sigma were to get the spirit of the new professional life that is now opening before chemists, they would leaven the whole body of technologists in a short time.

Restriction of Rubber Production Agreed Upon

At the beginning of 1920 the price of rubber in London was 2s. 11d. (71c. at normal exchange) a pound, from which it fell to 1s. 5½d. (35c.)—a figure very little above the average producing costs. Owing to the absence of American and British demand, stocks in London steadily increased, and finally, a month or so ago, the Rubber Growers' Association (London) recommended that production should be reduced by 25 per cent of the estimated normal monthly output, either by resting one-quarter of the tapping area or, preferably, by alternate-day tapping over one-half of the tapping area. If 70 per cent of the producers agreed, this scheme was to be put into operation Nov. 1.

The suggested scheme of restricted output has now received the necessary support, and the plan went into operation on Nov. 1, 1920. Under the agreement, the 25 per cent curtailment of production will operate until December, 1921. It is pointed out that while the output of rubber has increased five times since 1912, the price has fallen to less than one-fifth of the quotations then ruling.

Putting the Responsibility on the Student

BY JOSEPH W. RICHARDS

. . . care being taken to convey instruction in such a shape as not to make it compulsory on them to learn; because no trace of slavery ought to mix with the studies of the freeborn man.—PLATO.

AMERICAN institutions of higher learning are conducted entirely too much on the kindergarten plan and far too little on the principle of letting students work of their own volition. In the primary, secondary and grammar schools the hapless student is the object of a rigid system of "must," which leaves him no alternative but to work his hardest at the task imposed. In the high school things are much the same; lessons are assigned in a textbook, recitations are the principal exercise in the class room, and a rigid system of scoring absences insures that no student can be absent more than a specified number of times without being disciplined.

Our colleges, technical schools and universities continue this mechanical forcing of the student to his work. Every day has its appointed tasks, every hour is full of responsible duties, every precaution is taken that the student do at least the minimum amount of work before being passed for graduation. In fact, his teachers largely take upon themselves the burden of making him work; if a goodly proportion of the class does not attain the pitiful minimum of 60 per cent, the teacher's conscience begins to hurt him—he has not made them work hard enough.

Under these conditions, which prevail quite generally, what opportunity has the student to learn his own responsibility to keep himself at work? With no option but to attend and grind, how can he feel any right sense of the great opportunities which are his? He is forced to do what he ought to be happy to do of his own volition, and his better nature rebels at the compulsion. But his rebellious spirit finds no chance to realize its ideals; he is in the grip of the machine, he must do the work assigned and forced upon him, and he does it often with a discontented attitude, because he is made to do it.

What is the remedy? It is undoubtedly to put university students on their own responsibility, so that they can practice keeping themselves at their work. Do not *make* them do anything; let them make themselves do everything. You cannot teach a boy to use a knife without giving him one to use; he will probably cut himself in learning how, but give it to him you must. It is the same with the student's responsibility to bear his own burdens and to keep himself up to his work; the compulsion to work must be removed before the student can learn to take care of himself. Keep up the compulsion always, and you are robbing him of the chance to learn how to order and guide his own powers and his destiny; put the responsibility on him, and you are giving him the chance to learn to bear it.

The conclusion just stated may sound revolutionary and visionary to those so set in the old ways that they cannot see over the fences hedging in their narrow paths; but it works! Try it. Take no absences, hear no set recitations, stop treating university students like schoolboys who have to be made to work, and treat them like men who know what they are at college for and mean to get it.

Then eliminate the weaklings and the neglectful by occasional examinations, fairly given and carefully read and assessed. If a student shows that he has not been doing what he should and what he knew was expected from him, give him his medicine, drop him out after perhaps one warning; he has eliminated himself. This leaves in college the earnest and capable and the workers. They are all to whom the institution owes any obligation. Their work will progress better and more profitably by reason of the elimination of the unfit.

It is no proper part of the duty of a university teacher to make a student work. Lead the horse to water, but you cannot make him drink; it is folly to try. Tell the student of his great opportunities, spread the feast before him, but do not try to force him to eat. By this policy it is possible to eliminate from our American colleges and universities the indifferent, the unwilling, the "deadwood" of our classes, and to confine our further efforts to the inquisitive, the willing, the seekers after knowledge, who will work as hard as anyone could wish, without any compulsion.

This is the teachers' as well as the students' paradise—a university where no compulsion exists and students bear themselves the responsibility of working, led by the helpful advice and sympathetic counsel of their co-workers—the teachers.

Lehigh University,
Bethlehem, Pa

The Theory of Gas-Scrubbing Towers With Internal Packing

BY W. B. VANARSDEL

IN A RECENT article[1] on this subject by F. G. Donnan and Irvine Masson they first give a brief review of the rather scanty literature on the theory of gas scrubbing and then proceed to give attention to the results of Adeney and Becker,[2] which show that in the case of gases which obey Henry's solubility law, the rate of solution at any moment is proportional to the unsaturation of the liquid at that moment. The following is a brief summary of their calculations.

If m the concentration of absorbable component in the gas phase and n the corresponding concentration in the liquid, the rate of solution is proportional to

km n, where k $\frac{n}{m}$ at equilibrium; that is, k is

the Henry coefficient. The rate of solution depends also on a coefficient k_2, which the authors call the *dissolution coefficient*, and they remark: "Under strictly specified conditions this coefficient will be a constant quantity, but in general its value will increase with the degree of relative motion of gas and liquid and the degree of turbulence in both. The part played by the very thin 'stagnating layer' in hindering the exchange of heat energy or matter between different phases is well known to be a decisive factor in the design of heat interchangers and recuperators, furnaces, dissolvers, extractors, etc., and the thickness of this layer is diminished by increase of relative motion of the phases and by rupture of this layer due to the splashing of drops. We may term k_2 a *dynamical coefficient*."

In developing the theory of gas absorption in countercurrent towers on this basis Donnan and Masson con-

[1] *J. Soc. Chem. Ind.*, vol. 39, p. 236T (1920).
[2] *Proc. Roy. Dublin Soc.*, 1918-19, vol. 15 (N. S.), pp. 385, 609.

sider only the simplest case, by making the following assumptions:

1. Temperature kept uniform and constant throughout the tower.

2. The volume percentage of the absorbable gas constituent is supposed fairly small, so that volume changes due to its removal may be neglected as a first approximation.

3. The solubility of the main gas constituent is neglected.

4. The vapor pressure of the scrubbing liquid is supposed to be such that volume changes due to saturation of the gas with this vapor may be neglected as a first approximation.

5. The flow of both gas and liquid is supposed to be uniformly distributed over every cross-section of the packing.

6. The wetted area of the sides of the tower is neglected in comparison with the wetted area of the packing.

7. The absorption is a simple "physical" absorption—i.e., one not complicated by relatively slow chemical reactions in either gas or liquid.

The following symbols are used, calling the absorbable constituent of the gas X:

M_1 = grams of X per cu.m. of entering gas.
M_2 = grams of X per cu.m. of issuing gas.
m = grams of X per cu.m. of gas at level x in the tower.
N_1 = grams of X per cu.m. of entering liquid.
N_2 = grams of X per cu.m. of issuing liquid.
n = grams of X per cu.m. liquid at level x in the tower.
x = distance measured vertically downward from top of packing.
h = total height of packing.
V_g = flow of gas in cu.m. per minute.
V_l flow of liquid in cu.m. per minute.
S area of cross-section of tower (supposed uniform).
k Henry coefficient as defined above.
k_1 "coefficient of packing," area of interface between gas and liquid, in sq.m. per cu.m. of packing.
$f = \frac{V_g}{V_l}$ — "flow ratio."
$r = \frac{M_2}{M_1}$ = ratio of absorption.
k_2 = dissolution coefficient as defined above.

The authors point out that the coefficient of packing, k_1, must also be considered as a dynamical coefficient, since its value does not depend alone on the average wetted surface of the packing units, but may be due in large part to drops of liquid, in the form of drips and splash. It probably rises as the volume of liquid increases, but reaches a maximum and perhaps thereafter decreases when the flow becomes large enough to form small continuous streams.

Considering the element of volume between the heights x — dx and x in the tower, the following fundamental equations may be formed:

$$k_1k_2S(km - n)\,dx = V_g dm \tag{1}$$

$$n = fm - (fM_2 - N_1) \tag{2}$$

When these equations are combined, the resulting differential equation integrated and the limiting conditions substituted, either of two forms results:

$$\text{Log}_e \frac{(k - f)m + (fM_2 - N_1)}{kM_2 - N_1} = \frac{k_1k_2S(k - f)}{V}x \tag{3}$$

$$\text{Log}_e \frac{(k - f)M_1 + (fM_2 - N_1)}{kM_2 - N_1} = \frac{k_1k_2S(k - f)}{V_g}h \tag{4}$$

If $N_1 = 0$, as will often be the case,

$$\text{Log}_e \frac{k - f(l - r)}{kr} = \frac{k_1k_2S(k - f)}{V_g}h \tag{5}$$

The authors also write the simplified forms which result from assuming that M_2 is zero or negligible, or that the liquid issuing from the base of the tower is in equilibrium with the incoming gas.

In their conclusion it is shown that these equations give in a quantitative manner the way in which a high absorption efficiency depends on:

1. High interfacial area between gas and liquid.

2. High relative motion of gas and liquid (within limits).

3. High degree of turbulent motion in one or both phases.

4. Sufficient rate of flooding to secure the maximum drip effect.

Simplification by Use of Heat Interchanger Formulæ

These calculations are of great interest to all engineers who have anything to do with gas absorption on a large scale. For this reason it seems to the writer that attention might well be drawn to some simple consequences of the theory. The labor of calculation can be greatly diminished and the results become more significant when it is realized that the gas-scrubbing tower can be rigorously compared to a heat interchanger. The weight, W, of absorbable constituent which passes from one phase to the other may be determined from:

$$W = Ak_2C_mZ \tag{6}$$

where A is the area of interface between liquid and gas, k_2 a constant for the particular tower and manner of liquid and gas distribution, analogous to the constant of "conductivity" used in heat-exchange calculations, C_m a "mean concentration difference" analogous to the "mean temperature difference," and Z the elapsed time. Now on the basis of the expression derived by the authors for the variation in concentration with the level in the tower (counter-current flow) it is easy to deduce a value of C_m which will make equation 6 true. This value is as follows:

$$C_m = \frac{(kM_1 - N_2) - (kM_2 - N_1)}{\log_e \frac{kM_1 - N_2}{kM_2 - N_1}} \tag{7}$$

where M_1 is the concentration of the entering gas, M_2 that of the issuing gas, N_1 that of the entering liquid, N_2 that of the issuing liquid and k the "Henry constant," according to which, at saturation, $kM = N$. In case the absorption does not follow Henry's law, but an empirical relation between M and N is known, it is possible again to define C_m in concentration terms only, but its form is almost certain to be much more complicated.

The perfect analogy of C_m to the "logarithmic mean temperature difference" familiar in the heat calculations is obvious. The tower-constant, k_2, thus receives a more definite and suggestive meaning because of the familiarity of the heat-interchanger problem.

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Determination of Atmospheric Impurities—I

A Description of the Nature of Atmospheric Impurities, With Special Reference to Salt Lake City, Utah, Conditions—Methods and Apparatus Used for Their Determination—Results Obtained—Physical Character of the Solid Atmospheric Impurities

BY OSBORN MONNETT

EXACT knowledge of the nature and amount of atmospheric impurities is of considerable value in carrying out plans for smoke abatement. Ringelmann chart readings show the density of smoke as it leaves the stack and serve to show the relative importance of different classes of smokes and the amount of smoke sent into the atmosphere. They do not, however, show how much of this smoke actually stays in the city. Local topographical and weather conditions affect the nuisance profoundly. Thus Salt Lake City, whose gross coal consumption and smoke production are low compared with many other cities, has as aggravated a smoke nuisance as any city in the country. This is due to its location in a region of low wind velocity, in a valley almost surrounded by mountains. Another city of equal size and equal coal consumption but situated in a region of higher wind velocity might show identical Ringelmann chart figures and yet have very little smoke nuisance. It is evident, then, that figures showing the concentration of soot and other impurities in the atmosphere of the city are needed.

Such data show the sources of pollution in order of importance and tell the engineer in a very definite way what he must contend with. They also serve as a standard of reference for future years to determine with accuracy the progress made by smoke abatement measures. Conditions existing in cities today give rise to pollution of the atmosphere with soot and fine ash from burning of coal, with dust from traffic and industrial operations, and with small amounts of poisonous gases from industrial plants and coal fires. These all add to the "smoke" nuisance and contribute their share to making city air more or less detrimental to the health of the inhabitants and injurious to property.

NATURE OF ATMOSPHERIC POLLUTION

Pollution of city air is of several kinds:

1. Soot from burning of coal in industrial operations, large heating plants and domestic stoves and furnaces. This soot is the largest source of harm and annoyance. It is a mixture of varying proportions of carbon, tarry products of coal distillation, sulphur acids and ash. Taken in with the air we breathe, it lodges in the throat and nasal passages, and the finer particles get into the lungs. The presence of tar and sulphur acids makes it an active irritant and predisposes the breather to throat trouble and pneumonia. This soot soils and damages our clothing, curtains and woodwork and injures vegetation. Smoke from high-pressure plants tends to be high in ash and contains little tarry matter. Smoke from low-pressure plants and domestic stoves and furnaces is higher in tar acids and oily products of combustion and is more detrimental to health, property and vegetation.

2. Gases from burning of coal, from manufacture of industrial products and from decay of organic matter. Among these are sulphur dioxide, sulphuric acid, hydrogen sulphide, ammonia, chlorine, nitrogen acids and carbon dioxide. Of these only sulphur dioxide formed from the burning of coal and sulphuric acid formed from the sulphur dioxide by action of air and water vapor are usually present in more than negligible quantities. These are both poisonous and corrosive gases. In the West considerable litigation has taken place between farmers and smelters as a result of damage done to crops and live stock by sulphur dioxide from the roasting of ores. The relation of sulphur dioxide to the Salt Lake problem will be discussed fully in a later paragraph.

3. Dust of non-fuel origin. This includes considerable quantities of fine dust from industrial and building operations, paving dust from traffic, pollen, spores, decayed organic matter and soil. Such dust is as a rule less harmful to health and property. In Chicago it is estimated that 41 per cent of the solids in the atmosphere are of non-fuel origin.

NATURE OF ATMOSPHERIC POLLUTION IN SALT LAKE CITY

There is a very marked seasonal variation in the character and amount of atmospheric impurities in Salt Lake City. In the growing season from April through October the impurities are principally dust of non-fuel origin. With the beginning of the heating season the amount of coal smoke begins to increase until in December and January the city is often hidden in a pall of fog and smoke so dense that it is impossible to distinguish objects at 100-yd. distance. This smoke cloud is seldom pure soot, but is usually mixed with water vapor. The humidity in winter is high and smoke particles act as nuclei for the condensation of water vapor. This makes fogs of more frequent occurrence than if the atmosphere contained no foreign particles. Such fogs are dissipated with difficulty by the sun and may exist without evaporation for a considerable time even though the humidity of the atmosphere is considerably below saturation.

In the winter, when the smoke nuisance is at its height, the atmosphere is remarkably free from dust of non-fuel origin, but contains relatively large amounts of soot and ash from coal fires. Such material, due to its color and fine state of division, is a much greater nuisance, weight for weight, than the coarser and heavier industrial and other dust. A given weight of such soot will soil as large an area of white collar or lace curtain as one hundred times its weight of coarser

EDITOR'S NOTE: This is a chapter of the smoke-abatement report made by the Bureau of Mines in June, 1920, on its work in Salt Lake City, where it had the co-operation of the city and State University authorities. Published by permission of the Director of the Bureau of Mines.

dust. Hence although, as shown later, the actual weight of solid matter in the atmosphere is not extremely high, the actual nuisance in terms of soiling and damaging fabrics and architecture is very bad.

Methods Used to Determine Atmospheric Impurities

Three general methods have been used in the past for estimating the quantity and kind of solid matter in the atmosphere.

1. Filtration methods, in which a known amount of air is filtered through a paper or cotton wool filter. The weight of solid matter entrained by the filter may be expressed as weight per unit volume of air or the relative blackness of the filter may be used as a measure of the amount of solid matter present. Filters are examined microscopically to determine the character of solids and their relative amounts.

2. Counting methods, in which a known volume of air is blown against a prepared glass slide which is subsequently examined microscopically both as to number and character of particles. Results are expressed as to number of particles per cubic centimeter.

3. Settling methods, in which vessels of known dimensions are set up in places away from direct contamination by nearby stacks and the soot allowed to collect for a month or more. The deposit is subsequently weighed and examined chemically and microscopically. Results are expressed in tons of deposit per square mile per annum.

All of these methods give valuable information and none of them tells the whole story in itself. The filtration method, in which the actual weight of solid material per cubic foot is obtained, gives an exact figure which may be compared with results in other cities. On the other hand, it tells little of the character of the

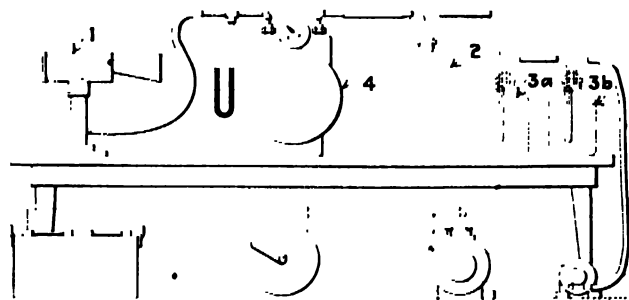


FIG. 1 APPARATUS FOR ATMOSPHERIC ANALYSIS

solid matter, and the presence of large particles of high specific gravity gives a high figure which may not indicate the actual degree of smoke nuisance. Several hours are needed for securing a weighable amount of solid matter. The procedure gives only an average result.

The method in which the number of particles in a given volume of air are counted allows instantaneous samples to be taken and tells something of the character, size and shape of the particles.

The soot fall method makes possible the collection of sufficient material for analysis and gives a basis for calculation of the amount of combustible matter discharged per annum. However, the amount of matter of other than fuel origin which finds its way into the jars is considerable and it is a difficult task to separate the constituents.

It seems best, then, to use if possible all these methods in order to definitely classify the solid material in the air as to nature and amount. Such results are of great value in expressing in a fairly exact way the extent of the smoke nuisance and serve as a standard by which the nuisance may be compared in successive years and with that prevailing in other cities.

For estimating gaseous impurities standard analytical procedure may be employed and accurate results obtained. The amounts of the various impurities are expressed in milligrams gas per cubic meter of air or in parts gas by volume per million parts air.

Description of Apparatus and Methods Employed

The apparatus employed in determining the amount of solid matter and other impurities in a given volume of air was essentially the same as used by the Chicago Smoke Abatement Committee.[1]

The analytical train as shown in Fig. 1 consists of:

1. Filtration apparatus.
2. Bottle for carbon dioxide determination.

3a. Absorbing solution of sodium hydroxide for determination of nitrous acid, chlorine and sulphur acids.

3b. Absorbing solution of hydrochloric acid for determination of ammonia.

The apparatus used for determining sulphur dioxide in the atmosphere will be described later.

A gas meter was placed between the filtration apparatus and the rest of the train to record the amount of air aspirated through the filter and train. A 6-volt motor and storage battery operating a rotary pump served to draw air through the train. About 10 cu.m. of air was drawn through the apparatus during the test, which lasted about six hours.

Filtration Apparatus

The apparatus as shown in the figure was arranged to hold a paper filtration thimble 43 mm. in diameter by 123 mm. long and to keep the thimble against the wind during the test in order to have duplicable conditions throughout. The collecting tube of the apparatus swings on a ball bearing and is sealed airtight with a mercury seal.

Considerable trouble was experienced in accurately weighing the paper thimbles. They were found to be extremely hygroscopic, changing several tenths of a gram in weight from day to day owing to changing humidity. In the procedure finally used the thimbles were dried in a constant temperature oven at 50 deg. C. for one week. Air dried over sulphuric acid was passed constantly through the oven. The thimbles were then allowed to cool in a dessicator over sulphuric acid and weighed in an aluminum container having a tight fitting screw top. This procedure was repeated from day to day until the weight was constant to 1 mg. Better accuracy than this could not be obtained. After use the thimble was again dried to constant weight.

Results were calculated in milligrams solids per cubic meter of air.

Determination of CO_2

The Pettenkofer method was employed.

Solutions Used. 1. Oxalic acid of strength such that 1 c.c. = 0.25 c.c. CO_2 at 0 deg. C. and 760 mm. pressure.

[1]Report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals, W. F. M. Goss, chief engineer. Rand, McNally & Co., Chicago, 1915, pp. 40-18.

Pure recrystallized oxalic acid ($H_2C_2O_4 2H_2O$) to the amount of 1.407 g. was dissolved in one liter of water and kept in a brown bottle. The strength of this solution is checked frequently by titration with N/20 sodium hydroxide.

2. Barium hydroxide of strength such that 50 c.c. baryta solution neutralizes 30 to 40 c.c. oxalic acid solution. This solution is prepared from a saturated solution of barium hydroxide by dilution with water. It was kept in a bottle having a soda lime tube and 50 c.c. overflow pipette.

3. Phenolphthalein solution. One gram of pure phenolphthalein is dissolved in 100 c.c. of 86 per cent alcohol. Two drops of this solution are used in the titration.

Procedure.—A wide-mouthed bottle having a volume of about four liters was used. This was placed in series with the analytical train and air aspirated through it for half an hour. The bottle was then removed from the train, corked with a rubber stopper in the center of which was a hole plugged with a small rubber stopper. The small stopper was then removed, 50 c.c. of standard baryta solution was run in from a pipette and the stopper replaced. The bottle was then shaken at intervals for twenty minutes so that the liquid wetted the sides completely. The excess baryta was then titrated with standard oxalic acid. A blank was also run on 50 c.c. of the baryta solution. Knowing the strength of the oxalic solution in terms of CO_2, the volume of the bottle, and the temperature and pressure, it was possible to calculate the carbon dioxide present. This was expressed in parts per million of air.

Determination of Nitrous Acid, Chlorine and Sulphur Acids

Absorbing Solution.—One pound of sodium hydroxide is dissolved in eight liters of water and 400 c.c. of this solution is placed in the absorbing bottle.

Analytical Method for Nitrous Acid.—The solutions used are:

1. Sulphanilic acid. Sulphanilic acid to the amount of 4 g. is dissolved in 500 c.c. of acetic acid, specific gravity 1.04.

2. Alpha-naphthylamine. Alpha-naphthylamine to the amount of 2.5 g. is dissolved in 500 c.c. of acetic acid, specific gravity 1.04.

3. Standard nitrite solutions. (*a*) $AgNO_2$ to the amount of 0.328 g. is dissolved in hot distilled water in a liter flask. Pure NaCl to the amount of 0.3 g. is added and when cold the solution is made up to a liter with distilled water, thoroughly shaken and the precipitate allowed to settle. (*b*) 100 c.c. of solution *a* is diluted to one liter. (*c*) 10 c.c. of solution *b* is diluted to one liter. 1 c.c. of solution *c* = 0.001 mg. HNO_2.

The procedure is as follows: Dilute to 50 c.c. 5 to 25 c.c. of the NaOH solution from absorption bottle, 15 c.c. of acetic acid, 2 c.c. each of No. 1 and No. 2. This is compared in a calorimeter against a standard solution made by adding 10 c.c. of solution *c* to 30 c.c. acetic acid, 150 c.c. of unused NaOH solution, 5 c.c. of No. 1 and 5 c.c. No. 2. A blank must be run on the NaOH solution.

Analytical Method for Chlorine.—The per cent of chlorine in Salt Lake air was too small to permit of estimation by the usual gravimetric or volumetric methods. Recourse was had to nephelometric estimation of the density of the precipitate of silver chloride.

The solutions used are:

1. Standard NaCl solution. Dissolve 0.165 g. pure fused NaCl in one liter of water. 1 c.c. = 0.1 mg. chlorine.

2. Standard NaCl solution. Dilute 10 c.c. of solution No. 1 to one liter in a graduated flask. 1 c.c. = 0.001 mg. chlorine.

3. Approximately N/100 $AgNO_3$.

4. Approximately N/10 HNO_3.

The procedure is: To 30 c.c. of NaOH solution from the absorption bottle are added 10 c.c. of N/10 HNO_3 and 10 c.c. N/100 $AgNO_3$. The solution is heated for thirty minutes at 50 deg. C.

A standard is prepared by adding to 110 c.c. of unused NaOH solution 10 c.c. NaCl solution No. 2, 40 c.c. N/10 HNO_3, 40 c.c. N/100 $AgNO_3$, and heating for thirty minutes at 50 deg. C.

These are compared in a nephelometer of the Kober type. A blank must always be run on the NaOH solution.

Analytical Method for Sulphur Acids. Just neutralize with conc. HCl 200 c.c. of NaOH solution from the absorption bottle, add 5 c.c. HCl in excess, add a little bromine water and boil the solution until the color is dispelled; add 25 c.c. of 10 per cent $BaCl_2$ solution and heat the solution on the water bath for one hour. The solution is then filtered and the paper ignited and weighed.

Determination of Ammonia

Absorbing Solution.—Dilute 20 c.c. of concentrated HCl to one liter. Eight liters of this solution is made up at a time.

Analytical Solutions.—There are two of these:

1. Standard NH_4Cl solution. Place 3.141 g. dry NH_4Cl in a liter flask and make up to one liter with distilled water. Dilute 10 c.c. of this solution to one liter with NH_3-free water, 1 c.c. = 0.01 mg. NH_3.

2. Nessler's solution. Dissolve 50 g. KI in smallest quantity of cold water. Add a saturated solution of $HgCl_2$ until a faint show of excess is indicated. Add 400 c.c. of 50 per cent KOH solution. Filter through asbestos on a Büchner funnel and make up to one liter.

The procedure is: Place 50 c.c. of the HCl solution in a Kjeldahl flask and add 20 c.c. 1 : 1 KOH and 80 c.c. NH_3-free water. Distill 100 c.c. into a Nessler tube and add 2 c.c. Nessler's solution. This is compared in the calorimeter with a standard of suitable strength made from the NH_4Cl solution.

Method of Determining Sulphur Dioxide

A very sensitive method for determining small amounts of sulphur dioxide in air has been developed by A. E. Wells[2] in connection with the work of the Selby Commission. This method was used to determine the amount of sulphur dioxide in the air of Salt Lake during December, 1919, and January and March, 1920.

A description of the method and apparatus used, essentially that described by Wells, is given herewith.

Briefly, the method consists in taking samples of the air to be tested by means of evacuated 24-liter bottles containing starch solution faintly colored with iodine. Comparison of this color with that of a blank and addition of iodine solution of known strength until colors

[2]Holmes, J. A., Franklin, Edward C., and Gould, Ralph A., Report of the Selby Smelter Commission, Bull. U. S. Bureau of Mines, No. 98, 1915, p. 13.

match enables quantitative determination of SO_2 in amounts as low as 0.1 part per million.

The solutions required are:

1. N/100 iodine solution. Place 1.27 g. of c.p. re-sublimed iodine and 5.0 g. of potassium iodide in a graduated flask and make up to one liter with distilled water.

2. N/100 sodium thiosulphate solution. Place 2.48 g. of pure $Na_2S_2O_3.5H_2O$ in a graduated flask and make up to one liter with distilled water.

FIG. 2. APPARATUS FOR DETERMINATION OF SULPHUR DIOXIDE

3. N/500 iodine solution. Run 50 c.c. of the N/100 iodine solution from a pipette into a 250-c.c. graduated flask and make up to the mark with distilled water. The solution is titrated against the N/100 thiosulphate solution; 5 c.c. N/500 iodine solution should equal 1 c.c. of the thiosulphate solution and 1 c.c. of the N/500 iodine solution is equivalent to 0.0224 c.c. SO_2 gas at 0 deg. C. and 760 mm. pressure.

Starch Solution. Add 2 g. potassium iodide to 400 c.c. distilled water and heat to boiling. One-half gram soluble starch is then added and when this has dissolved the solution is allowed to cool. This solution must be made fresh every day.

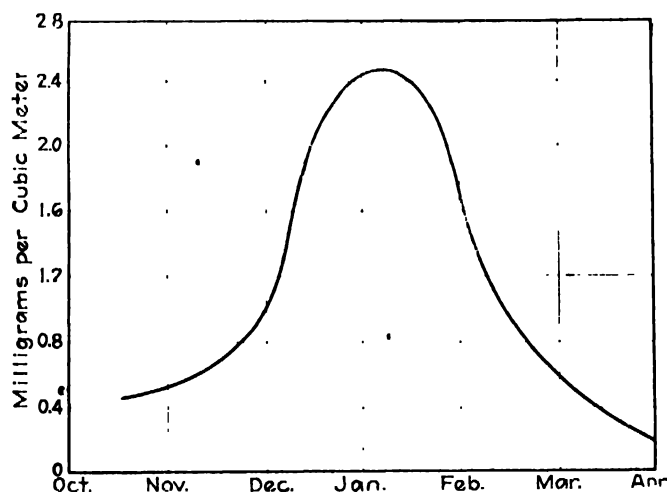


FIG. 3 SMOKE CONCENTRATION AT 344 SOUTH STATE STREET, SALT LAKE CITY, 1919-1920

Fig. 2 shows the apparatus employed. Bottles 1 and 2 are of 24-liter capacity. Bottle 1 is used in taking the samples. It is fitted with two single bore rubber stoppers containing glass tubes which may be closed by rubber tube and pinch cock as shown. Bottle 2 serves merely as a check and is fitted with single bore stoppers closed with glass plugs.

The titration bottles 3 and 4 are of clear white glass and about 400 c.c. capacity. They are fitted with two-hole rubber stoppers containing a right angle tube extending just through the stopper and a straight tube cut off below the top of the stopper and extending to a point just above the solution. In transferring the solution to the large bottle the finger is placed over the hole in the stopper and the bottle inverted. This transfers the solution without contamination from the air.

The manometer shown (5) is used in determining the pressure in the bottles. The manometer is so calibrated that by noting the temperature and evacuating the bottle to the mark corresponding to this temperature on the manometer scale the amount of SO_2 present may be read off directly in parts per million by multiplying by 2 the number of c.c. of N/500 iodine used. The manometer is calibrated by substituting in the formula[1]

$$M = \frac{273 + t}{0.000813V}$$

Where M = manometer reading in inches, t = temperature in degrees Centigrade and V is the volume of

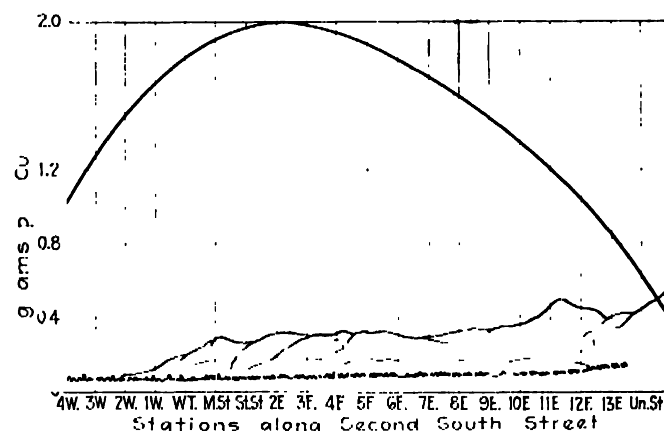


FIG. 4. AVERAGE SMOKE CONCENTRATION ALONG SECOND SOUTH STREET DURING DECEMBER, 1919, AND JANUARY, 1920

aspirator bottle in c.c. minus 200 c.c. (the space taken by the starch solution). Values of M corresponding to different temperatures are marked on the manometer scale and labeled with the corresponding temperature. A hand vacuum pump (7) is used in evacuating the bottle.

Procedure.—Place 400 c.c. of starch solution in one of the titration bottles and add iodine solution until the solution has assumed a definite lavender tint. The solution is then divided equally between the two bottles, the plugs removed from the tubulature stoppers in the aspirators, the right angle tubes of the titration bottles inserted in the stoppers and the solution transferred to the aspirator bottles. The titration bottles are then detached, the glass plugs reinserted, and the aspirators shaken for one minute. The solutions are then returned to the titration bottles for comparison.

In case a discharge of color in either bottle is noted, the solutions are mixed, a small amount of iodine solu-

[1]The formula assumes a constant pressure 25.4 in., an error of about 1.5 per cent.

tion is added to restore the original tint and the operation is repeated until the color of starch solution is not altered by the treatment. The bottles are then SO_2-free.

The solutions are then put back in the aspirators and the check bottle is closed with glass plugs. The manometer is connected to the upper stopper of the other aspirator and the vacuum pump to the lower. The bottle is evacuated to the point corresponding to the temperature and the pinch cocks are then closed and manometer and pump disconnected.

The top pinch cock is then opened and the air allowed to flow in, the bottle being shaken vigorously as the sample is taken and for one minute after. The blank

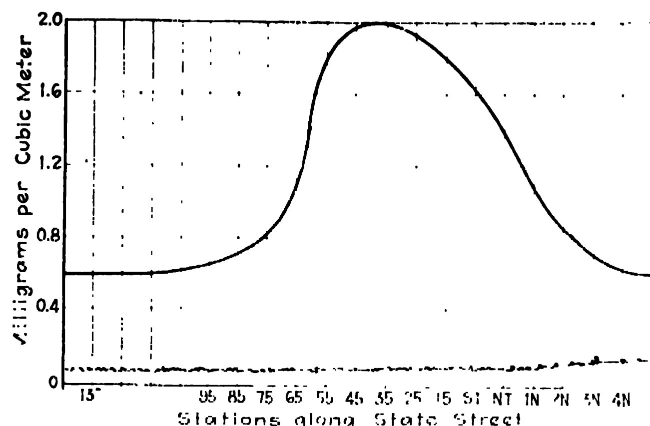


FIG. 5. AVERAGE SMOKE CONCENTRATION ON STATE STREET DURING DECEMBER, 1919, AND JANUARY, 1920

bottle is shaken for one minute. Solutions are then transferred to the titration bottles and the color of the determination restored to the same tint as that of the control by addition of N/500 iodine solution from the burette. The number of c.c. iodine multiplied by 2 gives the quantity of SO_2 in parts per million.

In this way 0.1 part per million of SO_2 can be detected. Accuracy is about 10 per cent for concentrations between 0.2 and 1 part per million.

RESULT OF ATMOSPHERIC ANALYSES

Solid Matter. The solid matter in Salt Lake City atmosphere varied during the time of observation (November-April) from less than 0.1 mg. per cu.m. to a maximum of 2.5 mg. per cu.m. From microscopic examination the solid matter so obtained is very largely of fuel origin and is in a very finely divided condition. There is both a seasonal and locational variation in the amount of solid matter present in the atmosphere. The highest concentrations were noted during the months of December and January and in the business district. Lower concentrations were observed during the other months of the year and in the outlying residential districts.

In Fig. 3 concentrations at 344 South State St. have been plotted throughout the time of observation in order to show the seasonal variation. It will be seen that the concentration rises from 0.5 mg. liter early in November to 2.5 mg. liter in January. It falls off to less than 0.1 mg. liter in the latter part of April. These figures are necessarily averaged over the entire day, since six or seven hours was needed to collect a weighable amount of solid material. The months of December and January are the times of minimum temperature and wind velocity, conditions favorable to the production of a large amount of smoke and a slow dissipation of the smoke formed.

Fig. 4 shows the average concentration along Second South St. during December and January. The concentration reaches a maximum in the business district, falling off gradually to a low point at the University.

Fig. 5 shows an east-west concentration variation on State St. during December and January. Again it is evident that the high concentration occurs in the business district.

These curves indicate in a general way the average concentrations. Individual days may vary to a large extent from the curves due to peculiar weather conditions. Sufficient data have been collected to verify in a very striking manner data from Ringelmann chart observations that the largest smoke production is in the center of the city within the zone of highest concentration as shown in Fig. 6.

Carbon dioxide determinations showed a variation from 270 to 430 parts per million, or an average throughout the year of 335 parts per million. No regular variation of the amount of carbon dioxide with the month or location in city could be discovered.

The quantity of carbon dioxide present averages but 35 parts per million higher than that present in the

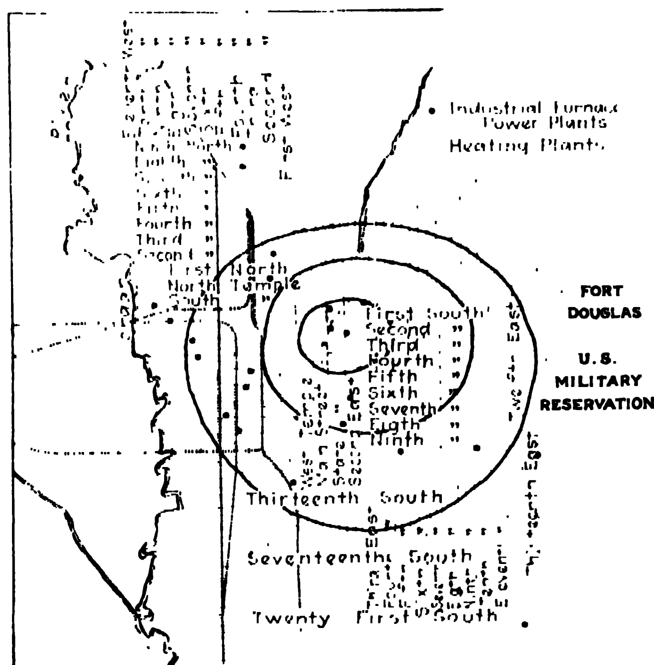


FIG. 6. MAP OF SALT LAKE CITY, SHOWING THE LOCATION OF INDUSTRIAL FURNACES, POWER AND HEATING PLANTS AND ZONES OF SMOKE CONCENTRATION

pure country air. Carbon dioxide is a negligible factor in the pollution of Salt Lake City atmosphere.

Nitrous Acid. Analyses showed a variation in the nitrous acid content of the air of from 0.009 to 0.0322 mg. per cu.m. The amount of nitrites present is higher on smoky days than on clear days.

Chlorine is present in very minute amounts, possibly carried as spray from the Great Salt Lake. Only a few determinations were made. These varied from 0.002 to 0.004 mg. per cu.m.

Sulphur acids are present in amounts less than 0.1 mg. per cu.m.

Ammonia varies from 0.001 to 0.08 mg. per cu.m.

None of these impurities is present in harmful amounts.

(Part II will be published in a subsequent issue.)

Corrosion Prevention in Petroleum Refining Vapor Systems

By Ralph R. Mathews and Philip A. Crosby

In a previous article[1] we showed that when petroleum which contained brine, with magnesium chloride as one of its constituents, was distilled in pipe stills, hydrochloric acid was evolved by hydrolysis, and in consequence serious corrosion took place in the fractionating system and in the condensers. Michael Freund[2] has also shown that such a reaction takes place, his observations being made on a Russian crude oil, and others have noticed corrosion when such oils were refined. As it is desirable to prevent, if possible, the rapid corrosion caused by the hydrochloric acid produced, several different methods have been investigated, and this paper covers some of the results obtained.

At the suggestion of President van der Gracht, of the Roxana Petroleum Corp., anhydrous ammonia was first tried as a neutralizing agent. The ammonia was obtained in drums containing approximately 150 lb. These were connected by means of a ½-in. line with the vapor line, just after the vapor left the stills, and before it reached the first dephlegmator.

At first an attempt was made to use a gas-bubbling bottle containing kerosene, and regulating the flow of the gas by rate of bubbling through the liquid. However, due to the low temperature caused by the expansion of gas as it left the cylinder, the bottles were broken and the oil was also carried over mechanically. In consequence the bubbling device was abandoned and the flow of ammonia required was regulated by examining the water which came to the receiving house from the last dephlegmator in the vapor system. Adjustment was made so that it carried a slight odor of ammonia, or at least was alkaline in reaction. Paper impregnated with phenolphthalein has been found best as an indicator of the character of the water. It was chosen because the color change is quite apparent at night, and regulation at night is as essential as during the day.

This method of regulation is not entirely satisfactory, because at times, due to a slight variation in vapor pressure, the odor comes much stronger than at other times; also, when the drum is getting nearly empty the pressure gets low, and it must be closely watched so that the valve can be opened wider. However, the stillmen have become so adept in handling the regulation that very few samples now come to the laboratory showing an acid reaction.

Comparison of Operations

In order to ascertain the benefits derived from the use of the ammonia in comparison with using none, an average sample of the water which comes from the top of the eighth dephlegmator was analyzed each day over given periods, to determine the iron content. No steam was being used in the system, and the condensed water came from the brine which was originally present in the crude oil. Comparative determinations of iron, in grams per liter of water, as shown in Tables I and II, illustrate the advantage of using ammonia. "Without Ammonia" was using a crude which contained less salt water than the other, and the difference would really have been greater if the same crude had been used as "With Ammonia."

[1] Chem. & Met. Eng., vol. 22, No. 11, p. 491.
[2] *Chemiker-Zeitung*, vol. 43, No. 149, p. 587.

TABLE I. OPERATION WITHOUT AMMONIA

Reaction of water was acid

	Iron Content G. per Liter	Estimated Vol. Water-Liters	Est. Wt. of Iron Lost Kg.	Lb.
1st day	3 65	1,000	3.65	8.1
2nd day	3 88	1,000	3.88	8.6
3rd day	4 55	1,000	4 55	9 8
4th day	4 83	1,000	4.83	10.4
5th day	5 01	1,000	5 01	11 0
6th day	4 85	1,000	4.85	10 5
7th day	7 13	1,000	7.13	15 7
8th day	6 11	1,000	6 11	13 5
9th day	7 87	1,000	7.87	17 3
Average per day			5 18	11 4

TABLE II. OPERATION WITH AMMONIA

Reaction of water was alkaline

	Iron Content G. per Liter	Estimated Vol. Water-Liters	Est. Wt. of Iron Lost Kg.	Lb.
1st day	0 03	4,000	0 12	0.3
2nd day	0 02	4,000	0 08	0 2
3rd day	0 77	5,200	0 40	8 8
4th day	1 20	6,400	7 68	16 9
5th day	0 11	7,600	0 83	1 8
6th day	0 04	8,800	0 35	0 7
Average per day			2 18	4 8

At first the average sample sometimes came to the laboratory having an acid reaction, due to difficulties in regulating the flow of ammonia. Over a period of five months these showed an average of 0.75 g. iron per liter water, while the total average, including the days when the water was alkaline, was only 0.35 g. Thus the water should be alkaline all of the time, not only to prevent corrosion by the acid vapors, but also the action on the metal of the ammonium chloride, which is corrosive in an acid system.

Salt Incrustations

That the ammonia and hydrochloric acid really react and form ammonium chloride has been proved by analyses of various deposits found in the vapor system. In fact, one line was found almost completely closed with a deposit, the composition of which is shown in the first analysis of Table III. The deposits found were variable,

TABLE III ANALYSIS OF DEPOSITS

	Per Cent
Moisture	0 67
Oil	1 07
Carbonaceous matter	1.20
NH_4Cl	5 38
$FeCl_2.4H_2O$	3 42
Iron oxide (by diff.)	88 26
	100 00
Moisture	1 77
NH_4Cl	69 50
$FeCl_2 4H_2O$	25.14
Undet. and iron oxide	3 59
	100 00

as shown in the second analysis of materials found in the vapor system. We have also found small amounts of ammonium chloride in the vapor line leading from the last dephlegmator to the tubular condenser.

About a year after the use of ammonia was begun the vapor pressure was found higher than normal in the vapor system. An investigation showed it might be due to deposition of NH_4Cl. The next to the last dephlegmator was accordingly washed with warm water and approximately the following amounts of material removed:

	Lb.
Ferrous chloride	102
Ammonium chloride	459
Insoluble matter	23

This is further proof of the reaction between the acid and ammonia and shows that the deposited NH_4Cl and $FeCl_2$ must occasionally be removed. The $FeCl_2$ and

insoluble matter (iron oxide) shows there is still some corrosion even when ammonia is used, but the longer life of the condensers as shown below is clearly indicative of the benefit derived.

Decrease in Depreciation

Before using the ammonia the tubular condenser was in use for approximately 100 days before it was necessary to replace any tubes, but after using ammonia it was about 280 days before any tubes had to be replaced. Not only is the cost of the tubes to be considered, but also the necessary labor and inconvenience sometimes caused. Where condensers are not in parallel it would mean shutting down the unit while new tubes were put in.

The cost of installation is small, and the main expense of course is for ammonia. It will probably vary with market conditions, but when using Mid-Continent crude oil it should not be over $0.005 per bbl. of oil run.

Determination of the water content of the crude oil in each tank before running, and the amount of salt in the oil, have been found of assistance. In connection with determination of the salt content a special method has been developed so that the amount present can be found without the necessity of waiting until sufficient brine separates from the crude. The method has been found very useful on crudes where the brine is present as a semi-permanent emulsion. Also, as stated before, the amount of iron in the water coming from the last dephlegmator is determined each day by analyzing an average sample for twenty-four hours.

Use of Soda Ash Not Successful

While the cost of using ammonia is not excessive compared to the benefit derived, it does, of course, mean an added refining expense. With the idea of reducing the cost, an attempt was made to prevent the formation of the hydrochloric acid by the addition of soda ash to the oil itself, the idea being to get the old familiar reaction between the magnesium chloride and soda ash. A solution of approximately 15 deg. Bé. was prepared and at first was put into the suction line of the feed pump, with the idea of getting as thorough mixing as possible. A proportional pump was used in adding the solution so approximately the proper amount could be added. However, the solution froze on contact with the cold oil and caused pump trouble. A connection was then made so that it could be added to the oil after the oil had been through one heat exchanger. The amount of solution added was so small, though, that even with the line covered the solution froze in the line before it reached the warm oil at the heat exchanger.

A 1-in. line inside of a 2-in. steam line was next tried, and while it fed in fairly well, the flow was intermittent and thus was not entirely satisfactory. In addition we found that even when the soda ash was going into the crude the water from the last dephlegmator was still slightly acid. This seemed due to organic acids collected from the vapor by the water and to carbonic acid. Samples of non-condensible gas were collected and analyzed when ammonia was not being used. They were found to contain 10 to 15 per cent CO_2. As the ammonia effected complete neutralization, it was of course a point in favor of its use. In addition, the use of soda ash apparently increased the amount of salts deposited in the retorts of the pipe still. In view of the above the attempt to use soda ash was finally abandoned and the addition of ammonia was continued.

Experiments which have been lately made show that the aqueous solution of ammonia is cheaper than the anhydrous, and we shall probably be using it exclusively in the near future.

We have not as yet been able to isolate the organic acids referred to above, neither have we been able to locate the source of carbon dioxide which we have found in the vapor system. However, we are proceeding with an investigation as rapidly as routine work will permit.

Roxana Petroleum Corporation,
Wood River, Ill.

Will Sodium Fluoride Come Into General Use for Preserving Wood?

By George M. Hunt

The desirability of sodium fluoride as a wood preservative is practically established. The data collected by the Forest Products Laboratory and published in the article by C. H. Teesdale on "Use of Fluorides in Wood Preservation"[1] are strong evidence to this effect. One large coal-mining company has been using sodium fluoride since 1915 for the treatment of its mine timbers, in preference to either coal-tar creosote or zinc chloride. In the 1919 *Proceedings* of the American Wood Preservers' Association, pages 138 to 145, Galen Wood, chemist of the Port Reading creosoting plant, presents evidence of the preservative value of sodium fluoride and the practicability of its use.

In spite of its proved value for the purpose, sodium fluoride is not being used to any extent as a wood preservative except by the single company mentioned. Other companies have expressed an interest in it, but they have never used it in quantity. The reason for this is obvious when the price of sodium fluoride is compared with that of zinc chloride, which is the standard water-soluble wood preservative. At present sodium fluoride is selling at about 15c. per lb., while zinc chloride is purchased in large quantities at approximately 8c. per lb. This difference in price prevents the wide use of sodium fluoride in the wood-preservation industry.

Use of Zinc Chloride

Some idea as to the field which might be opened to sodium fluoride in this industry may be obtained from Table I, compiled from the 1919 *Proceedings* of the American Wood Preservers' Association, which gives for a number of years the annual consumption of zinc chloride in preserving wood and the amount of wood treated with it.

TABLE I AMOUNT OF ZINC CHLORIDE USED IN THE U. S. AND WOOD TREATED WITH IT FROM 1909 TO 1918

Year	Zinc Chloride Used, Lb	Amount of Wood Treated Cu Ft
1909	16,215,107	32,678,797
1910	16,802,532	34,804,557
1911	16,359,797	36,814,039
1912	20,751,711	37,803,341
1913	26,466,803	44,772,287
1914	27,212,259	57,352,587
1915	33,269,604	62,849,901
1916	26,746,577	52,075,638
1917	26,444 689	54,311,726
1918	31,101,111	60,385,421

* These figures include wood treated with straight zinc chloride solution and wood treated with mixtures of creosote and zinc chloride.

Assuming a uniform cost of 8c. per lb., the amount of zinc chloride used in 1918 represented a value of

[1] *Wood Preserving*, January-March, 1917.

nearly $2,500,000. At pre-war prices for zinc chloride, the value of this amount would have been in the neighborhood of $1,250,000.

Of the various forms of timber treated with zinc chloride, nearly 95 per cent is in the form of railroad ties, and most of the remainder is construction timber. Small amounts are occasionally reported as used for poles, piling, wood paving blocks, cross-arms and miscellaneous lumber. Reports of the total amount of timber treated in the United States in 1918, the latest year for which statistics are available, show that nearly one-half was treated with zinc chloride.

Since zinc chloride is soluble in water, it will leach out if the treated wood is used in water or very wet locations. It finds its greatest use, therefore, in the drier parts of the country. In the Southern states coal-tar creosote is used in preference to zinc chloride particularly in treating piling to be used in water.

Advantages of Sodium Fluoride

Sodium fluoride can be used in the same manner, with the same apparatus and for the same wood-preserving purposes as zinc chloride. It possesses several minor advantages, but its superiority over zinc chloride for general use is not sufficient to justify the wood preserver in paying a much greater price for it. A comparison of some of the properties of these two chemicals which are of importance from a wood-preserving standpoint is given in Table II.

TABLE II COMPARISON OF PROPERTIES OF ZINC CHLORIDE AND SODIUM FLUORIDE

	Zinc Chloride	Sodium Fluoride
Solubility in water	Soluble in all proportions	Soluble to about 4 per cent
Toxicity	Toxic [illegible] materially [illegible] the life of wood	Over tw[illegible] as toxic as zinc chloride
Corrosive effect on st[illegible]	[illegible]what corrosive, but [illegible] steel apparatus	Much le[illegible] [illegible] zinc chloride
Effect on paint	Cannot be successfully painted over	Does not injure paint
Convenience of shipping	Shipped in 50 per cent solution or solid, but solid form is deliquescent and must be sealed in air tight container	Shipped as dry powder in slack cooperage
Present cost	About 8c per lb	About 15c per lb

From the fact that the toxicity or poisoning property of the sodium fluoride is given as more than twice that of zinc chloride, it might be argued that it would be twice as effective as a preservative, or that only one-half as much need be injected into the wood to produce the same effect. The toxicity is determined by laboratory tests only. Such test must be backed up by service tests, where timber is treated and put into actual use, before it can be determined positively that the relatively smaller amount of sodium fluoride indicated by the toxicity tests can be safely used. Tests of this kind are under way, but it will be a number of years yet before the results are known.

Question of Relative Price

The extent to which sodium fluoride will be used in treating wood, therefore, will depend mainly upon its price. There is little doubt that large contracts for sodium fluoride would be placed if the purchaser could be assured of a price equal to or less than that of zinc chloride. If sodium fluoride should begin to compete sharply with zinc chloride, the price of the latter would probably fall. Lowering prices of these two preservatives would encourage treatment and result in a larger volume of treated timber.

The question as to whether it is possible to manufacture sodium fluoride at a price low enough to compete with zinc chloride was recently answered as follows by a man very familiar with manufacturing conditions: ". . . you must consider that fluorspar which formerly cost about $10 now costs about $50, and hardly enough of 'acid quality' is obtainable for this enormous price. Soda ash costs more than twice as much as it formerly cost. Pyrite for the manufacture of sulphuric acid is also much higher than formerly. To this increase in the cost of all material entering into the manufacture of sodium fluoride comes the cost of labor, which has more than doubled in the last years. The cost of construction and repairs is also at least twice what it was formerly. Considering all these factors, the present price of sodium fluoride is very moderate. We are well aware that at present prices sodium fluoride can compete with zinc chloride for special purposes only. This applies to sodium fluoride made from hydrofluoric acid and soda ash."

From this it is evident that there is no apparent possibility of manufacturing sodium fluoride from fluorspar very cheaply under present conditions.

In the manufacture of fertilizer from phosphate rock, it is possible to recover a certain amount of sodium fluoride from the waste gases produced in the process. This is being done in a small way, but it is not a simple process, and a number of plants which have considered it have been deterred from the undertaking because of the chemical difficulties involved, the cost of constructing the required plant, or the difficulty of obtaining labor and materials. This industry offers a possible future source of cheap sodium fluoride; and although at present it is not producing much, it is to be hoped that the time is coming when it will be possible to furnish the wood-preserving industry with an ample supply at an economical price.

The ingenuity of our chemists should make available for general use a material having such desirable wood preserving properties.

Section of Wood Preservation,
Forest Products Laboratory,
Madison, Wis.

New Paper Pulp Industry in Argentina

The first factory in Argentina to make paper pulp was to begin operations during September, reports Trade Commissioner Brady, of Buenos Aires. The mill, which is located near Barranqueras, in the Chaco Territory, on the Parana River, is using as raw products a species of bog grass called "paja brava." This grass grows during the whole year, and is so abundant in the swampy places that it has been considered a nuisance.

At present the mill is equipped to make only pulp in sheets and strawboard for paper boxes. It has a capacity of three tons of strawboard per day. The construction of the mill was begun over two years ago during the war. The owners are German-Argentine and the engineer in charge is an Austrian. The equipment consists of old machinery rebuilt with some machines which were made in the country. It is intended later to increase the equipment in order to manufacture a finer quality of pulp and to obtain a greater production.

There is undoubtedly a good field for a more elaborate wood-pulp mill in the north of Argentina, since an abundance of trees and plants suitable for paper making exist in that region and there is a market for the product in Argentina.

The Fundamentals of the Electrolytic Diaphragm Cell*—III

Relation of Brine Concentration and Temperature to Voltage and Amperage—Cell Lag and Instant Results—Effect of Sulphate of Soda on Carbon Electrodes — Appendix: Calculation of Decomposition Voltage; Theoretical Yields per Ampere-Hour†

BY HUGH KELSEA MOORE

AS HAS been previously stated, it is possible to feed to the cells a salt solution of 99 per cent saturation. This does not mean, however, that the saturation in the inside of the cell will be 99 per cent saturation, for this is rarely the case. Most cells running at average decomposition efficiencies decompose the brine faster than it comes in. The average brine saturation in a cell running 93 to 95 per cent current efficiency varies from 80 to 82 per cent. It might be interesting to see what effect the brine saturation has on the voltage of a cell. To show this Table IX is submitted, illustrated by Fig. 9.

TABLE IX. DROP IN VOLTAGE WITH INCREASING SATURATION

Brine Saturation at 20 Deg. C.	Cell Temp. Deg C.	Drop in Voltage	Ampere
15	28.0	0.00	1,200
35	27.5	0.06	1,20
50	27.8	0.18	
	28.0	0.24	
	27.8	0.28	
	28.0	0.[illegible]	

Lowering the brine concentration in the cell not only uses up power but it tends to make the current electrolyze water, with the resulting liberation of nascent oxygen at the anode with the consequent more rapid destruction of the carbons. I cannot take the time to go into this now, but will be content with reference to the rapid destruction of the carbons. (See Table VIII, and Fig. 8C.)

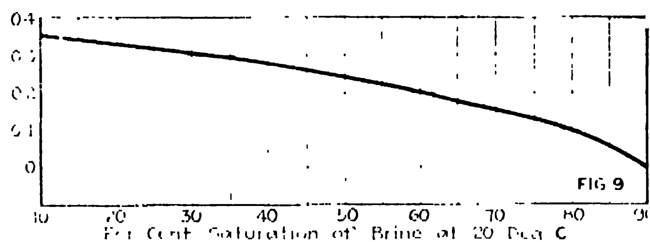


FIG. 9. RELATION OF ANODE BRINE SATURATION TO CELL VOLTAGE. CONSTANT TEMPERATURE

EFFECT OF TEMPERATURE ON VOLTAGE AND AMPERAGE

It is often difficult to evaluate the effects of brine concentration because of the disturbing effect of another variable—viz., temperature. To illustrate this I submit Table X and Fig. 10.

The abscissæ are temperatures in degrees C., while the ordinates show the decreases in voltage. Another set of ordinates show the per cent saturation of the brine at the varying temperature. The solid line shows the per cent saturation at 20 deg. C. The dash line corresponds to 640 amp., while the dot and dash line corresponds to 850 amp. It will be noted that these lines are nearly parallel, showing in each case approximately the same degree of drop. The solid line is inserted into this chart to show the concentrations in this particular experiment, but as the concentration and temperatures may vary independently of each other, this curve must not be used to predict a concentration at a given temperature.

TABLE X. BRINE TEMPERATURE INCREMENTS AND VOLTAGE DECREMENTS

Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease Voltage	Amper
26.8	81.5	3.40	0.50	640
30.0	81.0	3.36	0.46	640
35.8	83.5	3.28	0.38	640
44.0		3.20	0.30	640
50.0		3.14	0.24	640
57.5		3.05	0.16	640
68.0		3.00	0.10	640
82.0		2.90	0.00	640
35.5	81.0	3.70	0.80	850
41.5		3.52	0.62	850
52.8	77.0	3.40	0.50	850
48.0		3.46	0.56	850
57.5		3.34	0.44	850
61.0		3.30		850
76.0		3.20		850

In order to get the effects of temperature on voltage two experiments were conducted with the object of keeping the concentration constant. Table XI, illustrated by Fig. 11, and Table XII, illustrated by Fig. 12, show the results obtained.

TABLE XI

Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease in Voltage	Amperes
33.0	88.0	4.24	0.69	1,200
39.0	87.0	4.05	0.50	1,200
47.0	[illegible]	[illegible]	0.40	1,200
54.5	[illegible]	3.80	0.25	1,200
57.5	85.0	3.75	0.20	1,200
61.0	85.0	3.72	0.17	1,200
70.0	84.0	3.60	0.05	1,200
75.0	83.0	3.55	0.00	1,200

TABLE XII

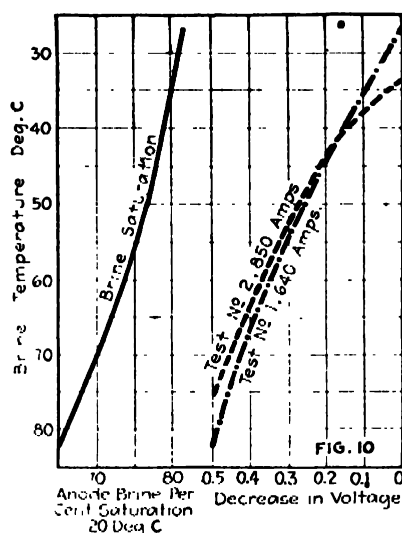
Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease in Voltage	Amperes
39.0	85.0	3.86	0.41	1,000
47.5	86.0	3.75	0.30	1,000
51.0	85.0	3.70	0.25	1,000
55.5	85.0	3.66	0.21	1,000
59.5	85.0	3.58	0.13	1,000
[illegible]	84.0	3.50	0.05	1,000
71.0	84.0	3.45	0.00	1,000

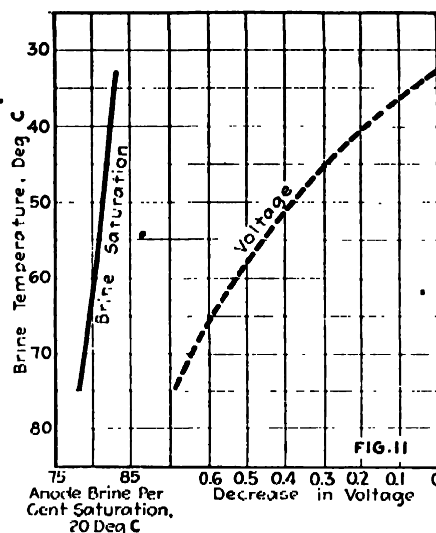
In each case the abscissa is the brine temperature in the anode compartment while the ordinates represent the decrease in voltage. As before, the solid line represents the concentration of the brine, while the dash line shows the drop in voltage. The saturation in Figs. 11 and 12 has been maintained by adding solid salt. The temperatures were obtained by blowing steam into the cell.

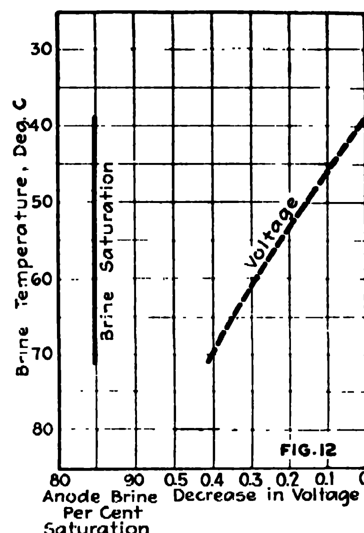
Raising the temperature in a cell also increases the fluidity of the brine and consequently it is well that we should know the effect.

The experiments illustrated by Tables X, XI and XII were conducted on especially high voltage cells in order that the increased flow due to rise in temperature should

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.
†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 21 and 22, Nov. 24 and Dec. 1, 1920, pp. 1,011 and 1,072.







FIGS. 10 TO 12.

Fig. 10. Anode brine temperature vs. cell voltage with constant saturation. Figs. 11 and 12. With decreasing saturation.

not be so great as to modify the other characteristics too markedly.

This brings up another matter, the increased flow due to temperature. Table XIII and Fig. 13 show this effect in a striking manner.

TABLE XIII

Brine Temp., Deg. C.	Flow in Liters	Amperes
39.0	11.7	1,000
47.5	12.2	1,000
59.5	14.8	1,000
71.0	20.2	1,000

TABLE XIV EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

Volts	Amperes	Causticity	Grams per L.	Chlorate	Anode Temp	Anode Sat.	Cathode Temp	Flow L.p. Hour	Specific Gravity	Decomposition	Eff.	Time
4.0	1180	41.0	164	0.28	46.5	73	32.0	10.2	1.2083	65.4	94.8	9 a.m.
3.92	1200	39.5	158	0.14	46.5	73	31.5	10.2	1.2104	64.6	89.8	10 a.m.
3.8	1225	37.5	150	0.28	55.5	68	34.0	11.8	1.2073	64.2	96.7	11 a.m.
3.8	1200	35.0	140	0.28	58.5	66	35.0	13.0	1.2023	61.5	101.0	12 m
3.7	1235	31.0	124	0.10	66.0	66	40.5	15.0	1.1769	59.0	101.0	1 p.m.
3.7	1225	29.5	118	0.00	67.5	64	43.0	15.6	1.1750	57.2	101.0	2 p.m.
3.65	1235	28.0	112	0.00	68.5	63	43.0	16.3	1.1749	56.0	98.3	3 p.m.
3.7	1250	28.0	112	0.00	70.0	63	45.5	16.8	1.1741	56.5	101.0	4 p.m.

TABLE XV EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

	Temperature	Sp. Gr.	Chlorate	Causticity	Volts	Amp.	Flow L. per Hr	Eff.	Time
(Without)	24.0	1.2104	0.45	35.0	3.52	775	7.6	91.9	10 a.m.
(With)	27.0	1.2063	0.26	30.0	3.32	775	11.4	122.5	11 a.m.
	30.5	1.1954	0.26	26.0	3.22	775	12.6	113.7	12 m
	33.0	1.1866	0.12	24.0	3.25	775	12.1	100.3	1 p.m.
	35.5	1.1798	0.0	20.0	3.15	765	14.9	117.0	2 p.m.
	40.5	1.1703	0.0	18.5	3.08	775	17.8	113.0	3 p.m.
	46.5	1.1675	0.0	16.0	3.02	775	18.6	104.0	4 p.m.

TABLE XVI EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

Volts	Amperes	Causticity	Grams per L.	Flow L. per Hr	Decomposition	Specific Gravity	Anode Sat.	Eff.	Cathode Temp.	Time
3.3	795	22	88	14.0	46.3	1.1820	65	102	32.5	9 a.m.
3.2	795	20	80	17.0	42.3	1.1720	65	114	36.0	10 a.m.
3.4	900	19.5	78	16.3	42.5	1.1670	65	95.2	38.0	11 a.m.
3.4	900	22	88	16.8	46.5	1.175	65	109	38.0	12 m
3.5	900	24	96	13.8	50.4	1.180	65	98	35.0	1 p.m.
3.58	900	26	104	13.6	52.2	1.182	65	105	34.5	2 p.m.
3.6	900	26	104	13.2	52.3	1.184	65	100	33.5	3 p.m.

In order to illustrate still further the effect of temperature on a diaphragm cell Tables XIV, XV and XVI and Figs. 14, 15 and 16 are submitted, showing the effects of blowing steam into the cell on the different factors noted. I wish to particularly call your attention to the decrease of chlorate in caustic liquor with the increase in temperature. In all probability this may be accounted for by the increased activity of the nascent hydrogen at the cathode on the decreased stability of sodium chlorate.

Cell Lag and Instant Results

On page 1074 I spoke of the possibility of getting more than theoretical efficiencies on tests of short intervals of time. I mentioned at this time one cause which would make it possible to obtain such results.

In Fig. 14 you will see another illustration of this fact, but for another cause—i.e., the lag in the cell. In the case before you we have a beautiful illustration of this fact. It will be noticed that during the experiment the causticity dropped from 35 to 16, while the flow increased from 7.6 to 18.6. The above condition always

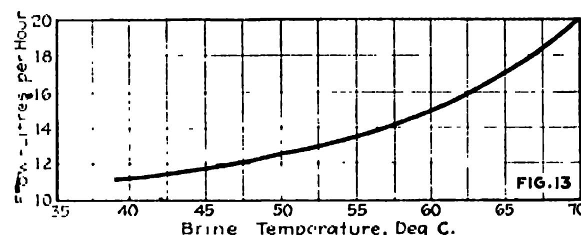


FIG. 13. RELATION OF FLOW FROM CELL TO BRINE TEMPERATURE

gives an apparent efficiency higher than the actual, and as the actual is near 100 per cent the apparent efficiency will be over 100 per cent. There is in every cell a certain volume of caustic held by capillary attraction in various parts of the cathode compartment. Now if one volume of the strong caustic so held is replaced by a light volume of a weaker caustic, the caustic effluent will contain more NaOH than was actually produced during the time in question.

While I am speaking of the high efficiencies of cells I might mention that the same effect will be produced if the cells run at an abnormally high amperage just before a test and then drop to normal as the test commences. I have known some crooks to do the above purposely for a joint test. This causes a high efficiency due

to the lag in the strong caustic getting away. Of course if these conditions are reversed you get efficiencies correspondingly low.

The above considerations are based on cells in which the amperage is accurately determined.

In studying Fig. 16 it will be seen that there is a rise in voltage on the second hour, even though there is a rise in temperature. This is due to a rise in amperage at the same time. The volts continue to rise but it will be noticed that the temperature drops while the amperage remains stationary. It will be noted also that the brine in the anode compartment is only 65 per cent saturation.

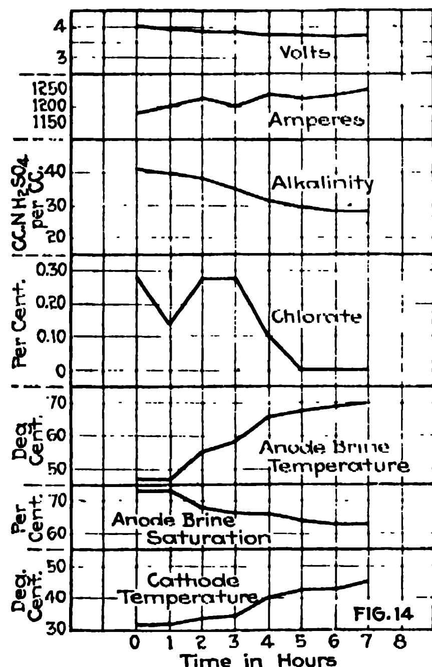
EFFECT OF SULPHATE

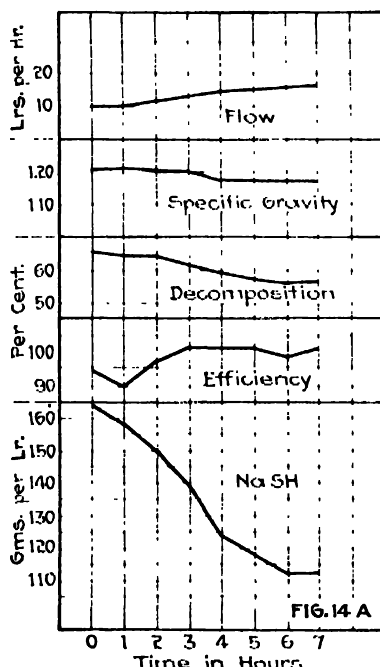
Many do not realize that small quantities of sodium sulphate in the salt fed to the cell can have a deteriorating effect on the cell itself. Experiments have shown that the absolute removal of sodium sulphate from the brine actually decreases the amount of carbon dioxide in the chlorine gas. The presence of this carbon dioxide in the gas not only causes a loss of brine in making bleach but it indicates a deterioration of the carbons in a cell. The loss from the carbons is, however, much greater than one would suppose from the amount of carbon dioxide in the gas. The explanation is simple. As that carbon going into carbon dioxide is removed from the structure of the carbon the cohesive force of other particles is lessened and they sluff off by the friction of the circulating electrolyte.

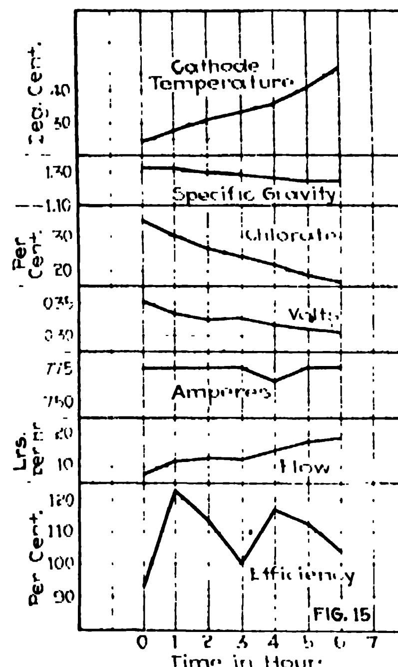
From the above one would expect that the absolute removal of sodium sulphate from the brine would increase the life of the carbons. Actual experiment has proved such to be the case. I am not, however, going to give these figures, inasmuch as I have not tried enough experiments to get an average figure which I can term reasonably correct.

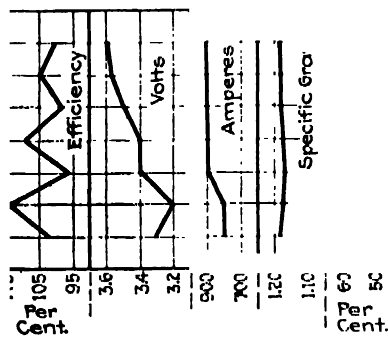
It might be interesting to note the increasing amount of chlorate formed in a cell of the submerged diaphragm type by the addition of a brine containing 1 per cent and 2 per cent sodium sulphate. Fig. 17 shows this. Inasmuch as the lag in the cell is very large and the cell had not reached equilibrium owing to the short time of run, I cannot give you a chart showing the per cent of chlorate which would uniformly be present for different percentages of sodium sulphate. The matter, however, is very important, inasmuch as herein lies a great source of danger to say nothing of expense.

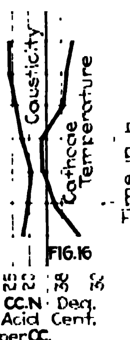
In evaporating a caustic solution it is possible to crystallize out most of the salt but impossible to crystallize out the sodium chlorate. When the kettles containing such chlorate become heated to a sufficient temperature, the sodium chlorate is liable to explode, throwing tons of molten caustic on the floor. Even if the kettles are so run that the sodium chlorate decom-

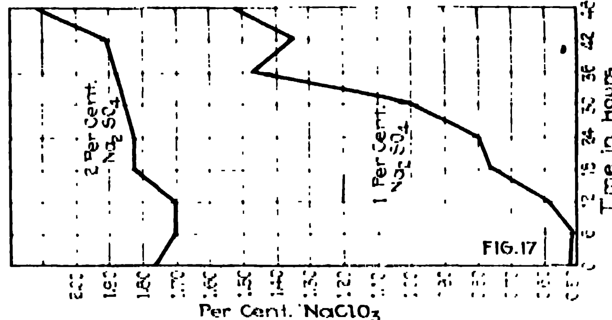












FIGS. 14 TO 17.

Figs. 14 to 16. Effect of steam on Allen-Moore cell. Fig 17 Effect of Na_2SO_4 solution on Le Sueur cell

poses gradually and smoothly, we may have a low test caustic from the presence of sodium chloride formed by the dissociation of the sodium chlorate.

Appendix

Calculation of Decomposition Voltage

It was stated by Helmholtz in 1847 and W. Thompson in 1851 that in a galvanic element chemical energy is completely transformed to electrical energy. Then if the heat of reaction in calories per gram-equivalent is called U, the electromotive force in volts which could be produced by it E,

$$E = \frac{U}{23046} \qquad (1)[1]$$

This is often approximately true, its error depending on the temperature coefficient of the electromotive force, and this in turn on the difference of the molecular heats of the reacting substances and the resultant substances. The theoretical basis of the correct method was established by Gibbs and Helmholtz somewhat later, but the new equations were of little use until Nernst's heat theorem was applied to the problem. The result may be written in the form:

$$E = \frac{U - 2BT^2}{23046} \text{ (approx.)} \qquad (2)$$

Where T is the absolute temperature, in Centigrade degrees, and $B = \frac{1}{2T}$ *(specific heat of all the reactants per gram equivalent)- (specific heat of all the resultants per gram equivalent).* But to apply even this expression, calculations must be made on a basis, first, of each phase being a pure solid or liquid substance; not, for instance, a solution. In the case of the ordinary electrolytic chlorine cell, for instance, the required specific heats must be known at a temperature at which the hydrogen and chlorine are liquid, and the salt and caustic are solid $NaCl.2H_2O$ and $NaOH.7H_2O$ respectively. The requisite correction to bring up the results to room temperature can then be made on the basis of the solubility-temperature curves. Such data, however, and especially the specific heats of low temperatures, are known for only a few substances. It is evident, then, that with the physical data now obtainable, the accurate calculation of decomposition potentials is impossible.

[1]Nernst, "Theoret. Chemistry." Sixth Ed., p. 733.

The approximate voltage obtained by equation 1 is, in fact, commonly used in practice. The unknown correction factor may be either positive or negative, and may range from zero to three-tenths, or four-tenths of a volt, or even more. In the case of the chlorine cell it is supposed to be about + 0.1 volt.

The heat effects and approximate decomposition voltages of sodium and potassium chlorides in aqueous solution are given herewith, indicating the degree of uncertainty in each case due to conflicting determinations of heat of formation.

Substance	Heat of Formation $MCl = M + Cl$	Heat of Formation $M + H_2O + Aq = MOH + H + Aq$	Net Heat Effect Cal. per g. Equivalent	Decomp. Voltage
NaCl	97,900	42,400	55,500	2.41
	to	to	to	Av. 2.35
	97,590	45,000	52,690	2.28
KCl	105,700	45,200	60,500	2.62
	to	to	to	Av. 2.56
	105,610	48,100	57,510	2.50

Brown Company,
Berlin, N. H.

THEORETICAL YIELDS PER AMPERE-HOUR

Elements

	Lb.	Grams		Lb.	Grams
Sodium	0.00189	0.858	Hydrogen	0.0000823	0.0373
Potassium	0.00322	1.459	Oxygen	0.000644	0.292
Calcium	0.00165	0.747	Chlorine	0.00292	1.322
Magnesium	0.00100	0.454	Bromine	0.00644	2.92
Iron (from Fe")	0.00230	1.041	Antimony	0.00330	1.497
Nickel	0.00242	1.092	Tin	0.00487	2.21
Cobalt	0.00243	1.101	Bismuth	0.00572	2.59
Zinc	0.00269	1.218	Cadmium	0.00461	2.09
Lead	0.00852	3.86	Copper (from Cu")	0.00260	1.18
Silver	0.00888	4.02	Platinum	0.00400	0.34
Gold (from Au")	0.00540	2.45	Aluminum	0.00075	0.34

Inorganic Compounds

	Lb.	Grams
$NaOH$	0.00329	1.492
KOH	0.00462	2.095
$Ca(OH)_2$	0.00305	1.382
$Mg(OH)_2$	0.00240	1.087
ZnO	0.00335	1.518
Cu_2O	0.00589	2.67
PbO_2	0.00492	2.23
White lead (approx.)	0.00631	2.86
$Na_2S_2O_4$ (from $NaHSO_3$)	0.00717	3.25
$Na_2S_2O_8$ (from $NaHSO_4$)	0.00957	4.34
$NaBO_3$ (from borax)	0.00338	0.153
$NaClO_3$ (from $NaCl$)	0.00146	0.660
$KClO_3$ (from KCl)	0.00168	0.761
Na_2CrO_4 (from $CrCl_3$)	0.00445	2.015
K_2CrO_4 (from $CrCl_3$)	0.00532	2.41
$PbCrO_4$ (from H_2CrO_4)	0.01330	6.02
$NaMnO_4$ (from Na_2MnO_4)	0.01168	5.29
$KMnO_4$ (from K_2MnO_4)	0.01301	5.90
$Na_2C_2O_6$ (from Na_2CO_3)	0.00684	3.10
$K_2C_2O_6$ (from K_2CO_3)	0.00816	3.70
NH_2OH (from HNO_3)	0.00045	0.205
$K_3Fe(CN)_6$ (from $K_4Fe[CN]_6$)	0.0264	11.94

Organic Compounds

	Lb.	Grams
Iodoform	0.00324	1.47
Anthraquinone	0.00428	1.94
Vanillin	0.00208	0.94
Chloral	0.0015	0.69
Saccharine	0.00252	1.14

British Power-Alcohol Research

It is reported that detailed research is shortly to be undertaken in India with a view to determining the practicability of producing power alcohol on a commercial basis, reports A. M. Walker, clerk to American Trade Commissioner, London.

At the same time that these experiments are being conducted, efforts are being made in Great Britain to make possible the ready use of such a substitute fuel whenever it becomes available in sufficient quantities. With this object in view, the Empire Motor Fuels Committee of the Imperial Motor Transport Council has recently appointed small technical committees to consider specifically:

(1) The modification of customs and excise regulations pertaining to alcohol;

(2) Experiments for determining the best conditions for developing the alcohol engine and types of alcohol fuels, alone or in mixture, for industrial purposes; and

(3) The denaturing of alcohol.

The problem of ascertaining what is a suitable denaturant is regarded as of very great importance, and the Empire Motor Fuels Committee, 50 Pall Mall, London, S. W., 1, has invited in confidence interested members of the public to submit practical suggestions as to possible denaturants. Such proposals will remain the sole property of the individual who furnishes them, and his interests will be properly safeguarded. The special requirements of a satisfactory denaturant, according to the committee, are (1) deterrent taste and smell; (2) non-poisonous; (3) must not be removable at a commercial cost; (4) must be readily detectable in small quantities; (5) must be readily mixable with the spirit, and (6) must be inexpensive.

Legal Notes

By Wellington Gustin

Fertilizer Manufacturers Should Watch Their Sales Contracts

In a suit by the Montezuma Fertilizer Co. against B. C. Hodges, the action resulted from a purchase by Hodges of certain fertilizers under a special formula furnished by the buyer, whereby it was agreed that the nitrogen was to be derived from "equal parts of fish scrap, blood and tankage." This fertilizer was shipped out under the registered brand "840." This brand "840" as registered with the Commissioner of Agriculture of Georgia is there stated to derive its nitrogen from "blood, tankage, cyanamide and sulphate of ammonia." A properly certified copy of the official analysis of this fertilizer "840" as made by the state chemist and furnished to the purchaser showed a deficiency in the phosphoric acid, which resulted in a lessening of the commercial value of the fertilizer amounting to more than 3 per cent. Subsequently, upon the request of the seller, the Department of Agriculture, through the state chemist, rechecked the original analysis from the original samples, and certified the new and corrected analysis, which showed a lessening of the commercial value amounting to less than 3 per cent. The state chemist testified that the corrected analysis was true and correct.

Defendant Charged Fertilizer Was Not as Registered

Upon a suit for the purchase price of the fertilizers sold Hodges set up two grounds of defense: (1) That brand "840," under which name or number the fertilizer was furnished, as registered with the Georgia State Commissioner of Agriculture, stated that its nitrogen was derived from "blood, tankage, cyanimide and sulphate of ammonia," whereas the fertilizer as actually shipped and sued for derived its nitrogen from "equal parts of fish scrap, blood, and tankage," and therefore the sale was illegal and the contract of sale void, inasmuch as the registration laws of Georgia governing fertilizers had not been complied with; (2) that in event the contract should not be adjudged illegal and void, he was still entitled to a reduction of 25 per cent of the price as a penalty, because the official analysis showed that the actual commercial value of the fertilizer fell more than 3 per cent below the guaranty.

Upon trial the Judge held the contract sued on was not void under the first contention given above. He further held the second or corrected analysis to be inadmissible in evidence for the reason the Georgia statute did not provide for any such corrections to be made of an official analysis. Therefore he applied the 25 per cent penalty and gave judgment accordingly.

Appeal by both parties was had and the Court of Appeals of Georgia certified certain questions to the Georgia Supreme Court. In answering the questions the court said that "where a contract for the purchase of fertilizers specifically provides from what source the phosphoric acid, the nitrogen or the potash is to be derived, and where the fertilizers furnished in accordance with such special order, such contract of sale would be void unless the fertilizers so furnished had been registered as provided by Civil Code 1910, Section 1771.

"The fact such fertilizers were furnished as ordered under a name or brand properly registered with the Commissioner of Agriculture, but which registration gives a source other than the actual one from whch the phosphoric acid, nitrogen or potash is derived, would not operate to change the rule above stated."

Court Decides There Was a Variance

And where the brand as registered states that the nitrogen is derived from "blood, tankage, cyanimide and sulphate of ammonia," and the proof shows that in accordance with the contract of purchase the nitrogen is derived from "equal parts of fish scrap, blood and tankage," there is such a variance between the registered sources and the actual sources as would invalidate the contract of purchase, under the statute governing registration of fertilizer brands.

On the question of whether a corrected analysis from the same sample of fertilizer may be made, the court said that after a sample of fertilizer drawn by the official inspector has been filed with the Commissioner of Agriculture and has been analyzed by the state chemist and certified to said Commissioner and by him recorded and entered as official, the State Commissioner of Agriculture has the right and power to make, through the state chemist, another or corrected analysis from the same sample, which upon proper certification is admissible as evidence in the courts of Georgia in the trial of any issue involving the merits of said fertilizers.

Strike Provision in Sales Contract

The principles laid down in the decision of the United States Circuit Court of Appeals, Fourth Circuit, delivered in the case of the Acme Manufacturing Co. against the Arminius Chemical Co. have to do with a strike provision in a sales contract. The case has been up again before the court on a rehearing, but there was no change in the opinion.

The chemical company contracted to sell sulphur pyrites to the Acme company during 1916, the contract being "subject to delays and stoppages caused by strikes accidents, delays by railway companies, and causes beyond the selling company's control."

The chemical company made similar contracts with others, and its entire obligations for deliveries in 1916 amounted to 64,793 tons. In January of that year, after these contracts were made, a cave-in occurred in the mine which prevented delivery of all but 8,977 tons of pyrite, the Acme company receiving but 796 tons under its contract calling for 6,000 tons.

The Acme company contended that an accident, strike or suspension clause in a contract, under circumstances analogous to the present case, does not justify the abrogation of such contract, but does have the effect of suspending performance only, except in cases where such accident or strike renders it impossible of ever being performed. In addition to this the court pointed out that certain letters, passing between the parties relating to postponement of shipments to the year 1917, along with a part performance of the contract by the chemical company, established a contract for shipments during 1917. It was said that even if the provisions of the contract had been such that, under the circum-

stances of this case, it would have expired on Jan. 1, 1917, as the contract provides, the same was extended by the agreement of the chemical company as shown by its letters.

Holding that the buyer is entitled to sue in anticipating a breach, the court said that where, during performance by the seller of a contract to deliver to the buyer a stated quantity of sulphur pyrites in monthly shipments, it expressly repudiated the contract on the ground that it had expired and refused to make further shipments, the buyer had the right at its option to treat the contract as ended and to maintain an action for its breach.

In stating the measure of damages for breach it was said that where the seller repudiated its contract without justification after partial performance, and where the buyer used diligence, but was unable to buy elsewhere under the market price, his measure of damages was the difference between the contract price and the market price at the time and place of delivery.

Strike Provision Does Not Excuse Non-Delivery

On the question of the strike provision in the contract the court laid down the rule that such a strike provision does not excuse non-delivery within a reasonable time after the strike has ended. It was contended that "an accident, strike or suspension clause in a contract has the effect of suspending performance only, and never justifies the abrogation of the contract and the refusal to ever perform it, unless such strike, accident, etc., makes the contract impossible of ever being performed."

In passing upon the point the court in another case, Jackson Phosphate Co. vs. Carleigh Phosphate, etc., Works, 213 Fed., 743, said: " . . . this court held that where one charges himself with an obligation possible to be performed he must make it good, and that unforeseen difficulties, however great, will not excuse him. It was also stated by the court that the rule as announced was subject to the qualification that, where a contract contains a limitation upon an otherwise absolute undertaking, one will be relieved from such obligation 'to the extent that such conditions rendered it unable to perform the contract fully, and to this extent only.' "

The rule as announced in 35 Cyc., 249, was adopted by the court. This statement follows:

" 'Where the contract provides that delivery shall be subject to strike, the existence of a strike merely suspends deliveries during the strike, and does not terminate the contract, and the seller is therefore bound to resume deliveries after a reasonable time after the strike has ceased.' Indeed the rule is so well established that we do not deem it necessary to cite further authorities.

"A careful consideration of the authorities relied upon by the defendant leads us to the conclusion that they do not apply to the case at bar. As we have stated, under this provision of the contract the defendant could have required the plaintiff to make the balance of the shipments within a reasonable time, and, such being the case, we think that such provision likewise inures to the benefit of the plaintiff, and that therefore the plaintiff was entitled to deliver the rock within a reasonable length of time after cars were to be had, and that the effort of the defendant to cancel the contract and its refusal to accept further deliveries under the same entitled the plaintiff to recover the amount sued for in this action."

The court said this rule was now well established in law.

Pro Rata Deliveries on Contracts

Again in the instant case the Acme company contended that the chemical company could not avail itself of the defense of pro rata deliveries on its several contracts. The court said the defendant is entitled to such defense where it finds it impossible, from causes over which it has no control, to fulfill the contract. In such cases defendant is required to do the next best thing, to wit, to apportion the amount available among all its customers, giving to each one his ratable share. This is an exception to the general rule, and is applied only for the relief of an unfortunate defendant who has, by this conduct, shown that he has in good faith made an honest effort to carry out the provisions of his contract. In order to enable one to avail himself of this defense, says the court, it must appear that he has treated all customers with absolute fairness, and it must further appear that in the circumstances he had done all that could be expected from one whose purpose is but fair dealing, giving each of his customers the ratable share to which he is entitled under the contract.

But the court pointed out that of the 13,848 tons of pyrites delivered on its 1916 orders, 11,110 tons were delivered to Caraleigh Phosphate Co., Grasselli Chemical Co. and the Richmond Guano Co., and these three favored customers were the only ones with whom the defendant had made new contracts. In view of these facts the court held that the seller could not escape liability on the principle of pro rata deliveries.

The judgment below was reversed and a new trial granted.

Claim of Noxious Ammonia and Insufficient Content Not Allowed by Court

In the action by the Palmetto Guano Corporation against J. D. McCormick to collect on a note given for the purchase price of thirty-two tons of commercial fertilizer, the defendant alleged in defense of non-payment that the ammonia content of the fertilizer was only 2.7 per cent when the contract was for a 3 per cent ammonia, and that the ammonia present was noxious because it wae derived from a leather product. The trial court directed a verdict for the company and the Supreme Court of South Carolina has affirmed this judgment.

Defendant offered the testimony of an expert witness named Rice to prove that 1 lb. of the fertilizer sent to the witness by McCormick contained only 2.7 per cent of ammonia, that the fertilizer contained a leather product and that the ammonia was probably derived from a leather product. It appears McCormick's whole reliance to defeat a recovery was on the competency of the testimony of Rice to prove a deficiency of ammonia and the noxious character of it.

The Supreme Court pointed out that there was no testimony to show that the 1 lb. analyzed by the witness Rice was taken out of the fertilizer sold by the company to the defendant. And it said had the testimony been admitted it would have tended to show only that out of thirty-two tons of fertilizer 1 lb. of it fell short of the ammonia contracted for by only an inconsiderable amount, and it does not show that the ammonia present was noxious.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Coking "Non-Coking" Coals. — After a thorough study of coke-oven phenomena, ARTHUR ROBERTS, of Evanston, Ill., offers the following explanation of the difference between coking and non-coking coals. From this theory he has developed a process for coking coals which have been found unsuitable for the manufacture of metallurgical coke in the ordinary type of coke-oven.

In general coke is formed by binding the fixed carbon and ash constituents of the coal together by means of a cementing material which is made out of and from the resinoid volatile hydrocarbon contained in the original coal. The classification of coals as "coking" or "non-coking" has been based upon results obtained in existing types of ovens. Semi-bituminous coals have been found to yield metallurgical coke, whereas the larger percentage of bituminous coals have failed in this respect. In the so-called "coking" coals, the amount of resinoids naturally present is so large that a sufficient proportion of binding material will be formed almost without regard to the process or manner of application of heat treatment, whereas in the so-called "non-coking" coals, the proportion of resinoids is so small that special consideration must be given to a process producing the heat treatment necessary to increase the production of and conserve the binding material from the resinoids. The binding material must be formed at the right time and under the proper conditions, if coke is to be produced. Opposing these conditions are the tendency for the resinoids to vaporize and escape from the coking mass, and the tendency toward destruction of the resinoids by chemical combinations with other elements present, particularly with oxygen. The influence of the oxygen content and of the hydrogen: oxygen ratio on the classification of coals is clearly shown from typical analyses. Coking coals have less than 10 per cent oxygen and a hydrogen: oxygen ratio (on the dry basis) of more than 0.58. That the hydrogen: oxygen ratio or its reciprocal is a function of the geological age of the coal is shown from the following data:

	Oxygen: Hydrogen Ratio
Wood	6.82
Peat	5.65
Lignite	5.06
Sub-bituminous coal	3.46
Bituminous coal	3.09
Semi-bituminous "coking" coal	1.11
Anthracite	0.61

The disturbing factors referred to are negligible in the case of most "coking" coals on account of the high content of resinoids and the low oxygen: hydrogen ratio, but they exert a controlling influence in the case of "non-coking" coals.

It is evident from a study of heat exchange in a coke-oven that the zone of volatilization of the resinoid materials advances from the sides of the oven toward the center as heat is transferred from the hot walls to the charge and that this zone precedes the formation of coke or what may be termed the coking wave. In treating non-coking coals, the conversion into coke will not occur unless the crest of the coking wave reaches each point in its travel rapidly enough to catch the resinous materials and convert them into cementing material by decomposition before these resinous materials can be oxidized or vaporized. The front of the wave must be steep enough to bring about this conversion, otherwise when the crest of the wave arrives the materials will have been removed from the mass. This involves supplying an amount of heat sufficient to raise the temperature of the whole charge quickly to the most favorable coking temperature. In order to accomplish this the inventor proposes to use a narrower retort and to charge the coal into a heated retort the oven structure of which is so proportioned as to contain an amount of heat sufficient to raise the charge rapidly to 600 to 700 deg. C. The amount of this reserve of heat is partially measured by a comparison of the weight of the walls and hot structure with the weight of the coal, taking account of the specific heat of the walls and structure. In practice, the following proportions have been found to give the best results: Width of retort, 12 to 16 in.; 29 to 30 lb. coal in retort per sq.ft. of heating surface; 12 to 13 lb. coal in retort per sq.ft. of surface in the heating gas passages; approximately 3.8 lb. of wall and wall structure (arranged to give up its heat rapidly on demand) per lb. of coal in the retort. (1,352,696; assigned to American Coke & Chemical Co.; Sept. 14, 1920.)

Anthraquinone by Catalytic Oxidation.—Anthracene in the vapor phase is oxidized by oxygen in the presence of an oxide of vanadium as a catalyzer at a temperature of about 300 to 500 deg. C. (1,355,098; JOHN M. WEISS of New York and CHARLES R. DOWNS of Cliffside, N. J., assignors to The Barrett Co.; Oct. 5, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Acridine Dyes.—Acridine dyes are obtained by heating a mono- or di-formyl derivative of a *m*-diamine of the benzene series with a salt of a monoalkylated or unsymmetrically dialkylated *m*-diamine of the benzene series or with β-naphthylamine hydrochloride, or by heating formyl derivatives of monoalkylated or unsymmetrically dialkylated *m*-diamines of the benzene series or formyl-β-naphthylamine with salts of *m*-diamines of the benzene series or their monoalkylated or unsymmetrically dialkylated derivatives. According to examples, products are obtained from the following pairs of components: 4-formylamino-2-aminotoluene and 3-aminodimethylaniline hydrochloride; 4-formylamino-2-aminotoluene and 4-amino-2-dimethylaminotoluene hydrochloride; diformyl-*m*-toluylenediamine and 3-aminodimethylaniline; 4-formylamino-2-aminotoluene and 4-amino-2-methylaminotoluene; monoformyl-*m*-phenylenediamine and 4-amino-2-ethylaminotoluene; diformyl-*m*-phenylenediamine and 4-amino-2-ethylaminotoluene; 4-chlor-1-amino-3-formylaminobenzene and 3-aminodimethylaniline hydrochloride; 4-formylamino-2-aminotoluene and β-naphthylamine hydrochloride; monoformyl-*m*-phenylenediamine and β-naphthylamine hydrochloride; 4-formylamino-2-dimethylaminotoluene and *m*-toluylenediamine hydrochloride; 4-formylamino-2-dimethylaminotoluene and 4-amino-2-ethylaminotoluene hydrochloride; formyl-β-naphthylamine and *m*-toluylene-

diamine hydrochloride; formyl-β-naphthylamine and 3-aminodimethylaniline hydrochloride; formyl-β-naphthylamine and 4-amino-2-methylaminotoluene hydrochloride. The sulphates, etc., of the diamines may be used instead of the hydrochlorides. The products dye leather yellow to orange red shades. (Br. Pat. 145,802—1919. AKT. GES. FÜR ANILIN-FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Purifying Mineral Oils.—A natural or an uncracked oil is desulphurized by vaporizing it and bringing the vapor into contact with granular alumina or ignited magnesite at a temperature below the boiling point of sulphur. The alumina may be prepared from the trihydrate or bauxite. Sulphuretted hydrogen resulting from the dissociation of the sulphur compounds may be absorbed in oxide of iron, Weldon mud, or the like. (Br. Pat. 145,818—1919. J. J. HOOD, London, Sept. 1, 1920.)

Concentrating Ores.—Copper sulphide such as chalcopyrite, carbonaceous material such as graphite or coal, and molybdenite, or any two or more of these substances are separated from other floatable minerals such as sulphides of iron, lead and zinc by an application of the froth-flotation process in the presence of a soluble frothing agent and a small proportion of an alkali, preferably an alkaline silicate. (Br. Pat. 145,852—1919. L. A. WOOD, and MINERALS SEPARATION, LTD., London, Sept. 8, 1920.)

Cellulose Esters.—For the manufacture of cellulose esters of fatty acids, a cellulose is employed which has been preliminarily treated at a temperature not exceeding 30 deg. C. with small quantities of acetic anhydride in presence of a catalyst diluted with glacial acetic acid. Thus, 100 parts of cellulose are treated with 50 parts of acetic anhydride, 3 to 5 parts of sulphuric acid, and 60 parts of glacial acetic acid at a temperature of 25 to 30 deg. C. for three to four hours; 250 parts of acetic anhydride are then added and the mixture maintained at 40 deg. C. for one to two hours to effect esterification. The esters may be separated by precipitation with water, or they may be converted by partial saponification into esters having different solubilities; the precipitated esters are insoluble in chloroform, whereas some of the saponified esters are insoluble in chloroform and soluble in acetone and others soluble in ethyl acetate. (Br. Pat. 146,092—1919. SOC. CHIMIQUE DES USINES DU RHONE, Paris, Sept. 8, 1920.)

Nitrogenous Phosphoric Fertilizer.—A solid nitrogenous phosphoric product suitable as a fertilizer is obtained by converting tricalcium phosphate by heating it with at least an equal quantity of nitric acid, preferably of 50 to 60 per cent strength, into monocalcium phosphate and calcium nitrate, and adding to the thin paste obtained sufficient limestone or other calcium compound or phosphate to neutralize the free acid, and convert the monocalcium phosphate into monohydrogen calcium phosphate. The product obtained is allowed to solidify and is then pulverized. (Br. Pat. 146,097—1919. NITRUM AKT. GES., Zurich, and H. SCHELLENBERG, Personico, both in Switzerland, Sept. 8, 1920.)

Preparation of Methane.—Methane is prepared catalytically by passing a mixture of carbon monoxide and excess of hydrogen through a series of furnaces containing heated contact material, for example, pumice carrying active nickel, the composition of the gases being adjusted at each passage, as for example by the addition of carbon monoxide, so that the amount of the latter does not exceed about one-fifth by volume of the hydrogen present, and the gases being freed from water vapor after each passage through a furnace. Thus, between each pair of furnaces there is provided a condenser, and a connection with a suitable measuring device for introducing a measured quantity of carbon monoxide, the gases used containing originally a large excess of hydrogen. In place of hydrogen, purified illuminating gas may be employed; and for carbon monoxide may be substituted a purified water gas. The traces of hydrogen finally remaining in the gases may be removed by passage over cupric oxide, or the methane may be liquefied by cooling the gases. (Br. Pat. 146,110—1919. FARBWERKE VORM. MEISTER LUCIUS & BRUNING, Hoechst-on-Main, Germany, Sept. 8, 1920. See also Br. Pat. 146,114—1919.)

Production of Calcium Aluminate.—Calcium aluminate is produced by heating coarsely crushed bauxite and limestone at a temperature such as not to cause fritting, for instance in a rotary furnace, and then fusing the mixture in a second furnace. The fused product may be granulated in water. The first heating may be effected by gases from the second furnace. Alternatively, a blast furnace may be employed, the charge consisting of alternate layers of red bauxite (which may contain 32 to 35 per cent of ferric oxide) mixed with limestone and of coke. The aluminate is recovered as a liquid slag and the iron as pig iron. In another modification, a converter is employed. It is charged with pellets of a mixture of bauxite, limestone and coke dust upon a bed of kindled coke. An agglomerated mass of crude aluminate is obtained, which is discharged by tilting the converter. (Br. Pat. 146,133—1919. SOC. ELECTRO-METALLURGIQUE FRANÇAISE, Paris, Sept. 8, 1920.)

Cementation.—Iron and steel are carburized by the action of nascent carbon monoxide under pressure slightly in excess of that of the atmosphere. The metal is packed in a closed chamber, together with a mixture of powdered charcoal and iron and manganese oxides, and heated. The treatment may be repeated at a higher temperature, say approaching 1,200 deg. C. Any low-grade ore which liberates oxygen at a high temperature may be used, or air or oxygen may be supplied. (Br. Pat. 146,504—1919. T. TASHIRO, Tokyo, Sept. 15, 1920.)

Ammonium Sulphate.—A mixture is made of niter cake, sodium sulphate, ammonium sulphate and water under such conditions that a quantity of anhydrous sodium sulphate is separated, and after the removal of this sodium sulphate, the liquor is used for absorbing ammonia from gases. When used for treating Mond gas, the solution is diluted before the absorption of ammonia and then concentrated again. When treating coke-oven gas or coal distillation gas, this dilution and evaporation may be unnecessary. The absorption of ammonia with the subsequent evaporation causes the separation of sodium-ammonium sulphate, which is removed, and a further evaporation causes the separation of ammonium sulphate, the double salt being used with more niter cake for repeating the process. When dilution and evaporation are not employed, the absorption of ammonia causes the separation of ammonium sulphate, the mother liquor being used with more niter cake for repeating the process. (Br. Pat. 146,546—1919. C. W. BAILEY, H. S. DENNY and W. H. H. NORRIS, all of Langwith, Nottingham, and Sir H. E. F. GOOLD-ADAMS, Westminster, Sept. 15, 1920.)

Purifying Sulphuric Acid. — Sulphuric acid of strength up to about 150 deg. Tw. is freed from arsenic by treatment with sulphuretted hydrogen under such conditions that the acid itself is not attacked —that is to say, the acid is thoroughly impregnated with the gas, which may be effected in apparatus described in Specification 2,113—1909 at a temperature not above about 18 deg. C. and the precipitate is quickly separated, preferably in a vacuum or pressure filter. (Br. Pat. 146,598—1919. G. K. DAVIS, London, Sept. 15, 1920.)

Fumaric Acid.—Fumaric acid is obtained by fermenting sugars (cane-sugar, dextrose, maltose, etc.) by means of a particular species of *Aspergillus* termed *Aspergillus fumaricus;* a description of this mold is given. The fermentation is effected in the presence of chalk or other neutralizing agents; the resulting calcium fumarate is converted into the free acid by means of sulphuric acid, or is converted into lead fumarate, which is then decomposed by sulphuretted hydrogen. (Br. Pat. 146,411—1919. C. WEHMER, Hanover, Germany, Sept. 15, 1920.)

Synthetic Tanning Agents. — Tanning agents are prepared by sulphonating crude anthracene, crude carbazole or anthracene waste, and decolorizing the sulphonated product by means of chlorine, hypochlorites, oxalic acid, formaldehyde, etc.; the decolorized product is capable of giving a light-colored leather. A similar product is obtained by sulphonating the crude bodies specified above by means of chlorsulphonic acid, preferably in the presence of an inert diluent, such as nitrobenzene, at a moderate temperature; this product may be subsequently treated with decolorizing agents as above described. (Br. Pat. 146,427 1919. BADISCHE ANILIN - UND SODA - FABRIK, Ludwigshafen-on-Rhine, Sept. 15, 1920.)

Obtaining Fats From Sulphite Lyes. — The sugar contents of waste sulphite lyes are converted into fat by growing a fungus *Endomyces vernalis* on the lye. The lye is first treated—for example, by aëration and neutralization—and is then inoculated with the fungus whose early growth may be assisted by adding nitrogenous substances such as beet juice to the waste liquor or by first growing the fungus in a culture-medium rich in nitrogen and then transferring it to the lye. The first stage of the process is marked by a large absorption of nitrogen and by rapid growth of the fungus. During the second stage the sugar in the lye is assimilated and converted into fat, and the growth of the fungus is slight. The masses of fungi are finally removed from the solution and treated for the recovery of fat. (Br. Pat. 146,430- 1919. W. JEROCH and REICHSAUSSCHUSS FÜR PFLANZLICHE UND TIERISCHE OELE UND FETTE GES., Berlin, Sept. 15, 1920.)

Fats.—Fats are produced from nutrient media which contain carbohydrates, nitrogenous substances and salts by growing in the media micro-organisms such as aërobic mold-fungi, mildews and yeasts—e.g., *Oïdium*, *Sachsia* or *Endomyces* species. The fungi are grown on substrata saturated with the nutrient solution or in the solution itself which is aërated. Injury to the organisms by acids formed during the reaction is prevented by neutralization. As soon as the 'vegetation" period is completed the fungi are subjected to a "fasting cure" and the fat formed is extracted in the usual manner—e.g., by pressure or by solvents. (Br. Pat. 146,431—1919. REICHSAUSSCHUSS FÜR PFLANZISCHE UND TIERISCHE OELE UND FETTE GES., Berlin, Sept. 15, 1920.)

Saccharifying Cellulose. — Soluble carbohydrates obtained from materials containing cellulose by treatment with concentrated sulphuric or hydrochloric acid, are, after lixiviation in a counter-current, separated from the conversion acids by a diffusion process similar to the "molasses osmose" process. Sufficient acid is allowed to remain with the carbohydrates for complete hydrolysis during subsequent heating, or the acid may be removed as fully as possible, and the solution neutralized, evaporated to dryness and used as fodder. (Br. Pat. 146,455 -1919. A. WOHL, Danzig, Sept. 15, 1920.)

Treating Waste Gases From Coke Ovens. — To separate into their constituents the waste gases from coke ovens which remain after the recovery of the tar, benzene, ammonia, etc., the gases are first highly compressed and treated for the removal of water and carbonic acid, then compressed further if necessary and cooled to liquefy all the remaining constituents except hydrogen, and the condensate fractionated to obtain nitrogen, carbon monoxide, methane and ethylene. Alternatively, the gases may be compressed and washed with water or other absorbent for the removal of carbonic acid and then with a solution of common salt or with alcohol or acetone for the recovery of ethylene, and afterward dried and liquefied as before. The absorption liquid may be selected so as to absorb two different gases, for instance ethylene and carbon dioxide, which is convenient if these gases are subsequently to be brought to mutual reaction. The gases given off during the different stages of the coking process may be collected separately and treated according to their composition, and it is more economical to replace the waste gases used for heating the ovens by other gases, such as producer gas, water gas or furnace gas. (Br. Pat. 146,839 1919; BOMBACHER HÜTTENWERKE, Coblenz, Germany, Sept. 22, 1920.)

Crucibles for Melting Aluminum. — Crucibles of graphite, iron or steel, or clay, for use in melting aluminum and aluminum alloys, are provided internally with a coating of aluminum bronze varnish before each melting operation, from which coating the varnish is burned out by heating slowly to about 400 deg. C. The aluminum coating becomes oxidized during the melting operation. The lid of the crucible may have its interior similarly treated. (Br. Pat. 146,841 1919; METALLINDUSTRIE SCHIELE & BRUCHSALER, Hornberg, Schwarzwald, Germany, Sept. 22, 1920.)

Preparation of Pure Starch From Rice. To prepare pure starch from rice without the aid of caustic alkali or common salt, the rice is first steeped for a few hours in cold or lukewarm water until sufficiently softened; the steeped rice is subjected to wet grinding until 98 per cent of the grist passes through a silk having a mesh of 130 × 130, water being added during the grinding so as to form a paste or cream containing about 38 to 40 per cent of dry solids; and finally the ground mass is diluted with water to a density of 18 to 25 deg. Tw. and the starch separated centrifugally, or to a density of 1.5 to 2 deg. Tw. if separation by decantation is employed. The residue, which is rich in albuminoids, forms a cattle food. (Br. Pat. 147,255 —1919; RECKETT & SONS and C. H. HARDY, Hull, Yorkshire, Sept. 29, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Shows Gas to Be an Important Weapon

That military gases played a very important part during the World War is shown by the report just made to Congress by the Surgeon General of the Army. It shows that approximately one man out of three that entered the hospitals of the American Expeditionary Forces was gassed. Enemy gas caused 72,056 casualties, of which 1,271 died. Thus one man out of fifty-seven lost his life. On the other hand, there were 160,783 casualties from battle causes other than gas. From those casualties one out of thirteen died. This does not include the 34,249 men who were killed outright on the battlefield. If they were included, the deaths would be approximately one to three wounded.

Based on the average total strength of officers and men in the American Expeditionary Forces, the number of men gassed was 67.5 per thousand. Of those wounded by rifle and machine gun bullets there were 19.5 per thousand. Wounds from high explosive shells number 16.7 per thousand. The shrapnel wounds were 32.3 per thousand, and wounded by bayonet 0.22 per thousand.

It is pointed out that the ratio of gas casualties undoubtedly would have been greater had the Germans been able to muster large supplies for use during the Meuse-Argonne offensive.

Gas, according to the Surgeon-General's report, accounts for 18 per cent of the time lost by casuals in the hospitals. Of those who were gassed and recovered, less than three per thousand were discharged on account of disability.

Spring Meeting, American Electrochemical Society

Plans have already been made for the spring meeting of the American Electrochemical Society, which is to be held at the Hotel Chalfonte, Atlantic City, April 21 to 23, 1921. A special symposium on corrosion will occupy the morning and afternoon programs of one day and will bring our information on this subject up to date. For another session it is planned to hold a symposium on electrolytic production of organic chemicals. Social features of the meeting will include a smoker and lecture on one evening and some moving pictures of appropriate electrochemical subjects, followed by a dance, on another evening. Dr. Carl Hering, Philadelphia, is chairman of the committee on arrangements.

Secure C.W.S. Commissions

The following have been found eligible to receive commissions as First Lieutenants in the Chemical Warfare Service: John H. Becque, Plasterco, Va.; Crawford M. Kellogg, Salt Lake City; C. E. Palmer, Newark, N. J.; E. G. Steis, South Bend, Ind.; F. J. Swanson, Fort Worth, Tex.; A. H. Waitt, Medford, Mass.

R. Carson Smith of Akron, Ohio, and Hugh A. Stewart of Brooklyn, N. Y., were found eligible as Second Lieutenants.

Chicago Section, American Ceramic Society

The annual meeting of the Chicago Section of the American Ceramic Society was held at the City Club on the afternoon of Nov. 27. The business session was called directly after the luncheon and the following officers were elected for the coming year: B. S. Radcliff, chairman; F. L. Steinhoff, vice-chairman; W. W. Wilkins, secretary-treasurer; C. W. Parmelee, councillor; H. E. Davis, chairman program committee; E. A. Brockman, chairman membership committee.

C. G. Armstrong delivered a paper on "Porcelain Enameling Furnaces." He traced the art of enameling from the time of Rameses III, about 1300 B.C., to the practice of modern times. The enameling of iron in the United States began with the establishment of a plant in Connecticut in 1863. Present-day furnaces may be classified under two groups as to the muffle type—namely, the semi-muffle and full muffle type—and several classes as to method of firing, as coal-fired, producer-fired, semi-producer, recuperative, oil-fired and gas-fired.

Comparisons were made between these types and the new design worked out by the author in which carborundum refractories embodying the regenerative features showed high efficiency for the latter. The paper will be printed in full in a later issue of CHEMICAL & METALLURGICAL ENGINEERING.

W. W. Wilkins, of the International Harvester Co., reviewed some notes on "Spark Plug Porcelain," presenting data to prove that 75 per cent of failures of spark plugs used in internal combustion engines of all types are due to faulty mechanical design, leaving only 25 per cent of failures attributable to failure of the refractory material. Tests have shown that zirconium refractories give remarkable performance.

R. Rodehouse described his oil-gas furnace for burning enameled ware. The burners operate with any sort of heavy oil atomized and mixed with air and steam. The control of temperature is absolute, with fool-proof devices to operate. The furnace has no muffles, employs no special shapes in construction, and has remarkably long life.

Oil consumption was said to be under 12 gal. of fuel per hour.

No Official Action by Electrochemical Society on Duty-Free Importations

The November *Bulletin* of the American Electrochemical Society contained an item urging friends of educational institutions to protest against the passage of the so-called Bacharach bill repealing the privilege heretofore given colleges and universities of importing scientific apparatus duty free. Official announcement has since been made by W. S. Landis, president of the American Electrochemical Society, to the effect that the item in the *Bulletin* did not represent official society opinion. He states that this matter has not received attention from either the board of directors or the membership.

Helium Discussed at the 113th Meeting of the Rochester Section, A.C.S.

At East High School on the evening of Nov. 23 Dr. Richard B. Moore lectured at the 113th meeting of the Rochester Section of the American Chemical Society, and its guests, the Science Section of the New York State Teachers' Association, on "Helium, Its Preparation and Uses."

After giving a brief history of its discovery, Dr. Moore said that helium, like the other rare gases, was found to be inert. It had no particular use and so was of no importance, except to the scientist. But in 1915 Sir William Ramsey, then with the British War Department, wrote to Dr. Moore, saying he thought there was a great possibility of helium being used in observation balloons in place of hydrogen, providing a cheap source of it could be found.

After this country entered the war, acting upon Sir William Ramsey's suggestion, the Bureau of Mines, of which Dr. Moore is chief chemist, began to study the possibilities of helium for balloons. The natural gases in Texas, Oklahoma, Washington, Kentucky and other parts of this country contain from two-tenths to five-tenths per cent of helium and the Bureau of Mines established plants in Texas, the one at Fort Worth costing about $2,000,000. The first shipment of helium was on its way to France when the armistice was signed. The plants in Texas are still in operation, for the army and navy recognize the great importance of this element. In the helium dirigible the engine can be put under or even inside, thereby getting a more direct drive and greater efficiency. When one considers that a large dirigible balloon costs about $3,000,000, the discovery of a lifting gas that will not burn is of great importance. Dr. Moore illustrated his lecture with slides of the Texas plants. He also filled a small balloon with some helium, then held a match under it, showing the helium would not burn, as hydrogen does.

Short Course in Boxing and Crating of Materials to Be Given at Forest Products Laboratory

The Forest Products Laboratory at Madison, Wis., will give three courses in boxing and crating for representatives of manufacturing concerns beginning the first of the year. The object of these courses is to demonstrate to the manufacturers and packers the principles that underlie proper box and crate construction and develop economical containers that will deliver the contents to destination in a satisfactory condition and at minimum cost. The work will include drop tests to demonstrate characteristic failures of different kinds of boxes, drum tests to demonstrate the necessity of adequate nailing, relative holding power of different kinds of nails, methods of application and efficiency of steel strapping and the use of solid and corrugated fiber board and wire-bound boxes and crates. The dates for the next three courses are Jan. 10 to Jan. 15, March 7 to March 12, and May 2 to May 7. A co-operative fee of $100 payable to the Forest Products Laboratory is charged to partly cover the cost of conducting the work. This fee does not include traveling and living expenses.

Needs a Ceramic Engineer

The Bureau of Mines is looking for a ceramic engineer to add to its staff at its ceramic experiment station at Columbus, Ohio.

General Fries Submits Annual Report

In concluding his annual report to Congress, General Amos A. Fries, head of the Chemical Warfare Service, made the following observations:

Just as every great earthquake is followed by a large number of lesser disturbances just so the World War has been followed by a host of minor upheavals, some of considerable importance and others just reflecting the general unrest caused by the overthrow of so many governments and other establishments of law and order. These disturbances during the past year have helped crystallize sentiment and force the sober-thinking man to conclude that wars are not yet past, much as he may long to see the arrival of that day in the world's progress.

The World War demonstrated that an enemy bent on aggression cannot be trusted to live up to any set rules of war. Methods of warfare develop just as all peaceful pursuits develop and they will continue to do so until such time as the nature of mankind as a whole has so changed that wars can be relegated to the past.

The United States has wisely decided to continue the Chemical Warfare Service with sufficient powers and with sufficient funds to develop its possibilities, not for aggression in any way whatsoever, but to insure that if American boys must ever again shoulder arms in defense of the liberties of their country they will do so on an equal footing with any other nation so far as chemical warfare is concerned.

The American is truly a sportsman and in war, as in sport, he is perfectly willing to stand any punishment providing he has an opportunity to give as well as take. The really serious objections to chemical warfare in the World War arose from the fact that the Central Empires, as well as most other countries, except the United States, had agreed not to use it. Under such circumstances a real sportsman who lives up to his agreement suffers a terrific handicap. No such handicap can occur in the future with the Chemical Warfare Service thoroughly alert to the possibilities of that arm and given power to prosecute its researches, its development and its training to the point where it knows that it is impossible for any other nation to have gone further. The knowledge among other countries that the United States is doing this will go a long way toward deterring them from forcing hostilities, knowing that the United States with its incomparable natural resources and highly developed manufacturing possibilities will be able to manufacture and to deliver on the field of battle a greater quantity of chemicals than any other single nation can manufacture and deliver, or indeed any other group of nations.

Louisiana Section, American Chemical Society

The regular monthly meeting of the Louisiana Section, American Chemical Society, was held at the Louisiana Museum, New Orleans, Tuesday evening, Nov. 16. The principal address was delivered by Dr. W. A. Noyes, who spoke on scientific research and the true nature of university work. He emphasized the value of research work in the higher institutions of learning in its application to the problems of the chemical industry as a whole for the benefit of all concerned, in contrast to the research work carried on in the individual industry for its own selfish ends.

The October meeting, the first of the season, was addressed by Dr. L. Lavedan, chief chemist, Hiller Vinegar Co., who spoke on "The Manufacture of Vinegar."

He pointed out the necessity of close chemical control to obtain efficiency in the production of vinegar. The percentage efficiency of acetic fermentation varies widely from plant to plant and operator to operator. The Southern climate is almost ideal for the work of acetic ferment. This ferment, or germ, must be nursed with great care if good service is expected. It must have regular meals of good quality. Sudden temperature changes are most harmful to production.

Conference on Colorado Clay

The Denver Civic and Commercial Association is convinced that full advantage is not being taken of the clay resources of Colorado. At the request of that organization, Dr. R. B. Moore, chief chemist of the Bureau of Mines, has arranged for a discussion of the situation in Washington. The meeting will be attended by Homer Vanderblue, the research director of the Denver organization; Dr. Moore; L. I. Shaw, assistant chief chemist; and R. T. Stull, superintendent of the bureau's ceramic station at Columbus, Ohio.

French Hydro-Electric Plant Completed

A large hydro-electric plant of 20,000 hp. has recently been completed by the Société Hydro-Electric of Lyon, a branch of the Compagnie du Gaz, Lyon, and the Compagnie Continentale Edison of Paris. The plant is located at Seyssel, Haute-Savoie, France. Importance is attached to the completion of this project because of the present scarcity and high price of coal, and likewise because of the effect it may have toward encouraging similar undertakings in France.

The plant is equipped with four turbines, each capable of developing a force of 5,500 hp. It is proposed to install another turbine at an early date, and thus increase the production to 27,000 hp., an amount that equals almost one-third of all the energy consumed under different forms by the city of Lyon.

Proposed Bill for an Association of Nitrate Producers of Chile

A cablegram from Ambassador Shea, Santiago, Chile, states that a bill has been presented to Congress by the Nitrate Commission of the Chilean Congress, to be discussed soon, for the creation of an association of nitrate producers of Chile. The bill provides for the control of freights and the purchase of ships, the purchase of materials for producers, and sales through direct agents. In addition it fixes prices and production, provides for technical work, direction of labor conditions, with a board of directors composed of eighteen men, six of whom will be appointed by the President. The government and members will contribute 10c. per 100 lb. produced until a capital of £5,000,000 is formed; the members must own an actively producing plant and not be purchasers from other producers. An export duty of 6.76 pesos gold (1 peso = 36½c. United States currency) is fixed for every 100 kilos of nitrate exported; this is to be reduced one-half for members of the association.

Industrial Situation in Holyoke

In common with other parts of the country, the industries in Holyoke, Mass., have been affected by the recent business slump. The textile mills in the city have been forced to shut down part of the time and are now running only three or four days a week.

The paper industry has also been hard hit, particularly the fine-paper mills. Many of the mills have departments down for part of each week, while others have not been operating for some time. The coarse-paper market has not yet been influenced perceptibly by the present business conditions, but there are indications that it will soon feel the effects of these conditions, as the unfilled orders of some of the mills have decreased during the past month. The dull time of the year, which includes the holiday season and inventory time, is close at hand, and the manufacturers do not see any prospect of betterment before the new year.

Many consumers of paper are not buying now, hoping that prices will go down. They have not large stocks ahead, and are buying only to such an amount as they find absolutely necessary. No great changes in prices need be expected at present in the high-grade writing papers, as raw materials and wages are still high. New rags, which are used in the highest grade writings, will probably remain at their present prices or may go higher, due to the fact that few of the textile mills in New England are producing any cuttings.

Although manufacturing conditions are unsatisfactory, there is as yet little unemployment. The manufacturers are trying to keep their organizations intact by having their mills running part time. There will probably be enough work to prevent any hardships to the employees this winter. There has been no talk of a reduction in wages, and there is no likelihood of any for some time.

Water, fuel and transportation conditions are satisfactory. The mills have enough coal for the coming winter, and unless unforeseen circumstances arise will get through fairly well.

Sherwin-Williams Co. Optimistic About Paint Industry

The sales of Sherwin-Williams Co. for the fiscal year ended Aug. 31 show a total of $75,952,000, which is a gain of $22,000,000 over the banner year of 1919. Comparison of the sales of $51,817,000 for the American companies alone with the $36,992,000 of the previous year shows a gain of 40 per cent.

According to the balance sheet the company has current assets of $27,679,859 compared with current liabilities of $6,636,738. It has $992,855 in the cash account, and inventory of $15,814,260. During the year a stock dividend of 50 per cent was declared so that the surplus account shows $4,481,667 this year compared with $7,175,311 a year ago.

Commenting upon business conditions, Walter H. Cottingham, president of the company, says:

> We see no reason why there should be any immediate let-down in the sale of paints and varnishes where the unsatisfied demand is still great. There is an immense amount of left-over repainting to be done, and with the big building boom which is bound to come, we are looking forward to continued sales gains. In fact the figures since the start of the new year, Sept. 1, show constant increases over the figures of last year.
>
> We know of no better barometer for business conditions than to study the operations of our own ten districts, twenty-seven divisions and seventy-five warehouses and distributing points, practically all of which report continued sales increases.
>
> Merchants, it is true, have a tendency to order smaller stocks, but the wise merchants are not allowing their business to run down at the heels for lack of stock. They are not letting possible declines, which might amount to a few hundred dollars in their purchases, stand in their way of making several thousand dollars profit by having good stocks on hand to keep up a permanent business and give service to their customers.
>
> In our own retail stores for the year just closed we showed a gain of 65 per cent, and since the new year started Sept. 1 there is an increase of 20 per cent over the record figures for the same period last year. This indicates an active consumer demand.
>
> A group of our managers who recently toured the country report that in all sections they visited, with a few exceptions, they heard and saw only evidences of basic soundness and prosperity. This goes back to agricultural conditions in the last analysis.

Personal

Lieutenant Colonel WALTER C. BAKER has been transferred from the Coast Artillery to the Chemical Warfare Service and has been placed in charge of the supply division in the office of the Chief of the Chemical Warfare Service.

Lieutenant Colonel CLAUDE E. BRIGHAM has been transferred from the Coast Artillery to the Chemical Warfare Service and has been placed in charge of the administrative and personnel divisions of the Service.

WILLIAM W. COBLENTZ, physicist of the Bureau of Standards, Washington, D. C., has been awarded the Janssen Medal by the French Academy of Sciences.

FRITZ J. FRANK, vice-president of the Iron Age Publishing Co., has been elected president of that company, following the resignation of William H. Taylor, who had been president and general manager for more than ten years. Mr. Taylor has resigned because of ill health, and has retired from active connection with the Iron Age Publishing Co. He went to *Iron Age* as general manager, after a group of publishers had acquired the ownership from David Williams. Previously, Mr. Taylor had been connected with various trade and engineering publications over a period of fifteen years, having for a time been vice-president of the McGraw Publishing Co. and later president of the Taylor Publishing Co. of Chicago, which consolidated *Engineer* and *Steam Engineering*. He and his associates on acquiring *Iron Age* separated what had long been a hardware department of that journal, and established it as *Hardware Age*. Mr. Frank has been with the Iron Age Publishing Co. since 1910, after an active association with other trade publications, among them *Colliery Engineer* and *Mining and Scientific Press*. He has a wide acquaintance in the iron and steel and machinery trades, is experienced in business journalism, and is thoroughly committed to the traditions and standards of *Iron Age*, which belongs in that progressive group of business publications which put editorial service to the reader as the basis for substantial and sound publishing development.

G. K. HERZOG has recently been transferred from the research department of the Electro Metallurgical Co., Niagara Falls, N. Y., to the Haynes Stellite Co., Kokomo, Ind., in charge of the research and development department.

A. STUART KELSEY is now assistant research chemist with the Standard Textile Products Co. The present investigation is at the Buchanan, N. Y., factory.

DEXTER S. KIMBALL, professor of industrial engineering at Cornell University, Ithaca, N. Y., spoke before the Detroit Engineering Society on Dec. 3 on "A Broader Field for the Engineer."

Dr. SAMUEL A. MAHOOD, formerly senior research chemist of the Forest Products Laboratory, Madison, Wis., is now associate professor of organic chemistry, Tulane University, New Orleans, La.

CHARLES A. MUNROE, vice-president of the People's Gas Light & Coke Co. of Chicago, has been elected president of the American Gas Association.

C. G. SELDEN and C. E. ANDREWS of the Walker Chemical Co., Pittsburgh, Pa., have recently sailed for England and the Continent on business for the company.

Dr. GERALD L. WENDT, of Chicago University, has just returned from a Western trip. He spoke before the Tri-City Chemists' Club at Davenport, Iowa; the Kansas City, Neb., Omaha and Ames Sections of the American Chemical Society on "Electrometric Titration." At the University of Nebraska and Grinnell College, he delivered lectures on "Activation and Elementary Gases" and the "Nature of the Atom."

Book Reviews

WHAT'S ON THE WORKER'S MIND. By *Whiting Williams*, personnel director Hydraulic Pressed Steel Co. 329 pp., illustrated. New York: Charles Scribner's Sons. Price $2.50.

Whiting Williams was not the ordinary kind of personnel director. He wished to get a first-hand impression of the man in overalls for the general good in solving the problems of capital and labor. Having arranged for his salary as personnel director to go to his family, he went forth with $25 to earn his living as a common laborer for seven months. The observations from his experiences have been set down in this interesting book. Mr. Williams' previous experience of life had been as assistant to the president of Oberlin College and as executive secretary for the Cleveland Welfare Federation.

This alert looking young American got into a sheepskin overcoat and let his face go unshaved until he looked the part. During seven months in 1919 he worked in steel mills, coal mines, railroad yards, iron mines and shipyards. As soon as he had walked the plank of "the good ship 'White Collar,'" he found himself in a different world. He learned the feelings of men herded outside the hiring gates at the mercy of bullying guards, and of the irritating inadequacy with which many firms deal with their employees. At one large steel plant where 10,000 men are employed, "the young clerks supposed to do the hiring gave most of their time to tickling the backs of the necks or the much-exposed chests of the young stenographers," while the applicants, to whom jobs and proper consideration meant a great deal, could talk to the clerks only through two misplaced holes in plate-glass.

In all the jobs where he worked the author found much waste and inefficiency resulting from the bad influence of the wrong kind of bosses. So many corporations have elevated the wrong type of individual over his fellows that bitterness and enmity have driven out co-operation. Leaders instead of drivers are needed for foremen, the author makes plain, and chronic fatigue does not pay, as efficiency engineers have agreed since Taylor conducted his famous experiments in loading pig iron. The average unskilled worker is lacking in enthusiasm for his work, because he does not understand what it all means, and generally no inspiration is to be obtained from the foreman.

Strange to say, higher wages are not the solution of labor unrest, declares Mr. Williams. "What makes the wheels of all of us go 'round is the desire for a satisfying sense of our own individual worth-while-ness, and the cause of practically all the friction between people, and especially between people of different groups and statuses, is to be found in offended or obstructed self-respect, injured pride and hurt feelings." This is a lesson that employers are extremely slow at learning; the truth has been pointed out again and again, yet even so well stated an argument as Mr. Williams' will probably be heeded by only a few. He continues, "We give to the dollar altogether too great an importance when we consider it the cause either of men's industry or their intrigue, their virtues or their vices. The dollar is merely an especially convenient and simple means for facilitating the measurement of a man's distance from the cipher and insignificance among his fellows. If it does not serve that end it is not sought beyond the narrow limits required for the daily bread as where conspicuous leisure proves more valuable to this end and so causes loafing in exactly the same way that the standing which the dollar can buy for the employer brings him down diligently on time every day to his desk. Beyond a certain point, dependent upon the standing and status which the dollar can buy in the community, the increase of wages is thus quite as likely to lessen as to increase effort." Incidentally, much the same kind of argument has been advanced by the present reviewer during the past several years in articles

in *Engineering News-Record*, *Mining and Scientific Press*, and *Engineering and Contracting*.

Mr. Williams emphasizes the great good to the community accruing from the worker's self-respect, the self-respect that keeps "the millwright at his bench every working day, an upright, forward-looking and sincere worker and citizen." When workers lose their self-respect, says the author, from mistreatment under grouchy foremen, or from having to stand at hiring gates, or from being herded out of their rights by pompous officials, there is a certain paralyzing effect which destroys the morale of a significant part of the industrial community.

In the last several chapters of the book Mr. Williams makes some definite suggestions for bettering conditions in industry. He is opposed to the twelve-hour day and seven-day week which prevail in much of the iron and steel industry, because chronic tiredness and temper do not pay. The worker should have more security of steady work, and should not be hired and fired as a commodity to which nothing else is due a point which Samuel Gompers has long emphasized. The so-called "Americanization," which is so glibly prated about, should be taught not only by English classes and welfare officials, but by actual demonstration of what Americanization means, as when a foreman commands, a judge instructs, a newspaper reports and a salesman sells. In other words, the officials elevated to positions of importance in our communities should be picked more carefully for their influence in illustrating the best ideals of America.

The final picture of the worker that Mr. Williams gives is that of a human being neither lazy nor avaricious, but willing to co-operate if he can understand the work and will be rewarded fairly for giving the best that he has in him. The worker is much like the rest of us, in fact, though with much less chance to learn what he wants to know about things. On the other hand he "can see fine points in a dull and monotonous job with an eye that should shame us," and he has a naïve wish to be useful and to be recognized as useful. Such considerations as these should be given sincere thought by employers. The problem of capital and labor is assuming menacing proportions. If arguments such as Mr. Williams' are not heeded, dire disaster may come to American industry. Employers should use more imagination and prescience than has been the custom among their kind. More men like Whiting Williams should be promoted to the critical positions in industry.

P. B. McDONALD.

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GAS AND FUEL ANALYSIS. By *Alfred H. White*, professor of chemical engineering, University of Michigan, Ann Arbor. International Chemical Series; second editon, revised and enlarged. Pp. xiii + 304; 54 figures. New York and London: McGraw-Hill Book Co., Inc., 1920. Price, $3.

The author of this book undertook an exceedingly difficult task when attempting to combine the functions of a text book with those of a reference volume. His purpose to this end is stated in the preface of this second edition as follows: "The needs of students have been kept in mind, but the intention has also been to make the book one which would supply the practicing engineer and chemist with the most necessary information." Despite the difficulty involved, the work succeeds admirably in presenting for student use as well as for experienced workers the important types of gas- and fuel-testing equipment and the methods for their successful use.

The second edition profits greatly by the extended additions which have been made from recent work by the Bureau of Mines, Bureau of Standards and several technical societies, notably the American Chemical Society and the American Society for Testing Materials. In most instances the methods described are the latest and best which have found general practical acceptance. In only a few cases have novel methods not yet generally used been permitted to displace or overshadow the better recognized procedures. It is evident that the author has carefully kept in mind the fact that one who will use the book will want a description of methods and equipment generally available and acceptable, rather than more novel procedures not yet accepted or for which apparatus is not usually available.

If a more frequent and elaborate attention to interpretation of analyses had been possible, this would add materially to the value of the text, both for the student and the practical worker. Because of the very general application of the work, however, such discussion of interpretation of results would have been difficult and possibly at times misleading. The author may, therefore, be excused for this omission.

It is a little unfortunate that the treatment of absorption methods for gas analysis is so limited. In this particular chapter many of the most valuable chemical procedures are mentioned, but there is no presentation of the more valuable recent types of apparatus for use in this field. The single illustration of this chapter presents an old-style Hempel outfit of a type showing evidence of such assembly as might be expected from the undergraduate student in college. The idea all too generally held that the Hempel apparatus is superior in accuracy to equipment of the Orsat type, using numerous modern styles of pipette, should not receive this encouragement. This fallacy is still further encouraged by the presentation of the Orsat apparatus in two modifications, both old and out of date, in the chapter on technical gas analysis, whereas in the chapter on exact gas analysis there is no hint by illustration as to the form of pipette which is recommended. This lack will perhaps be offset in any course of instruction by proper aid from the lectures and laboratory advisers; but for use of the practical man outside the college there is nothing to suggest that exact gas analysis is made as much more difficult by improper selection of pipette as by inferior burette or improper technique.

Successful gas and fuel analysis is chemically and physically of extreme theoretical simplicity. Success demands care and skill rather than much knowledge. The apparatus and its manipulation demand more finished technique on the part of the operator than almost any other type of chemical analysis commonly used. The opportunity for error on chemical grounds is almost *nil* by comparison. If one recognizes these points as a result either of experience or careful instruction, he can well take this text as a most valuable guide for his work. If he does not take it, it would be difficult to say what else could be recommended as a substitute in American literature.

R. S. McBRIDE.

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KAOLIN OF INDIANA. By *W. N. Logan*, State Geologist of Indiana. 132 pp., cloth; 43 illustrations and colored plates. Indianapolis: The Department of Conservation, State of Indiana, Division of Geology.

This report is devoted to the geological conditions of the occurrence, the origin, geographical distribution, the physical and chemical properties and the uses of kaolin in the state of Indiana. The occurrence of large beds of kaolin in southern Indiana has long been known. Its extremely pure and crystalline appearance, together with its interstratification with sedimentary rocks, has been the cause of a great deal of speculation concerning its origin and geological occurrence. Some have suggested that a coal bed at one time occupied this horizon and was burned out, while others see in this unusual deposit the residue of a decomposed limestone. A new theory of origin is proposed in the report.

Although this clay has been used intermittently for several years, it was left for the author to make a detailed survey of the deposits and work out its origin. Extensive laboratory tests have been made of the chemical and physical properties of the clay. Samples have been tested in a large number of laboratories connected with industrial plants and Government bureaus. Topographical and geological maps of the areas in which the kaolin is found are embodied in the book.

The matter is well presented and holds much of interest to ceramists and clayworkers.

CHESTER H. JONES.

NEW INDUSTRIAL UNREST. By *Ray Stannard Baker.* 232 pp. New York: Doubleday, Page & Co.; 1920. Price, $2.

So much of the literature on industrial unrest has been written by interested parties that a discussion by a trained writer cannot fail to have an interest and a value of its own. It is difficult, however, for anyone to write on such a subject without being guided, to some extent at least, by personal opinions, and to many it will appear that Mr. Baker writes from the viewpoint of a sympathizer with organized labor rather than an impartial observer. The first twelve chapters of the book are more in the nature of a description and an interpretation of recent events in the industrial world of America. The six concluding chapters are largely devoted to a discussion of the shop-council system and its application both in Europe and in America. In this the author is developing a line of thought that is not particularly popular in our industrial world today, since, except in certain specific industries, shop councils are not in favor in America with employers or, more especially, with employees. The author recognizes the difficulty of indicating any simple solution of a problem of such complexity and appears at his best in his concluding paragraph, in which he says:

"In another sense, there is a solution. It consists in the attitude, the spirit, which one maintains toward the labor problem—an adventurous, inquiring, experimental attitude, ever hospitable toward new facts; and a generous and democratic spirit. I wonder if men can find this solution in its completeness without some high faith in God, and some vital interest in their fellow men." T. T. READ.

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THE MANUFACTURE OF SULPHURIC ACID IN THE UNITED STATES. By *A. E. Wells* and *D. E. Fogg.* 216 pp., 36 figures and 15 plates. Washington: Superintendent of Documents.

This bulletin, No. 184, is a fine report on the investigation of the sulphuric acid industry by the Bureau of Mines. It will be gladly received by the men in the industry, especially by those who have not had the opportunity of making many observations due to limitations in their outside connections. Sulphur, pyrite and pyrrhotite and byproduct sources of SO_2 are treated in an adequate manner. Production methods and equipment for the chamber and contact processes are described in fifty pages each. A remittance of 40c. is asked to help defray the costs of the distributing office.

WALLACE SAVAGE.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 6, 1920.

It could hardly be said that the general trend of affairs changed materially in the chemical market during the past week. As a whole trading was along quiet lines with the tone fairly steady. Continued absence of forced selling, however, is establishing a better feeling, while stronger confidence is gaining in business prospects for 1921. Miscellaneous buying inquiries for domestic and export needs were reported for *bichromate of soda* and these have strengthened the spot market and nearby positions to a perceptible degree. Sales for material ex store reached 9½c. per lb., while January shipments were quoted firm by dealers at 10½c. per lb. Leading producers named 15c. per lb. for contracts over 1921, and this price also held good for export. Resale lots for *aluminum sulphate* were offered at 3¾c. per lb. for the iron-free grade, while rumors were current that a price of 3½c. per lb. could be had on firm business. Moderate quantities of the commercial type were quoted at 2¾c. per lb. Small lot trading of *oxalic acid* was reported at 18c. per lb., with sellers asking up to 19c. per lb. The demand is very slow and buyers show little interest in quantities exceeding actual wants. *Formaldehyde* inquiries for domestic and export requirements reached the market in more volume than any chemical on the list. Odd lots were reported to have sold at 18¾c. per lb. early in the week, with a pronounced strengthening during the latter half. At the close the market appeared quite steady at 19c. per lb. Jobbers are holding standard brands of solid *caustic soda* at $3.75@$4 per 100 lb., and reported scattered transactions at these figures. The movement in this chemical has been along quiet lines of late and the tendency to bring buyers into the market was noticed when dealers quoted figures as low as $3.65 per 100 lb. Manufacturers' views on contracts remain unchanged at 3¾c. per lb. basis 60 per cent f.o.b. works for 1921 shipment. Producers continue to name 18c. per lb. works for prime American *chlorate of potash*, while large resale lots of imported and domestic material are being offered freely at various prices down to 13c. per lb. with no actual trading noted.

COAL-TAR PRODUCTS

Prominent factors in the crude and intermediate markets are viewing conditions with more optimism. The volume of cheap resale material seemed to be diminishing in one quarter and another and some producers are expecting to name contract prices over next year in a very short time. The general feeling seems to be that considering the cost of production, the nearness of present prices to those of the pre-war period and the heavy demand that will be noted when normal conditions appear will automatically prevent any lower range, but will show good prospects of advances in a majority of commodities. Trading during the past week was of the quiet routine nature that has followed along the same lines for the past month, with buyers exhibiting timidity in most directions. The crude market is uncertain. Some items are holding steady, while others are in little demand and reflecting an easy tendency as to price. *Benzene*, c.p., is moving in fair volume with drums held at 35c. per gal. The 90 per cent is offered at 32@33c. per gal. *Naphthalene* producers have named 9@10c. per lb. for contracts over 1921. Consumers did not come into the market with this announcement, although a more stable condition is looked for in the near future. Inquiries for *alpha naphthol* are attracting attention lately and the few factors making it report the supply very limited, with the crude grade held at $1.10 per lb. and the refined at $1.45 per lb. On account of the general quiet conditions throughout all the markets and the extra receipts of *anthracene* from abroad, the supply of this product has been much easier of late and buyers have been able to force holders to make considerable concessions in some quarters. The 80 per cent grade ranged from 85c. to $1 per lb. Domestic demand for *alpha naphthylamine* remained quiet, while resale lots were not being offered as freely and producers continued to quote 47@50c. per lb. A quiet routine business is being noted in *Dinitrotoluene* in smaller lots and prices held steady at 27@30c. per lb. in the absence of any low-priced resale stocks. There is a very quiet market reported in *orthotoluidine*, with consumers taking only limited quantities to cover present needs. Prices are quoted unchanged at 30@32c. per lb.

Chemical Outlook for 1921

The chemical and allied markets have reflected flashes of activity lately, and those eager to take an optimistic view of these demonstrations believe that the long period of liquidation with all its depressing influences is nearing its end. Producers do not expect any active resumption of business similar to that of the early months of 1920, but feel confident that the new year will bring with it a vast improvement in the industrial conditions of the country. The first quarter of 1921 is looked forward to furnish the change, but a conservative, steady expansion in general business circles is expected prior to that time. The probability of easier money rates and loans from leading financial institutions is a probable factor in the business situation. Captains of finance have expressed their intentions of relieving any intense situation that may arise, and are ready with plenty of available funds. This will undoubtedly allow the launching of new enterprises and the elaboration of plans

which were formulated some time ago by leading chemical manufacturers. It stands to reason that heavy liquidation in securities and in practically every important commodity in the country has released a large supply of funds which bankers will be eager to place as soon as yearly dividends and settlements are completed.

CREDITS TO FOREIGN BUYERS

America is also confident that ways and means will shortly be established for the granting of extended credits to foreign buyers. This would relieve the tight situation confronting our present export trade and foster new foreign buying. While this might temporarily work against exchange rates, it is absolutely essential that European countries be allowed to purchase raw products here, as their supply is so small that it is retarding greatly their progress in a return to normal trade. Prominent chemical producers have frequently expressed their belief that Europe is sorely in need of raw materials of all kinds.

LABOR CONDITIONS

Labor conditions are still abnormal. Organized labor has undermined unionism by its drastic demands for continuous increases. Tanneries, soap factories, textile mills and dye plants have been compelled to close their doors at various times because the decline in price of finished products was not reciprocated by labor. The result is that labor will be enrolled at a price more commensurate with the cost of finished commodities when these plants resume operation. It is already significant that labor is entertaining a more conciliatory view, and as the cost of living comes down a more equitable understanding will prevail.

NO REASON FOR PESSIMISM

Americans are not inclined to pessimism. A country with over 100,000,000 persons to be clothed, fed and housed will not find conditions stagnant for an indefinite period. Depression has featured the chemical industry since last May. Although large losses have been taken, there are still a few more to be assumed. The sooner this is realized the better; but the dark streaks are gradually dwindling away and American industry is coming into its own before long primed for its battle of world-wide trade supremacy.

The Baltimore Market

Baltimore, Dec. 4, 1920.

Little change can be reported in the local market on fertilizer raw materials. Baltimore fertilizer manufacturers depend largely on the Southern territory as an outlet for their goods. Because of the sudden break in the price of cotton, Southern planters are generally in a bad financial condition, and as a consequence the manufacturers are having little success in collecting for goods shipped during the past season. As a direct result of this tight money situation in the fertilizer industry, comparatively small tonnages of raw materials are being purchased and the purchases that are being made are strictly on a hand-to-mouth basis. At this time it would appear that the tonnage of fertilizer used in the South will be greatly curtailed.

We may sum up the situation by saying we have a waiting market with good stocks of material in evidence and no particular interest being shown in them.

Acid Phosphate. The market may be quoted nominal at $16.50 per ton, basis 16 per cent bulk, run-of-pile. Round tonnages to fertilizer dry mixers could be closed as low as $16 on this basis.

Nitrate of Soda. Importers are quoting the market nominal at $2.90 per 100 lb. ex vessel Atlantic ports. Resale lots of round tonnages, however, have been recorded as low as $2.75. The market on nitrate at this time is quite uncertain and the trend seems to be downward.

Sulphate of Ammonia.—Resale lots have been offered this week as low as $4 per 100 lb., basis 25 per cent, in single or double bags f.o.b. shipping point. Large stocks are not in evidence at this time.

Potash.—A number of resale parcels of German and Alsation salts have been placed before our trade. We quote the market nominal, muriate $1.80 per unit, kainit and manure salts $1.75 per unit, all ex vessel North Atlantic ports. Nebraska potash is being quoted nominal at $2 per unit f.o.b. mines, in single bags.

Fish Scrap.—There has been no further change in the market on machine-dried unground menhaden fish scrap. This commodity is still being quoted and occasional sales are effected at $4 per unit of ammonia and 10c. per unit B. P. L. ex schooner, Baltimore, in buyers' bags. A good stock of unground scrap is still being held by the fish factories. This is a very unusual situation, as the scrap production is usually entirely absorbed by the end of the fishing season. We have previously reported that all the factories on the Chesapeake Bay have "cut out" for the year.

The Iron and Steel Market

Pittsburgh, Dec. 3, 1920.

The reductions in bars, shapes and plates to the Steel Corporation level made a week ago today, as noted in last report, have not induced the placing of an appreciable amount of business, nor indeed was it expected that any great amount of business would result at once. It was simply a case of the independents being clearly in an untenable position as to prices, with the incentive for maintaining prices removed, the incentive previously having been that of being able to make contract deliveries. Contracts had run out or customers were refraining from furnishing any further specifications. At this writing two or three of the Eastern independents have not yet reduced their quotations, and this may indicate that they still have some contract tonnage. As to the market, there is no range of prices, since any one of the sellers at the Steel Corporation prices could take care of the entire demand now found in the market.

Monday of this week a large independent producer of wire in the Pittsburgh district came down to the Steel Corporation prices, 3.25c. for plain wire and $3.25 for nails. Other independents have shown no haste to make formal reductions, their position being that they still have some contract business on books, while there is no important business in the market to be lost by not meeting the situation. The entire market for wire products is now quotable as follows: Wire nails, $3.25; plain wire, 3.25c.; galvanized wire, 3.95c.; painted barb wire, 3.65c.; galvanized barb wire, 4.35c. The nail price is that of the Industrial Board schedule, but the price on wire is $5 per ton above the Industrial Board figure, the American Steel & Wire Co. having made an advance of that amount last August.

MANUFACTURED STEEL PRODUCTS

Adjustments are naturally to be expected in manufactured steel products, in harmony with the declines in the hot rolled material. Last Monday two producers of cold-finished steel bars formally reduced their quotations by $8 a ton, from 4c. to 3.60c., and others intimated that they would reduce their quotations whenever attractive business should be offered. On Wednesday a leading producer of bolts and nuts announced new discounts, representing reductions from prices previously prevailing of approximately 20 per cent. Rivets, spikes, chain, etc., are awaiting readjustment.

CONTRACT ADJUSTMENTS

In most cases when producers have made reductions it is either formally stated or is inferred that any unfilled business remaining on books will be adjusted to the reduced prices. This is the common practice in finished steel products. While contracts are made, the contract is largely in the nature of an option given the buyer, who by refraining from specifying can nullify the contract. Long ago a contract for three months, six months or a year was regarded practically as involving simply a lump amount, but a few years ago the mills instituted a change, whereby the contract required specifications in equal monthly quantities, and any tonnage unspecified monthly would automatically be canceled. The option feature of the arrangement is usually extended so that a mill will accept cancellation when the actual specifications have been filed, provided manufacture has not been commenced. In semi-finished steel and pig iron the sales practice is different, contracts being regarded as

absolutely binding, though as a matter of accommodation postponement of delivery is frequently permitted. Several years ago the sheet mills instituted what they denominated a great reform, a binding contract being adopted, providing for reciprocal damages, against the mill if delivery was not made and against the buyer if specifications were not furnished and the material accepted. It is doubtful, however, whether the sheet mills will seriously attempt to enforce contracts at this time.

Pipe and Sheets

In tin plate, bars, shapes, plates and wire products the independent market is now down to the Steel Corporation market, the change having occurred quickly and proving much less spectacular than might have been expected. Of the prominent rolled products rails, sheets and pipe still present two markets. In rails the Steel Corporation has not formally announced its prices, but these will doubtless be 6.20c. for galvanized sheets, these prices being $10 a ton with the Industrial Board schedule, and presumably the independents will make the same prices.

In sheets the market continues to decline rapidly, the decline in the past week being half a cent a pound or more. Several independents are now willing to take business at 4.05c. for blue annealed sheets, 4.85c. for black sheets and 6.20c. for galvanized sheets, these prices being $10 a ton above the Steel Corporation or Industrial Board prices.

In pipe, which has been by far the strongest of the finished products, the Steel Corporation and independents have been only $7 a ton apart, the Steel Corporation's prices representing a basing discount of 57½ per cent, while the list issued by the independents early in the year is on a 54 per cent basis. Independents have at times secured large delivery premiums above their regular list. The market is in such condition that the independents may not have occasion to reduce for many weeks.

Yesterday the American Sheet & Tin Plate Co. had its semi-annual opening of order books, whereby contracts will be made with manufacturing consumers for the first half of 1921, prices being the Industrial Board prices continuously maintained by the Steel Corporation: Tin plate, $7 per base box, 100 lb.; blue annealed sheets, 10 gage, 3.55c.; black sheets, 28 gage, 4.35c.; galvanized sheets, 28 gage, 5.70c. As the company will carry over about three months of work, the deliveries to be arranged on new contracts will be practically for the second quarter.

Pig Iron

Declines in pig iron have continued. Although there has been scarcely any incentive by way of inquiry, furnace quotations are down in the week by $2.50 on bessemer and $2 on foundry and basic, to $37 for foundry, $35 for bessemer and $33 for basic, f.o.b. valley furnaces, freight to Pittsburgh being $1.96. Again it is suggested by furnace interests that the remainder of the pig iron decline will be relatively slow, and doubt is even expressed whether basic iron will be down to $30 before April 1. As to the eventual bottom of the pig iron market, before an upturn occurs, practically all views lie within the limits of $25 and $30 for basic and foundry grades.

The Future

The iron and steel market generally is altogether too stagnant for the condition to last. After a period of activity the market can be entirely inactive for a time, but in a prolonged period of dullness there must be some buying from day to day. On this basis a moderate revival in demand is expected to occur immediately after Jan. 1, but no general buying movement, with any stiffening in prices, is to be expected before April at the earliest. While the decline in the independent market to the Steel Corporation level was universally expected, hardly anyone expects the independents to stop at that level, and it is probable that more or less shading will eventually develop, though perhaps not to an extent that would require the Steel Corporation to reduce its prices. Apart from the matter of prices, which is a detail the steel producers are bright enough and quick enough to take care of, no heavy demand for steel can be expected until the country has completed its readjustment and the cost of consuming steel has been reduced.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots		Less Carlots	
Acetic anhydride	lb			$0 65 -	$0 75
Acetone	lb.	$0 15½-	$0 16	16½-	17
Acid, acetic, 28 per cent	100 lbs	3 00	3 25	3 50	3 75
Acetic, 56 per cent	100 lbs	7 25	7 50	7 75	8 00
Acetic, glacial, 99½ per cent, carboys	100 lbs	10 50	11 00	11 25	11 50
Boric, crystals	lb	14½	15	15½	16
Boric, powder	lb	15½	16½	.17 -	.18
Citric	lb	–		50 -	52
Hydrochloric (nominal)	100 lb	1.85 -	2.25	2.75 -	3.00
Hydrofluoric, 52 per cent (nominal)	lb	15 -	16	.16½-	.18
Lactic, 44 per cent tech	lb	10 -	11	11½-	12
Lactic, 22 per cent tech	lb	04½	05½	.06 -	.07
Molybdic, C. P.	lb	4.00	4 50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).					
Nitric, 40 deg	lb	.07	.07½	.08 -	08½
Nitric, 42 deg	lb.	07½	08	08½-	.09½
Oxalic, crystals	lb	17	17½	.18	19
Phosphoric, Ortho, 50 per cent solution	lb	.19 -	19½	19½-	.21
Picric	lb.	28 -	.35	.40 -	50
Pyrogallic, resublimed	lb	2 50	2 55	2 60 -	2 65
Sulphuric, 60 deg., tank cars	ton			–	
Sulphuric, 60 deg., drums	ton			14 00 -	15 00
Sulphuric, 66 deg., tank cars	ton	18 00 -	19.00		
Sulphuric, 66 deg., drums	ton	21 00 -	22.00	22.50 -	23 00
Sulphuric, 66 deg., carboys	ton			–	
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23 00	24 00	–	
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25 00	26 00	. 50	27 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32 00	35 00	40 00	
Tannic, U. S. P.	lb			1 35	1 45
Tannic (tech.)	lb	50	55	56	60
Tartaric, crystals	lb.			46	49
Tungstic, per lb. of WO	lb.			1 20	1 40
Alcohol, Ethyl (nominal)	gal	–		5 50	6 00
Alcohol, Methyl (see methanol)					
Alcohol, denatured, 188 proof (nominal)	gal			84 -	86
Alcohol, denatured, 190 proof (nominal)	gal			88	.90
Alum, ammonia lump	lb	04½	.04¾	05 -	.05½
Alum, potash lump	lb.	05½	06	06½	.07
Alum, chrome lump	lb	13 -	13½	14 -	.14½
Aluminum sulphate, commercial	lb	02¾	03	.03½-	03½
Aluminum sulphate, iron free	lb	03½	04	04½-	04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb	07¾-	08	.08¾	09½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb	33	.35	36	.38
Ammonium carbonate, powder	lb	14	14½	14½	15
Ammonium chloride, granular (white salammoniac)	lb	12	12½	12½	13
Ammonium chloride, granular (gray salammoniac)	lb	11	12	.12½	13
Ammonium nitrate	lb		10	11 -	14
Ammonium sulphate	lb	04	04½	.04½-	.04¾
Amylacetate	gal			4.50 -	5.00
Amylacetate tech	gal.			4.00 -	4.20
Arsenic, oxide, lumps (white arsenic)	lb	12 -	12½	.12½	.13
Arsenic, sulphide, powdered (red arsenic)	lb	15 -	.15½	15¾	.16
Barium chloride	ton	85 00	90 00	95.00 -	100 00
Barium dioxide (peroxide)	lb	24	25	.25	.27
Barium nitrate	lb.	12 -	12½	.13	.13½
Barium sulphate (precip.) (blanc fixe)	lb	04½-	.05	.05½-	.06
Bleaching powder (see calcium hypochlorite)		–		–	
Blue vitriol (see copper sulphate)		–		–	
Borax (see sodium borate)				–	
Brimstone (see sulphur, roll)				–	
Bromine	lb	70	80	.85 -	.90
Calcium acetate	100 lbs	2 50	2 75		
Calcium carbide	lb	04 -	04½	04¾-	05
Calcium chloride, fused, lump	ton	30 00 -	32 00	33 00 -	35 00
Calcium chloride, granulated	lb.	02 -	02½	.03 -	03½
Calcium hypochlorite (bleaching powder)	lb	.03½	03¾	04 -	04½
Calcium peroxide	lb			1 50	1 70
Calcium phosphate, monobasic	lb			75 -	.80
Calcium sulphate, pure	lb.	–		25	30
Camphor	lb			1 05	1 10
Carbon bisulphide	lb.	08 -	08½	09 -	.09½
Carbon tetrachloride, drums	lb.	13	13½	14	.14½
Carbonyl chloride (phosgene)	lb.	–		60 -	75
Caustic potash (see potassium hydroxide)		–		–	
Caustic soda (see sodium hydroxide)		–			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	09 -	.09½	10 -	.10½
Chloroform	lb.			43 -	.50
Cobalt oxide	lb			3.90	4 00
Copperas (see iron sulphate)				–	
Copper carbonate, green precipitate	lb.	23 -	24	24½-	25½
Copper cyanide	lb			.65 -	70
Copper sulphate, crystals	lb	06½	.06¾	.07	07½
Cream of tartar (see potassium bitartrate)					
Epsom salt (see magnesium sulphate)				–	
Ethyl Acetate Com. 85%	gal			1.05 -	1.10
Ethy Acetate pure (acetic ether 98% to 100%)				–	
Formaldehyde, 40 per cent (nominal)	lb	18½	18¾	19 -	.20
Fusel oil, ref	gal.	–		3 60 -	3.75
Fusel oil, crude (nominal)	gal.	–		3 25 -	3 50
Glauber's salt (see sodium sulphate)		–			
Glycerine, C. P. drums extra	lb.	–		1	22
Iodine, resublimed	lb.	–		3 75 -	4 00
Iron oxide, red	lb.	–		15 -	.25
Iron sulphate (copperas)	100 lbs.	2 25 -	2 50	2 75 -	3 00
Lead acetate, normal	lb.	–		13½	.16
Lead arsenate (paste)	lb.	13	14	14½	.15
Lead nitrate, crystals	lb.			90 -	1.00
Litharge	lb	.12	12½	13 -	.13½
Lithium carbonate	lb			1 50	
Magnesium carbonate, technical	lb.	10½	11	11½	12
Magnesium sulphate, U. S. P.	100 lb.	3 50	4 00		
Magnesium sulphate, commercial	100 lb.	–		3 00	3 25
Methanol, 95%	gal	–		1 90	2 00
Methanol, pure	gal			2 31	2 35
Nickel salt, double	lb			12	12½
Nickel salt, single	lb.			13 -	.13½
Phosgene (see carbonyl chloride)		–			
Phosphorus, red	lb.	50 -	52	53	55
Phosphorus, yellow	lb.	–		.35 -	37
Potassium bichromate	lb.	.20 -	.21	.21½-	.22½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	.. -	$0.43 - $0.47
Potassium bromide, granular	lb.	... -	.45 - .50
Potassium carbonate, U. S. P.	lb.	.50 - .55	.56 - .60
Potassium carbonate, crude	lb.	.13 - .13½	.13½ - .14
Potassium chlorate, crystals	lb.	.13 - .14	.15 - .18
Potassium hydroxide (caustic potash)	lb.	.16 - .16½	.16½ - .17
Potassium iodide	lb.	..... -	3.00 - 3.20
Potassium nitrate	lb.	.14 - .16	.16½ - .17
Potassium permanganate	lb.	.60 - .63	.65 - .70
Potassium prussiate, red	lb.	.55 - .57	.58 - .60
Potassium prussiate, yellow	lb.	.34 - .35	.35½ - .36
Potassium sulphate (powdered)	ton	$240.00 - 255.00	..... - .....
Rochelle salts (see sodium potas. tartrate)		..... -	..... - .....
Salammoniac (see ammonium chloride)		..... -	..... - .....
Sal soda (see sodium carbonate)		..... -	..... - .....
Salt cake	ton	..... -	52.00 - 55.00
Silver cyanide (nominal)	oz.	..... -	1.25 - .....
Silver nitrate (nominal)	oz.	..... -	.55 - .57
Soda ash, light	100 lb.	1.90 - 2.00	2.10 - 2.30
Soda ash, dense	100 lb.	2.50 - 2.75	3.00 - 3.25
Sodium acetate	lb.	.08 - .08½	.08½ - .09
Sodium bicarbonate	100 lb.	2.90 - 3.00	3.25 - 3.50
Sodium bichromate	lb.	.09¼ - .09½	.09¾ - .10
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ - .07	.07½ - .08
Sodium borate (borax)	lb.	.08½ - .08¾	.09 - .09½
Sodium carbonate (sal soda)	100 lb.	1.85 - 2.00	2.15 - 2.25
Sodium chlorate	lb	.10 - .10½	.10½ - .11
Sodium cyanide, 96-98 per cent	lb	.24 - .25	.26 - .28
Sodium fluoride	lb.	.17 - .17½	.17½ - .18½
Sodium hydroxide (caustic soda)	100 lb.	3.75 - 4.00	4.25 - 4.35
Sodium hyposulphite	lb.	.....	.04 - .04½
Sodium molybdate	lb	2.50 -	3.25 - .....
Sodium nitrate	100 lb.	3.00 -	3.25 - .....
Sodium nitrite	lb.	.07 - .07½	.07½ - .08
Sodium peroxide, powdered	lb.	.35 - .40	.42 - .45
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	-	.33 - .35
Sodium prussiate, yellow	lb.	.18 - .18½	.19 - .20
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01¾	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.03 - .03½	.03½ - .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	2.15 - 2.50	2.60 - 2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.07 - .07½	.07½ - .08
Sodium sulphite, crystals	lb	.04 - .04½	.04½ - .05
Strontium nitrate, powdered	lb.	.20 - .20½	.21 - .22
Sulphur chloride red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	..... - .....
Sulphur dioxide, liquid, cylinders	lb.	.09 -	.10 - .12
Sulphur (sublimed), flour	100 lb.	..... -	3.70 - 4.35
Sulphur, roll (brimstone)	100 lb.	..... -	3.40 - 3.90
Tin bichloride, 50 per cent	lb.	.18 - .19	..... - .....
Tin oxide	lb.	..... -	.50 - .51
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.12 - .13	.13½ - .14
Zinc cyanide	lb	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, XX	lb.	.09½ - .09¾	.10 - .10½
Zinc sulphate	lb.	.03½ - .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.47 — .50
Aniline oil, drums extra	lb.	.26 — .27
Aniline salts	lb.	.32 — .33
Anthracene, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.15 — 1.20
Benzidine sulphate	lb.	1.10 — 1.15
Benzoic acid, U.S.P.	lb.	.80 — .85
Benzoate of soda, U.S.P.	lb.	.80 — .90
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35 — .40
Benzene, 90%, in drums (100 gal.)	gal.	.32 — .33
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech.	lb.	.25 — .35
Beta-naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta-naphthol, sublimed (nominal)	lb.	.75 — .80
Beta-naphthol, tech (nominal)	lb.	.42 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal	1.10 — 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 — 1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzene	lb.	.07 — .10
Diethylaniline	lb.	1.45 — 1.50
Dimethylaniline	lb.	.75 — .80
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.27 — .32
Dinitronaphthalene	lb.	.42 — .45
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.75 — .77
H-acid (nominal)	lb.	1.60 — 1.65
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.17 — .18
Monoethylaniline	lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09 — .09½
Naphthalene, flake	lb.	.09 — .09½
Naphthalene, balls	lb.	.09½ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.30 — .32
Para-amidophenol, base	lb.	2.20 — 2.25
Para-amidophenol, HCl	lb.	2.10 — 2.15
Para-dichlorbenzene	lb.	.10 — .15
Paranitroaniline	lb.	1.05 — 1.10
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.20 — 2.35
Para-toluidine	lb.	1.85 — 2.00
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.08 — .10
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	2.90 — 3.00
Resorcinol, pure	lb.	3.75 — 4.15
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.33 — .35
Salicylic acid, U. S. P.	lb.	.37 — .40
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 — .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .22
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.45 — 1.50
Toluidine, mixed	lb.	.45 — .55
Toluene, in tank cars	gal.	.35 — ....
Toluene, in drums	gal.	.38 — .40
Xylidines, drums, 100 gal.	lb.	.45 — .50
Xylene, pure, in drums	gal.	.40 — .42
Xylene, pure, in tank cars	gal.	.45 — ..
Xylene, commercial, in drums, 100 gal.	gal.	.37 — .38
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.26 — $0.27
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.35 — .40
Carnauba, No. 1. (nominal)	lb.	.80 — .90
Carnauba, No. 2, North Country	lb.	.37 — .38
Carnauba, No. 3, North Country	lb.	.25 — .26
Japan	lb.	.19 — .20
Montan, crude	lb.	.12 — .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07½ — .08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07½ — .07¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 — .09¼
Paraffine waxes, refined, 125 m.p.	lb.	.09½ — .09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10½ — .11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13½ — .14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.14½ — .15½
Stearic acid, single pressed	lb.	.16½ — .17
Stearic acid, double pressed	lb.	.17 — .18
Stearic acid, triple pressed	lb.	.19 — .20

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$10.50 — ...
Rosin E-I	280 lb.	10.50 — ...
Rosin K-N	280 lb.	10.50 — ...
Rosin W. G.-W. W.	280 lb.	10.75 — 11.00
Wood rosin, bbl.	280 lb.	11.00 — ...
Spirits of turpentine	gal.	.96 — ...
Wood turpentine, steam dist.	gal.	.94 — .....
Wood turpentine, dest. dist.	gal.	.94 — .....
Pine tar pitch, bbl.	200 lb.	..... — 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... — 15.00
Retort tar, bbl.	500 lb.	15.00 — 15.50
Rosin oil, first run	gal.	.70 — ....
Rosin oil, second run	gal.	.73 — ....
Rosin oil, third run	gal.	.90 — .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.22 — $0.23
Upriver coarse (nominal)	lb.	.15 — .16
Upriver caucho ball (nominal)	lb.	.16½ — .17½
Plantation—First latex crepe	lb.	.19 — .....
Ribbed smoked sheets	lb.	.18 — .....
Brown crepe, thin, clean	lb.	.16 — .....
Amber crepe No. 1	lb.	.17 — .....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.14½ — $0.15
Castor oil, AA, in bbls.	lb.	.15 — .15½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11 — .11½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.14½ — .15
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.15½ — .16½
Corn oil, crude, in bbls.	lb.	.09½ — .10
Cottonseed oil, crude (f.o.b. mill)	lb.	.06 — .07
Cottonseed oil, summer yellow	lb.	.09½ — .10
Cottonseed oil, winter yellow	lb.	.11 — .12
Linseed oil, raw, car lots (domestic)	gal.	.80 — ..
Linseed oil, raw, tank cars (domestic)	gal.	.75 — .77
Linseed oil, boiled, car lots (domestic)	gal.	.82 — ....

Olive oil, commercial	gal.	2.75 — 3.00
Palm, Lagos	lb.	.08 — .09
Palm, Niger	lb.	.07½ — .08½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½ — .09
Peanut oil, refined, in bbls	lb.	.14½ — .14½
Rapeseed oil, refined in bbls	gal.	1.15 — 1.20
Rapeseed oil, blown, in bbls	gal.	1.25 — 1.35
Soya bean oil (Manchurian), in bbls N.Y.	lb.	.09½ — .10
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 — .07½

FISH

Light pressed Menhaden	gal.	$0.65 — $0.70
Yellow bleached Menhaden	gal.	.67 — .70
White bleached Menhaden	gal.	.72 — .75
Blown Menhaden	gal.	1.05 — 1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —$30.00
Barytes, ground, off color, f o.b. Kings Creek	net ton	22.00 — 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 — 12.00
Barytes, floated, f.o b. St. Louis	net ton	26 50 — 28 00
Barytes, crude, first grade, Missouri	net ton	10 00 — ..
Blanc fixe, dry	lb.	.05 — .05½
Blanc fixe, pulp	net ton	60.00 — 65.00
Caseine	lb.	.14 — .18
Chalk, domestic, extra light	lb.	.05 — .06
Chalk, domestic, light	lb.	.04½ — .05½
Chalk, domestic, heavy	lb.	.04 — .05
Chalk, English, extra light	lb.	.05 — .07
Chalk, English, light	lb.	.05 — .06
Chalk, English, dense	lb.	.04½ — .05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8 00 — 10 00
China clay (Kaolin) washed, f o.b Georgia	net ton	12 00 — 15 00
China clay (Kaolin) powdered, f o b Georgia	net ton	18 00 — 22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00 — 12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 — 40 00
China clay (Kaolin), imported, lump	net ton	25 00 — 35 00
China clay (Kaolin), imported, powdered	net ton	30.00 — 35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 — 14.00
Feldspar, crude, f.o.b. Maine	net ton	7 50 — 10 00
Feldspar, ground, f.o.b Maine	net ton	21 00 — 23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 — 21.00
Feldspar, ground, f.o.b. N Y State	net ton	17 00 — 21.00
Feldspar, ground f o b Baltimore	net ton	27.00 — 30 00
Fuller's Earth, f.o.b. New York	net ton	.. — 18.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 — .
Fuller's earth, powdered, f.o.b Fla.	net ton	18.00 — .
Fuller's earth, imported, powdered	net ton	35.00 — 40.00
Graphite, crucible, 90% carbon, Ashland, Ala.	lb.	..... — .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07 — .09
Graphite, higher lubricating grades	lb	.11 — .40
Pumice stone, imported, lump	lb.	.04 — .50
Pumice stone, domestic, lump	lb.	.06 — ..
Pumice stone, ground	lb.	.04 — .07
Quartz (acid tower) fist to head, f o b Baltimore	net ton	..... — 10 00
Quartz (acid tower) 1½@2 in., f o b. Baltimore	net ton	..... — 14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... — 17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 — 7.50
Shellac, orange fine	lb.	1.00 — 1.05
Shellac, orange superfine	lb.	1.05 — 1.10
Shellac, A. C. garnet	lb.	.90 — .95
Shellac, T. N.	lb.	.85 — .95
Soapstone	ton	15.00 — 25.00
Sodium Chloride	long ton	. — 17.50
Talc, paper-making grades, f o b. Vermont	ton	12.00 — 22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 — 15.00
Talc, rubber grades, f o b. Vermont	ton	12.00 — 18 00
Talc, powdered, Southern, f o b cars	ton	12 00 — 15 00
Talc, imported	ton	60.00 — 70 00
Talc, California Talcum Powder grade	ton	20.00 — 45.00

Refractories

Bauxite brick, 56% Al, f o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o b Eastern shipping points	net ton	60 65
Fire clay brick, 1st quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in shapes, f.o b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17 — .18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 — .17
Ferro-manganese, 76-80% Mn, domestic	gross ton	140 00 — 145 00
Ferro-manganese, 76-80% Mn, English	gross ton	135 00 — 140 00
Spiegeleisen, 18-22% Mn	gross ton	60 00 — 65 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 00 — 2.50
Ferro-silicon, 10-15%	gross ton	60.00 — 65.00
Ferro-silicon, 50%	gross ton	80.00 — 85.00
Ferro-silicon, 75%	gross ton	... — 160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.65 — .75
Ferro-uranium, 35-50% of U, per lb. of U contained	lb.	7.00 — .....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 — 7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 11% moisture	gross ton	$10 00 — $11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60 65
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.60 — 65
Coke, foundry, f o.b. ovens	net ton	9 00 — 10 50
Coke, furnace, f.o b. ovens	net ton	8 00 — 9 00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00 — 26.00
Fluorspar, lump, f o b Tonuco, New Mexico	net ton	17 00
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22 50 25 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ — .01½
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	45 — 50
Manganese ore, chemical (MnO_2)	gross ton	65 00 — 70 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	55 — 60
Monazite, per unit of ThO_2 c i f, Atlantic seaport	unit	35.00 —
Pyrites, Spanish, fines c.i.f., Atlantic seaport	unit	.12 — .
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.17 — ...
Pyrites domestic, fines, f o b mines, Ga	unit	.12 — .14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 — .
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	5.00 — ..
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	4.25 — 5.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 — 3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 — 3.00
Vanadium pentoxide, 99%	lb.	12 00 — 14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.50 — .....
Zircon, washed, iron free	lb.	.05 — .....

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	15 00
Aluminum, 98 to 99 per cent	32 00
Antimony, wholesale lots, Chinese and Japanese	6 00
Nickel, ordinary (ingot)	43 00
Nickel, electrolytic	45 00
Tin, 5-ton lots	34 50
Lead, New York, spot	6 25
Lead, E. St Louis, spot	6 25
Zinc, spot, New York	7 00
Zinc, spot, E. St. Louis	6.75

OTHER METALS

Silver (commercial)	oz.	$0.91½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb	2 55
Cobalt	lb.	6 00
Magnesium (f.o b. Niagara Falls)	lb.	1.75
Platinum	oz.	75.00
Iridium	oz.	350.00@400 00
Palladium	oz	75.00
Mercury	75 lb.	55 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb
Copper sheets, hot rolled	22 50
Copper bottoms	34 00
Copper rods	29 00
High brass wire and sheets	22 25
High brass rods	19 00
Low brass wire and sheets	30 50
Low brass rods	19 50
Brazed brass tubing	36 25
Brazed bronze tubing	41 50
Seamless copper tubing	26 00
Seamless high brass tubing	25 00

OLD METALS.—The following are the dealers' purchasing prices in cents per pound:

	New York Current	New York One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 00	17 00	11 00	11 50
Copper, heavy and wire	11 50	16 00	10 50	11 00
Copper, light and bottoms	10 00	14 00	9 50	10 00
Lead, heavy	5 50	4 75	5 00	5 25
Lead, tea	4 50	3 75	3 75	4 00
Brass, heavy	7 00	10 50	7 00	11 25
Brass, light	5 50	7 50	5 00	6 00
No. 1 yellow brass turnings	7.00	10 00	5.50	6 00
Zinc	4.50	5 00	3 50	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3 80	$4 15	$3 47	$3 58	$3.37	$3.58	$3.47
Soft steel bars	3 70	4 15	3 37	3 34	3.27	3.48	3.37
Soft steel bar shapes	3 70	4.15	3.37	3 48	3.27	3.48	3.37
Soft steel bands	4 65	5 50	4.07	6 25	....	....	....
Plates, ¼ to 1 in. thick	4 00	4.15	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Continental Gin Co., 3330 10th Ave., has awarded the contract for the construction of a 1-story, 132x400 ft. foundry and a 1-story, 100x300 ft. machine shop, to the H. K. Ferguson Co., 6523 Euclid Ave, Cleveland, O Estimated cost, $500,000.

Connecticut

BRIDGEPORT—The city has awarded the contract for furnishing and installing machinery and equipment for the proposed sewage disposal plant on Harborview Ave., Black Rock Station, to the Sanitation Co., 50 Church St., New York City. Estimated cost, $19,500.

HARTFORD—The Bd. of Water Comrs. will receive bids January 10 for furnishing 21,000 yd. of filter sand and about 12,000 yd of filter sand for filter beds. C M. Saville, engr.

WEST HAVEN—The Union School Dist., Orange, is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, between $350,000 and $400,000. R. W. Foote, 185 Church St, New Haven, archt.

Indiana

INDIANAPOLIS—The Pioneer Brass Wks, 424 South Pennsylvania St., is having plans prepared for the construction of a 1-story machine shop. J H. Brinkmeyer, pres. C. Brossman, engr.

MICHIGAN CITY—The Steel Fabricating Co., Harvey, Ill., is building a plant here.

Iowa

SHELBY—The Bd. Educ. has awarded the contract for the construction of a 2-story, 120x190-ft. high school, to J. F. Wakefield Co., 750 Brandeis Theatre Bldg., Omaha, Neb. A chemical laboratory will be installed in same. Estimated cost, $119,900.

Maryland

AMCELLE (Baltimore P. O.) — The Amer. Cellulose & Chemical Mfg. Co. Ltd., 681 5th Ave., New York City, has awarded the contract for the construction of a 1 story plant, to the G. A. Fuller Co., 175 5th Ave., New York City. Estimated cost, $200,000.

BALTIMORE—The Metal Package Corp., Wolfe and Thames Sts, plans to construct a tinplate and lithographing plant.

Massachusetts

NATICK—The Griess Pfleger Tanning Co. of Massachusetts, P. O. Box 271, plans to build an addition to its leather manufacturing plant.

Michigan

DETROIT—The Anchor Bldg. Co., c/o F. J Winter, archt, 2331 Dime Bank Bldg., is having plans prepared for the construction of a 2-story, 50x100 ft. paint shop on West Grand Blvd. Estimated cost, $50,000.

DETROIT—The Bd. Educ, 50 Bway, will receive bids until December 21 for the construction of a 5- and 7-story, 250x350 ft. technical high school on 2d Ave. and High St. A chemical laboratory will be installed in same. Estimated cost, $2,500,000. Higginbotham, Malcolmson & Palmer, 405 Moffat Bldg., archts.

DETROIT—G. W. Graves, archt., 43 John R. St., will receive bids until Dec. 10 for the construction of a 1-story, 90x200-ft. foundry for the Zenith Fdry Co., Miller Ave. Foundry equipment will be installed in same.

Minnesota

MANKATO—The Immanuel Hospital Association plans to build a 2- or 3 story addition to hospital. A chemical and pathological laboratory and an X-ray department will be installed in same. Estimated cost, $150,000.

ST. PAUL—The city has awarded the contract for 30,000 lb of liquid chlorine for treating city water in 100-lb. cylinders, to Noyes Bros & Cutler, 6th and Sibley Sts., at 9c. per lb Noted Oct. 27.

New York

ITHACA—Cornell University plans to construct a 5-story, 190x268-ft. chemical building. Gibb & Waltz, Trust Co. Bldg., archts.

YONKERS—The Hudson & Rubber Corp., Proctor Bldg., has awarded the contract for the construction of a 3-story factory on Nepperhan Ave, to James Mitchell Inc., 76 Montgomery St, Jersey City, N. J. Estimated cost, $300,000.

North Dakota

JAMESTOWN—The Bd. Educ. will receive bids Jan. 1 for the construction of a 3-story, 125x195 ft. high school. A chemical laboratory will be installed in same. Estimated cost, $175,000 Shannon, Boyd & Boyd, engrs.

Ohio

CLEVELAND—The Atlas Fdry Co., 7275 Shaw Ave., has awarded the contract for the construction of a 1-story, 37x45-ft. addition to its foundry, to D Gilchrist, Peoria. Estimated cost, $25,000. Noted Oct 27.

MT. VERNON—The C. & G. Cooper Co., 11 Bway, New York City, has awarded the contract for the construction of a 1- and 2-story foundry and machine shop, to D. P. Robinson & Co., Inc., 125 East 46th St., New York City. Estimated cost about $400,000.

Oklahoma

BARTLESVILLE—The Bd. of Comrs. will soon receive bids for the construction of a sewage disposal plant, etc. Estimated cost, $200,000. E. D. Kirkpatrick, engr.

SAPULPA—The city is having plans prepared for the construction of a dam, reservoir, filter basins, force main, distributing reservoirs, etc. The Halway Eng. Co., 230 Lynch Bldg., engr.

Pennsylvania

LEWISTOWN—The Pennsylvania Wire Glass Co., Pennsylvania Bldg., is having plans prepared for the construction of a 1-story, 175x600-ft. glass plant. Epuipment will be installed in same. F. A. Hayes, Pennsylvania Bldg., archt.

Rhode Island

PAWTUCKET—The Berry Spring Mineral Water Co, 3 Charlton Ave., has awarded the contract for the construction of a 2-story, 10x40 ft. addition to its plant, to the C I. Bigney Constr. Co., 357 Westminster St., Providence. Estimated cost, $15,000.

Texas

EASTLAND—The city will soon award the contract for the construction of a sewage disposal plant to include an Imhoff tank, sprinkling filter and sludge bed. J. A. Wright, city engr.

Virginia

QUANTICO—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for the construction of an incinerator plant to include a septic tank, etc., at the Marine barracks, here, from the King Lumber Co., Charlottesville, $41,800; Hyde & Baxter, 1311 G St, N.W. Wash., D. C., $46,000; Newport Constr. & Eng. Co., Newport News $48,310. Noted Nov. 3.

West Virginia

WHEELING—The Wheeling Axle Co. has awarded the contract for the construction of a 2-story addition to its axle factory on 27th St., to J. E. Moss. Estimated cost, $6,500.

Wisconsin

GRANVILLE—The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., has awarded the contract for the construction of a 1-story, 40x200-ft. creosoting plant, etc., to J. L. Stanage, 144 Oneida St., Milwaukee. Noted Nov. 24.

MILWAUKEE—The Milwaukee Children's Hospital, 319 10th St., is having preliminary plans prepared for the construction of a hospital building, etc., on Grand Ave. A chemical laboratory will be installed in same. Estimated cost, $450,000. Scott & Mayer, Colby-Abbot Bldg., archts. and engrs.

TWO RIVERS—The Bd. Educ. will soon award the contract for the construction of a 3-story, 80x155-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $400,000. J. D. Chubb, 109 North Dearborn St., Chicago, Ill., archt.

Ontario

BROCKVILLE—The Provincial Bd. of Health plans to construct a filtration plant. Estimated cost, $50,000.

PEMBROKE—The McGuire, Patterson & Palmer, Ltd., 343 Dorchester St. W., Montreal, has awarded the contract for the construction of a match factory, to Fraser Brace & Co., Ltd., 83 Craig St., W., Montreal. Estimated cost, $5,000,000.

PORT DALHOUSIE—The city has awarded the contract for the construction of a sewage disposal system, etc, to R. M. Smith, 58 Howard St., Toronto. Estimated cost, $45,000.

ST. CATHERINES—The Kinleith Paper Co., Welland Canal, has awarded the contract for the construction of a 2-story addition to its paper factory, to the Tremble Co., Thorold St. Estimated cost, $25,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its winter meeting at New Orleans, Dec. 6 to 9. Headquarters are at the Hotel St. Charles.

AMERICAN PHYSICAL SOCIETY will hold its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies Building from Dec. 7 to 10 inclusive.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25 Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Supreme Court Declares Hydrogenation Patents Invalid

LAST week the United States Supreme Court handed down a decision of epoch-making importance to the chemical industry in the case of PROCTER & GAMBLE vs. the BERLIN MILLS CO. relating to the hydrogenation of cottonseed and similar oils. In a unanimous opinion in favor of the defendant the court declared invalid claims 1 and 2 of the Burchenal patent for the production of a homogeneous lard-like food product consisting of a partly hydrogenated vegetable oil such as from cottonseed. The case practically turned on the interpretation of the words "homogeneous" and "lard-like."

PROCTER & GAMBLE'S suit against the BERLIN MILLS CO. for alleged infringement of a product made under the Burchenal patent was instituted in 1915 and has attracted widespread attention on account of the prominence of the litigants and the far-reaching importance of the decision when it should be rendered. The plaintiff obtained a favorable decision in the Circuit Court of Appeals, but the defendant succeeded in appealing to the Supreme Court on questions of law. We believe this is one of only seven cases in which the Supreme Court has reviewed an opinion of the Circuit Court unless conflicting opinions had then been rendered.

We hope later to present a more extended review of this important case and will confine immediate comment to a mere indication of one or two salient features. One immediate effect of the decision is to throw open to the public the manufacture of an edible product by the hydrogenation of an oil. Another more widespread result will be from a probable effect on patent law: the recognition of the principle that a product may not be described in terms of a process.

Two Great Americans On Chemical Independence

CHIEF among the founders of our Republic stands ALEXANDER HAMILTON. The governing principle of his policy, of WASHINGTON who supported him, and of the whole Federalist party which followed him, was to establish supreme sovereignty. HAMILTON sought this prime object by threefold means, as is clearly brought out in an excellent appreciation of his life by an admiring Englishman, FREDERICK S. OLIVER. The idea of his financial policy was the welding of the Union, of his foreign policy to confirm independence, and of his commercial policy the development of the estate. Of these, only the last failed of vigorous prosecution and substantial acceptance during his brief lifetime. Indeed the last has been ever at the mercy of logrollers rather than in the hands of statesmen.

HAMILTON'S report to the House of Representatives on manufactures urges that "not only the wealth but the independence and security of a country appear to be materially connected with the prosperity of manufactures. Every nation, with a view to those great objects, ought to endeavor to possess within itself all the essentials of national supply. These comprise the means of subsistence, habitation, clothing and defense.

"The possession of these is necessary to the perfection of the body politic; to the safety as well as to the welfare of the society. The want of either is the want of an important organ of political life and motion; and in the various crises which await a state it must severely feel the effects of any such deficiency. The extreme embarrassments of the United States during the late war, from an incapacity of supplying themselves, are still matters of keen recollection; a future war might be expected to exemplify the mischiefs and dangers of a situation to which that incapacity is still, in too great a degree, applicable, unless changed by timely and vigorous exertion."

By "the late war" HAMILTON referred to a successful war against Great Britain; many of these phrases bear equal application to conditions existing during and after our recent war against Germany. Indeed, HAMILTON stood on fundamentals and saw wide; he viewed the future as a true prophet. He saw a great continent united by miraculous good fortune into one state, of unknown extent, unexplored except for an eastern fringe. His vision was of one great nation, capable of producing within its own wide borders everything that its citizens would require for safety and for comfort. Distant from its neighbors, it might hope to escape from embroilment in their quarrels; dependent upon them solely for some essential, the wars, disasters and policies of strangers would be a constant menace to its prosperity. It is at the mercy, not only of the malice of its rivals, but of the misfortunes of its friends.

A well-balanced domestic establishment and self-sufficiency in essentials is now and perhaps ever will be a question worthy of serious thought and careful action. Witness the following quotation from the message delivered last week to the short session of Congress by President WILSON—whom even the most rabid critic would not accuse of levity or rashness:

"Permit me to emphasize once more the need for action upon certain matters upon which I dwelt at some length in my message to the second session of the Sixty-sixth Congress: The necessity, for example, of encouraging the manufacture of dyestuffs and related chemicals; the importance of doing everything possible to promote agricultural production along economic lines, to improve agricultural marketing and to make rural life more attractive and healthful."

Can the Republicans follow HAMILTON'S advice and the Democrats follow WILSON'S advice to the extent of adopting a sound policy on chemical independence?

Methods of Making Market Prices

NORMALLY the locomotive engineer regulates the speed of his train from moment to moment according to the nature of the roadway. On the one hand he is not supposed to exceed the safe limit and on the other hand he is expected to keep up to the schedule, while the schedule in turn has been made with a view to getting the patrons of the road to their destinations in the shortest time consistent with other influences. It would certainly be a very crude and inefficient method for the engineer to reduce speed only when he felt some of the wheels leaving the track, or to go as slow as he chose until the passengers held an indignation meeting and formally instructed him to go faster.

The manner in which market prices for many commodities are set is not essentially very different from the alternative manner of operating a railroad train suggested above. Prices are held until an accident occurs, by way of somebody cutting the price, and then producers make a fresh stand upon the reduced price until another accident occurs. For the lower limit, there is a law against unfair or destructive competition whereby in certain circumstances legal process could be invoked to prevent a manufacturer selling below his cost.

A practice of artificial price control among manufacturers is regarded as inherently wrong and against public policy. It is contrary to the common law and is in direct violation of a specific statute, the Sherman "antitrust" act of 1890, enacted to crystallize the common law, prescribe methods of procedure and fix definite punishment for violation.

In the '90s and in the early years of the present century there were various "pools" and "associations" in the finished steel trade. This was brought out by the Government in the recent suit against the Steel Corporation. The court found, in substance, that the procedure was wrong, and cleared the Steel Corporation chiefly on the ground that its participation ceased in 1904. At the present time there are few associations among manufacturers of the ordinary steel mill products, but there are many associations among consumers of those products. These associations claim to be operating wholly within the law, and that the Federal Trade Commission is cognizant of all their actions. A study of market prices, however, shows that in most cases the manufactured goods sold to the public by members of these associations stand at greater percentages above the pre-war prices than do the rolled steel products which are purchased as raw material from the rolled steel industry.

The spirit of some of these associations seems to be that since they have not the power to hold prices absolutely at all times from going below the level affording a fair profit they should get more "when the going is good" in order to make a suitable average in the long run.

While the steel industry is naturally indisposed to criticize its customers, it does not seem entirely fair that the ultimate consumer should pay a larger profit upon one stage of the manufacture than upon another, when the amount of business done by each successive manufacturer is regulated more or less by the price the ultimate consumer pays.

Commodity prices in general, particularly of manufactured goods, are made by a distinctly hit or miss process. In the case of hits the seller tries to make them as hard as possible, and for the misses there is nothing but to hope that the hurt will not be serious or permanent. Obviously the old law of competition, if it ever was a safe law, is absolutely ineffective to produce prices at all times fair both to producer and to consumer, because "overhead" has become so large a part of manufacturing cost and in competition a manufacturer does better to lose part of his overhead by selling below total cost than to lose it all by closing his factory. The whole thing is very crude and it is a wonder we get along at all.

Adsorption Phenomena as Applied to Vapor Recovery

IT HAS been only in the past year that research on adsorption of vapors by silica and activated charcoal has given any sign of being productive of an industrial conquest. This is largely due to the introduction of poisonous vapors in offensive warfare with the consequent development of the gas mask as the defensive equipment. In the past the phenomenon of adsorption has received a great amount of speculative treatment and comparatively meager qualitative and quantitative study. The factors have long been recognized in terms about equally complex as adsorption itself, such as capillary-equilibrium between the liquid and vapor phases, which in turn can be resolved first into wetting power of the liquid phase and then to intramolecular forces.

It is observed that when a drop of any liquid is placed on any solid surface, the behavior of the drop is dependent on the resultant of three forces: The surface tension of the liquid in equilibrium with its vapor phase, the contact tension between the liquid and solid, and the surface tension of the solid itself. The magnitude of each of these forces is probably a function of density and intramolecular cohesion, from which we may anticipate the high-surface tension of mercury relative to that of water, and explain the familiar globular form of mercury when in contact with lighter chemically-inert materials. Wetting power is of fundamental importance in capillary adsorption phenomena, for it governs the action of Jurin's Law upon which differences in vapor pressure head depend.

Beginning with this issue, the action of silica gel on single vapors will be described. In the near future, the selective adsorption of the intermediate paraffine series from natural gas by activated charcoal will be taken up, showing that equilibrium tends toward saturation with the higher molecular weight liquids, which expel the lighter ones. Water vapor is at once about the most condensible and greatest vapor expeller that is encountered in adsorption work. Needless to say, where it occurs with the vapor to be adsorbed, the adsorption has to be performed in two stages.

The possibilities of fractionation of mixed vapors by selective adsorption are great, but up to the present they do not seem to have been very extensively investigated. Gases have been cooled below their critical temperature, where the liquid-vapor equilibrium phase replaces the gas state, and there appears to be a possibility that an improvement may be made on the refrigeration method of fractionating such mixtures as air into liquid oxygen and nitrogen gas, with a higher yield than can be economically obtained by the older methods.

Is Chemical Warfare Service Being Stifled?

NOT long ago the Surgeon General of the Army published a report on casualties in the World War which brings out clearly the important part played by gas warfare. In view of the recent history of the Chemical Warfare Service it seems well to summarize them once more.

Out of a total of 258,338 casualties, 70,552, or 27.3 per cent, were caused by gas. Of the 266,112 wounds inflicted upon 224,089 Americans admitted to hospitals, 88,980, or 33.4 per cent, were due to gas. Hand grenades were responsible for 1,158 wounds, pistols 257, bayonets 245, airplane bombs 160 and sabers 14.

Less than 2 per cent of the men suffering from gas admitted to hospitals died, while in the case of the 153,-537 suffering from all other classes of wounds admitted to hospitals 12,470, or 8.1 per cent. died. Furthermore, during the years 1918 and 1919, tuberculosis was respectively only 70 and 55 per cent as prevalent among gassed men as among those not gassed.

Study of these data convinces one not only that gas warfare is very effective but that it is also one of the most humane methods of waging war. With these facts in mind, consider the present status of the Chemical Warfare Service. Here are the facts:

The Army reorganization act, approved June 4, 1920, provided for the Chemical Warfare Service in the following language:

> Sec. 12a, Chemical Warfare Service. There is hereby created a Chemical Warfare Service. The Chemical Warfare Service shall consist of one chief of the Chemical Warfare Service with the rank of Brigadier General, one hundred officers in grades from Colonel to Second Lieutenant, inclusive, and 1,200 enlisted men. The chief of the Chemical Warfare Service under the authority of the Secretary of War shall be charged with the investigation, development, manufacture or procurement and supply to the Army of all smoke and incendiary materials, all toxic gases, and all gas-defense appliances; the research, design and experimentation connected with chemical warfare and its material; and chemical projectile filling plants and proving grounds; the supervision of the training of the Army in chemical warfare, both offensive and defensive, including the necessary schools of instruction; the organization, equipment, training and operation of special gas troops, and such other duties as the President may from time to time prescribe.

With this authorization, what have the War Department officials done?

Shortly after the passage of the Army reorganization bill, the following paragraph set forth the idea of a special board regarding chemical warfare:

> That no troops of the Chemical Warfare Service should be assigned within the Army as combat organizations, but that this Service shall carry on research and development. This is a supply service whose product should be utilized when necessary by combat troops of all arms of the line.

Following the publication of the above mentioned paragraph, tables of organization were issued, in which no mention whatever is made of chemical warfare troops in any military organization for peace or war.

No Chemical Warfare officers have been provided for in any other positions in armies, corps or divisions, notwithstanding they were used on the staff of every commanding general in the World War and were provided for under War Department rules carrying out the provisions of the appropriation act of July 11, 1919, which continued the Chemical Warfare Service during the fiscal year 1920.

This means—if it means anything—that the Army will get no training whatever in chemical warfare.

Apparently to make certain that this training cannot be carried out, a recent decision is that no line officers will be permitted to attend Chemical Warfare Service schools, and that no Chemical Warfare officers will be detailed as instructors in Army service schools or with the National Guard, or in Reserve Officers Training Camps. A tremendous quantity of gas masks and other gas-defense material in the hands of Regular Army divisions in this country and also in the Philippines will soon be without the trained men necessary for their proper care.

Another decision along the same line is not to allow target practice with chemical ammunition other than smoke except at Edgewood Arsenal or Lakehurst, N. J. One of the reasons given for this action was that gas cannot be fired on ordinary target ranges without objection of civilians near by. This in spite of the demonstrated fact that gas can be used with greater safety on such ranges than high explosive.

Is it the idea to teach the Army that gas is too dangerous to train with in time of peace?

Despite the decision that Chemical Warfare Service should primarily carry on research and development, even this activity has been hampered by such acts as the refusal of permission to construct quarters for high-grade civilians at Edgewood Arsenal. This refusal was rendered notwithstanding the Judge Advocate General sustained the opinion of the chief of the Chemical Warfare Service that there was ample law for the use of money now in the hands of the Chemical Warfare Service for that purpose.

While the total appropriation recommended by the War Department for the year 1922 amounts to about $700,000,000, a little less than $4,500,000 is for chemical warfare. Is an organization handling a weapon fifty times as effective as hand grenades, pistols, bayonets, sabers and airplane bombs, all combined, to be starved to death?

That these decisions are largely the opinions of Washington War Department officials only is evident from the many requests made for chemical warfare instruction or chemical warfare troops by commanding generals of divisions, corps areas, departmental areas or service schools outside of Washington. For instance the commanding general of Camp Benning, Ga., has tried for six months to have a company of chemical warfare troops sent there. The chief of infantry has strongly indorsed such request. Needless to say also, the chief of the Chemical Warfare Service has done everything he could to get them sent there, but every request has met with constant refusal.

We repeat the question at the head: "In the light of these facts, can one conclude that the Chemical Warfare Service is being stifled?"

Minerals Separation's Application Again Denied

UPON another page we print a brief abstract of the opinion of the United States Circuit Court of Appeals, which not only fully sustains the District Court in its denial of a petition to find the Miami Copper Co. in contempt for continuing its flotation operations but would seem to add force to what we interpreted as a rebuke from the District Court because of its necessity of speaking twice to be heard.

Readers' Views and Comments

Electric Furnace Refractories

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent arcticle in your journal entitled "Electric Furnace Refractories," by A. F. Greaves-Walker,[1] certain statements are made with regard to magnesite which need correction.

The author mentions the two general types of naturally appearing magnesite—namely, crystalline and amorphous, and then proceeds to state that the latter is entirely unsuited for the manufacture of refractories. This statement has been shown, both by laboratory research and actual practice, to be incorrect, although it has occurred from time to time in the literature and has been generally accepted as true up to very recent times.

The truth of this statement was given some apparent substantiation by the general failure of the California amorphous magnesite to yield a satisfactory refractory magnesite and by the great success, as a refractory, of the dead-burned magnesite shipped from Chewelah, Wash., by the Northwest Magnesite Co. But the Northwest Magnesite Co. was the first in the United States to build and operate a plant which produced a true dead-burned magnesite. No such plants have ever existed in California on an extensive scale, and no true dead-burned magnesite has ever been produced in California, except on a small scale. However, this small production has been recognized for some years as a very high-grade refractory material, and it served a valuable purpose during the war as a lining for furnaces producing carbon-free ferro-alloys. Washington magnesite, if calcined by the usual California method, would be worthless as a refractory material. The production of a high-grade refractory magnesite is largely a matter of process and apparatus, and provided the original analysis of the rock is within certain prescribed limits it makes no difference whether it be in crystalline or in the so-called amorphous state, if the proper procedure be followed which is necessary for the production of dead-burned magnesite.

These statements, which are the result of practice, of course proceed from certain underlying facts regarding the nature of magnesite. There is no real distinction between crystalline and so-called amorphous magnesite, except in the size and development of the crystals. (The amorphous is in reality a cryptocrystalline magnesite.) Crystalline magnesite is usually less pure than the cryptocrystalline, and particularly it usually contains more iron; but there are deposits of cryptocrystalline magnesite in California which contain more iron than the Washington crystalline magnesite, and also some which contain less iron and more lime and silica.

Both crystalline and cryptocrystalline magnesite, when properly calcined at 750 to 800 deg. C., yield amorphous magnesia entirely free from CO_2 gas and of a greater or less degree of purity, according to the constituents of the original rock. Amorphous magnesia, owing to its low specific gravity and its tendency to shrink at high temperatures, is worthless as a refractory material. If its temperature is raised to 1,550 deg. C. and if 5 to 6 per cent Fe_2O_3 be present and intimately mixed with it, amorphous magnesia is completely transformed to a crystal known as periclase and the resulting product is dense, hard and sintered, and is known as dead-burned magnesite.

These facts disclose that dead-burned magnesite is produced by a heat treatment of CO_2-free amorphous magnesia, whereby periclase is formed, and it makes no difference whence the amorphous magnesia came. Furthermore, the production of dead-burned magnesite is only incidentally connected with the calcining of magnesite. All of the CO_2 can be driven from magnesite without producing a single per cent of periclase, and on the other hand periclase can be produced from amorphous magnesia which never had been in the form of the carbonate. Periclase was never completely formed in California magnesite, and the magnesite was therefore never completely dead burned because the calcined magnesite was never heated as high as 1,550 deg. C., but if it did happen to be heated to this temperature in the process of manufacture, there was not sufficient iron present to initiate the crystallization. The great bulk of California magnesite, therefore, which was shipped in the early days of the industry, was not thoroughly dead burned. It was considered so at that time, however, because dead burning and calcining were confused and it was thought that all that was necessary to accomplish the dead burning of magnesite was to completely drive off the CO_2 gas.

The presence of iron oxide is necessary in making dead-burned magnesite because it catalyzes the transformation of amorphous magnesia to periclase. If iron is not present, this transformation requires a higher temperature than is practical in ordinary commercial furnaces using oil or coal as fuel. Microscopic examinations have demonstrated that iron oxide added to the rock under proper conditions is exactly equivalent in its action to the iron which occurs naturally in the rock.

Consideration of these facts entirely refutes the old and oft-repeated claim which Mr. Walker has again repeated, that Austrian magnesite is a material in a class by itself. No one disputes the fact that it is an excellent refractory material, but we now know both from practice and laboratory research that we are producing the same material in America, and the best proof of this statement is that American metallurgical industries, including those employing electric furnaces, have been operating without hindrance in so far as refractories are concerned for over two years, using almost entirely American magnesite. Inquiries which have been made from time to time of those operating open-hearth furnaces and electric furnaces establish the fact that American magnesite is giving the highest satisfaction and is considered the equivalent, in every particular, of Austrian magnesite.

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[1]Nov. 10, 1920, vol. 23, p. 933.

Action of Steam and Gases on Yields of Ammonia From Carbonization of Oil Shales and Coal

Discussion of the Various Factors and Physicochemical Laws Affecting the Ammonia Equilibrium—Synthetic Action of Steam and Hydrogen—Removing Action of Inert Gases From Decomposition Zone

BY ARTHUR J. FRANKS

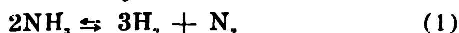
THE importance of nitrogen to the industrial, agricultural and military progress of nations has stimulated prolific research in methods of production, and especially conservation of this resource. In certain localities the principal source of nitrogen lies in the byproduct ammonium compounds obtained from the carbonization of coal and oil shales; and activities in the direction of byproduct recovery are continually expanding in the great countries of the world.

The steaming of retorts has accelerated this advance toward the conservation of the ammonia yield, and steaming practice has been under investigation for nearly a century with the view of magnifying its usefulness. Yet when one refers to the literature for the reactions involved, or the *modus operandi* of the steaming process, only very meager data, generally from plant practice (and sometimes of questionable accuracy), are found, together with the admission of our ignorance of the principles involved, or, what is less satisfactory, dubious hypotheses which are unable to withstand the light of our present knowledge.

PRINCIPAL FACTORS INVOLVED IN AMMONIA EQUILIBRIUM

As ammonia decomposes at temperatures below those of the ordinary coal or oil shale retort, how are we to explain the yield which is nevertheless produced, as practice shows? Ignorance of the laws involved has given rise to many controversies. Some have even gone so far as to state that "there is something unsound in your theory, which is not a safe guide to follow." It is generally not the theory which is at fault, but its misapplication to conditions under which the theory cannot be expected to hold. It will be the purpose of this paper to consider these various physical conditions, in connection with the effect of steam and inert gases on the ammonia yield, and to interpret the phenomena that attend in the light of our physicochemical laws.

It is first necessary to consider all the pertinent facts involved in the ammonia equilibrium[1]



$$2NH_3 \rightleftharpoons 3H_2 + N_2 \quad (1)$$

as well as the general laws that govern:

At or above 780 deg. C., and at atmospheric pressure, the equilibrium is displaced completely to the right (in an iron tube and in the absence of catalysts)—that is, the decomposition is complete.[2]

The dissociation is endothermal, hence the equilibrium is shifted toward the right as the temperature rises.

The decomposition proceeds with an increase in volume and is therefore favored by the reduction of pressure.

The introduction of inert gases at *constant volume* has no effect on the equilibrium.

Dilution with inert gases attended with an increase in volume displaces the equilibrium to the right, or *increases* the dissociation.

Increasing the concentrations (and hence the partial pressures) of either the N_2 or H_2, or decreasing that of the NH_3, will shift the equilibrium to the left.

The rate of the reaction to the left is proportional to the product of the concentrations of the decomposition products, with a constant thermodynamic environment.

Catalysts have a very pronounced action on the temperatures of decomposition and especially upon the reaction rate, which is very slow.

DECOMPOSITION TEMPERATURE

According to the experiments of Ramsay and Young pure ammonia is completely decomposed at 780 deg. under the conditions given. But it must be remembered that these conditions do not obtain in practice during the retorting of oil shale or coal, for equilibrium is not attained, and that temperature is the controlling factor in determining the degree of dissociation *only when complete equilibrium is reached.* Unless the system is in equilibrium we have no means of predicting what the dissociation constant will be, but the dissociation will, of course, be greatly decreased.

Other factors, not considered in the observations of Ramsay and Young, enter during the carbonization process to further complicate the thermodynamic environment. Hence, for our present purpose, the results of those experiments are of little value, and become less and less applicable as the number of variables in the system increases.

DISSOCIATION IS ENDOTHERMAL

From the endothermicity of the reaction and the principle of Le Chatelier it is evident that heat aids the dissociation of ammonia into its elements, and that the higher the temperature the greater is the decomposition. The magnitude of this dissociation by heat is, of course, greatest at equilibrium, but it proceeds at all times to a greater or less degree, depending upon the nature and number of other variables in the system. Table I demonstrates the effect of temperature rise on the amount of ammonia found in an equilibrium mixture of 75 per cent hydrogen and 25 per cent nitrogen at one atmosphere pressure, the values being taken from the observations of Jost.[3]

TABLE I. EFFECT OF TEMPERATURE ON NH_3 FORMATION

T. Abs. C.	deg. C.		
973	700	0.000174	0.000183
1,073	800	0.000088	0.000089
1,203	930	0.000043	0.000042
1,273	1,000	0.000032	0.000029

[1] Jellinek, "Physikalische Chemie der homogenen und heterogenen Gasreaktionen," p. 682.

[2] Ramsay and Young, *J. Chem. Soc.*, vol. 45, pp. 88-93; 1884.

[3] *Z. anorg. Chem.*, vol. 57, p. 425 (1908).

In this table X is the volume of NH_3 per unit volume of mixture as observed, and X_c the calculated results from Nernst's form of the reaction isochor.[4]

The influence of the presence of other gases in the mixture together with the lack of equilibrium would effect a tremendous difference in the above figures, but the actual results under such changed conditions could hardly be predicted except within the limits of pure speculation. This is clear from results of experience in gas manufacture. If the dissociation proceeded at the rate given for the temperatures in Table I no ammonia would ever be found in the gas, as it would all be decomposed at 800 to 900 deg., the temperature which practice demonstrates to be the most favorable[6] for the greatest ammonia yield.[5] The explanation for such apparently contrary phenomena can be found only in the absence of equilibrium and the presence of gases other than ammonia, especially hydrogen. The manner in which these conditions produce the above-mentioned results will be evident from the discussion in another part of this paper.

Effect of Pressure and Volume

Since the dissociation proceeds with a volume increase, pressure will act to reverse the reaction and shift the equilibrium to the left according to the Le Chatelier principle. Conversely, a reduced pressure favors the disintegration of the ammonia molecule. Now this action of pressure is not affected by the presence of inert gases (so long as the partial pressure of the ammonia in the gas mixture is unaltered), and tends to manifest itself whether the system is in equilibrium or not. Unfortunately, however, carbonization is generally carried out at pressures but slightly greater than atmospheric; hence we can look to no aid from this source to explain away our anomaly, and the pressure factor may be hereinafter neglected.

Effect of Inert Gases at Constant Volume

It is at once apparent from Dalton's law that dilution of the reaction mixture with indifferent gases at *constant volume* would have no effect upon the dissociation, since the partial pressures of the reacting components would not be so changed. But the introduction of steam and inert gases (such as are evolved during the carbonization) cannot be considered as taking place without a volume change, as this is accomplished at practically *constant pressure*, and the gas volume is thereby *increased*. This gives rise to the condition considered under the next head.

Effect of Inert Gases With Increase in Volume

From the principle mentioned above it would be logically supposed that dilution attended with an increase in volume would increase the dissociation. This is always the case where the decomposition is accompanied by a volume increase or where the products of the dissociation occupy a greater volume than the undissociated substance, since the dilution results in a lowering of the partial pressures of the components concerned in the reaction.

The mechanism of the diluting phenomenon will be clearer from a study of the following example. Assume an ammonia equilibrium within a constant thermodynamic environment, the temperature being that at which the gases are present in the molal concentrations given in equation 1 for ease in calculation, and the pressure being six atmospheres. According to the mass law there is a definite ratio at all times between the amounts of each component of this mixture, from which is obtained the dissociation constant K, or from equation 1,

$$\frac{[N_2][H_2]^3}{[NH_3]^2} = K; \tag{2}$$

where [ ] signify the volume concentration of the component in question. Since the concentrations of the constituents are proportional to their respective partial pressures, or to the number of mols present, equation 2 may also be written:

$$\frac{P_{N_2}(P_{H_2})^3}{(P_{NH_3})^2} = K_p = \frac{1\,(3)^3}{(2)^2} = 6.75. \tag{3}$$

Now assume a dilution to occur without a change in pressure, so that the volume is now two times the original. The partial pressures of the ammonia, hydrogen and nitrogen are consequently reduced to one-half their former values and the equation becomes:

$$\frac{0.5\,(1.5)^3}{(1)^2 X} = \frac{1.6875}{X} = 6.75. \tag{4}$$

Since K_p is a constant the value of X becomes ¼, which means that the equilibrium will shift until the concentration (and hence the partial pressure) of the ammonia becomes one-fourth of its original value. Thus the dissociation would have been increased fourfold by a dilution with an equal volume of an inert gas.

In spite of the above facts and the deductions therefrom it is known from practice that the yield of ammonia is increased by dilution instead of decreased, as would be expected. This is simply accounted for by the fact that part of the diluting gas is hydrogen, which is not inert, and that the mass law is valid only at equilibrium; and since the conditions that exist are far from such a state the law does not pretend to hold. However, the *tendency* toward dissociation of course exists, but is more than completely overcome by the relatively high velocity of the gases through the reaction zone, which, due to the slow rate of reaction to the right (in equation 1), causes the ammonia molecules to be removed before the predatory actions of temperature and dilution have had an opportunity to accomplish much of their evil work, and by the presence of much hydrogen, which operates against the decomposition.

Shifting the Equilibrium

Obviously, this is again an application of the mass law. If the concentrations of the nitrogen or hydrogen exceed those required by the equation, and the presence of an excess of one or both of these elements can be accounted for in ordinary carbonization practice, then we will have another part of our explanation for the conservation of the ammonia yield. The hydrogen has an especially potent action on the shifting of the equilibrium to the left, for, from equation 3, the amount of ammonia varies directly as the *cube* of the hydrogen partial pressure or concentration, assuming a constant thermodynamic environment. For example, increasing the partial pressure (at constant temperature) of the hydrogen from three to six in equation 3 causes a shift in the equilibrium until the ammonia concentra-

[4] *Z. Elektrochem.* (1910), p. 100.

[5] Lewes, Carbonization of Coal, p. 259.

[6] In an ordinary horizontal retort and without steam.

tion becomes *eight times* the original value, as the calculations demonstrate:

$$K_p = 6.75 = \frac{(1)\,(6)^3}{X(2)^2} = \frac{54}{X};\ \text{or}\ X = 8. \qquad (5)$$

Following the same reasoning, it is seen that the nitrogen will have less effect on the equilibrium, the ammonia varying directly with the nitrogen concentration. Here again it must be remembered that while the above phenomena occur to the extent shown only at equilibrium, the tendency is nevertheless in the direction indicated.

In order to apply the results of these observations to the retorting of oil shale or coal, the source of the nitrogen and hydrogen and their relative approximate concentrations must be determined. This must be accomplished for four different sets of conditions:

A. Retorting at low temperatures without steam.
B. Retorting at low temperatures with steam.
C. Retorting at high temperatures without steam.
D. Retorting at high temperatures with steam.

RETORTING AT LOW TEMPERATURES WITHOUT STEAM

Research on carbonization[7] has established the fact that at low temperatures (not above 500 deg. C.) ammonia is a primary decomposition product and is formed directly from the nitrogen compounds existing in the material distilled. Such being the case, the influence of an excess of ammonia decomposition products would result in the tendency to prevent the equilibrium from going toward the right, since the combination of hydrogen with nitrogen is very slow and the reaction to the left would therefore be practically *nil* under the conditions that obtain.

The ammonia in the gases from the low temperature carbonization (at about 500 deg. C.) of oil shales or coal seldom exceeds 5 per cent by volume.[8] The hydrogen in the coal gas, on the other hand, will vary between 25 and 30 per cent,[9] and in the oil-shale gases it will be between 20 and 25 per cent.[10] The percentage of nitrogen is quite low in good gas, and as it has relatively little effect on the decomposition it need hardly be considered. The predominance of hydrogen over ammonia at these temperatures is therefore apparent, as well as the result.

RETORTING AT LOW TEMPERATURES WITH STEAM

At the low temperatures here considered the dissociation of steam into its elements is almost zero, as Table II[11] shows.

Also, the amount of hydrogen produced from the ac-

TABLE II DISSOCIATION OF WATER VAPOR AT ATMOSPHERIC PRESSURE

Temperature, Deg. Abs.	Percentage Dissociation
1,000	0 00003
1,500	0 022
2,000	0 59
2,500	3 98

tion of steam on carbon is relatively small up to 500 deg. C.[12] Hence the steam can be considered here to act mainly as a mechanical agent which serves to prevent the decomposition of the ammonia by removing it from the zone of reaction and thus forestalling equilibrium. The hydrogen formed during the carbonization has, of course, the same action as in retorting at low temperatures without steam, but to a lesser degree, due to the lowering of its partial pressure by the steam. Any inert gas would have practically the same effect as the steam under these conditions.

RETORTING AT HIGH TEMPERATURES WITHOUT STEAM

The same general considerations governing retorting at low temperatures without steam hold at high temperatures of carbonization (about 800 to 900 deg. C.), except that the percentage of hydrogen in the gases is much greater, being usually from 45 to 55 per cent.[13] Hence its protective action will be much increased. But on the other hand, the destructive tendencies of the elevated temperature will also be more pronounced; yet its influence is mitigated by the slow velocity of reaction (equation 1) to the right. It is evident that the resultant of these two opposing forces could not be predicted with any precision because it is dependent, under the given conditions of temperature and pressure, mainly upon the velocity of the gases through the zone of reaction. So the problem would have to be worked out empirically for any given set of conditions.

In connection with the action of hydrogen on the yield of ammonia from coal at high temperatures, the work of Tervet[14] will be of interest. His experiments showed that a stream of hydrogen, introduced at red heat into a mass of coal from which the rich hydrocarbon gases had just been distilled, caused the formation of ammonia in considerable quantity. These experiments were carried out with charges of 100 g. of coal in a 4-in. iron tube, the temperatures running up to almost 1,000 deg. C. The higher the temperature and the greater the velocity of the hydrogen through the tube the greater was the amount of ammonia produced.

Tervet's explanation of the action of the hydrogen is that "the nitrogen existing in coke can be liberated in the form of ammonia, it being only necessary to bring the compound into a state of strain by subjecting it to the superior affinity which exists between the combined nitrogen in the coke and the free hydrogen at a particular temperature and in a predominating atmosphere, which shall prevent it from subsequent decomposition." Tervet made experiments with other gases also, and found that nitrogen, methane and carbon dioxide had no action, and carbon monoxide very little, but that coke which had been submitted for hours to the action of these gases, which had failed to wash out any trace of ammonia, directly a stream of hydrogen was passed through it yielded ammonia in abundance.

If any ammonia had been produced during the carbonization at these high temperatures as a *primary* decomposition product, then some of it should have been found in all the wash gases, at least at high velocities through the tube. Its absence permits only one conclusion that the ammonia was synthesized from the nitrogen in the coke and the hydrogen, the presence of the enormous excess of the latter preventing the reversal of the ammonia reaction toward the right and increasing the velocity of the reaction to the left. The mechanism of this phenomenon will be elucidated later.

RETORTING AT HIGH TEMPERATURES WITH STEAM

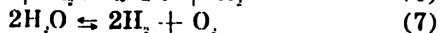
The use of steam during high-temperature carbonization introduces a number of complications, since it can no longer be assumed to be inert. Under the condi-

[7] Lewes, Carbonization of Coal, p. 254.
[8] *Ibid.*, p. 255.
[9] *Ibid.*, p. 255.
[10] From analyses by the author.
[11] Nernst, Theoretische Chemie, 6 Aufl., p. 681.
[12] Luggin, *J. Gasbel. u. Wasserversorg.*, vol. 41, p. 713 (1898).
[13] Lewes, Carbonization of Coal, p. 163.
[14] *J. Soc. Chem. Ind.*, vol. 2, p. 445 (1883).

tions that obtain we have to deal with the system C, H_2O, CO, CO_2, H_2, and hydrocarbon vapors, in addition to the system represented by the ammonia equilibrium. The reactions and possible side reactions involved are quite numerous:



$$C + H_2O \rightleftarrows CO + H_2 \quad (6)$$



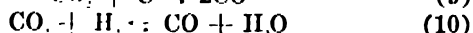
$$2H_2O \rightleftarrows 2H_2 + O_2 \quad (7)$$



$$C + O_2 \rightarrow CO_2 \quad (8)$$



$$CO_2 + C \rightleftarrows 2CO \quad (9)$$



$$CO_2 + H_2 \rightleftarrows CO + H_2O \quad (10)$$



$$2CO_2 \rightleftarrows 2CO + O_2 \quad (11)$$

The main reaction is represented by equation 6, but the others also occur to a greater or less extent, depending upon the thermodynamic environment. The oxygen is not included in the system, because it is always in combination with either the hydrogen or carbon; and the extent to which it combines with one or the other depends also entirely upon the thermodynamic environment.

The reason for introducing the above equations into our considerations is that they must all be studied in order to ascertain the amount of free hydrogen which may be expected to be present in the system under a given set of conditions, since this seems to be the primary factor in determining the progress of the ammonia decomposition and association reactions. As the hydrocarbon vapors are practically all evolved during the first part of the carbonization when the temperature of the material being distilled is low, they may be dropped from the system at this point. The carbon dioxide and excess of undecomposed steam have no action, and the carbon monoxide practically none, on the formation of ammonia, but act merely as diluents and mechanical agents for removing the ammonia molecules from the zone of reaction before decomposition can make material progress. Only the hydrogen is left then for consideration here.

At high temperatures hydrogen has the effect noted in retorting at high temperatures without steam, but to a much greater degree due to the increased amount present, and also the synthetic action studied by Tervet.[15] An idea of the amount of hydrogen formed by the action of steam on coke at various temperatures may be obtained from Table III.[16]

The amounts of the various gases are expressed in volume per cents, and the velocity, V, in liters per second.

It is evident from the table that at high temperatures the steam is almost entirely decomposed by the carbon according to equation 6, and that the side reactions occur only to a negligible degree. The high percentages of hydrogen are also to be noted. During the earlier part of the carbonization hydrogen is also produced in considerable amounts, and its action at that stage would be mainly in the direction of depressing the decomposition of the ammonia. As the temperature of the mass of coal or oil shale rises, more and more hydrogen is produced from the steam, and the Tervet reaction begins, it being more and more prominent as the amount of hydrogen and the temperature increase. Here again the high velocity of the gases through the retort and the great excess of hydrogen produced from the use of steam, together with the slow rate of decomposition of ammonia, account for its integrity on the one hand and its partial synthesis on the other.

TABLE III. CARBON WATER REACTION AT VARIOUS TEMPERATURES

Temp., Deg. C.	H_2	CO	CO_2	H_2O	V
674	8.4	0.6	3.8	87.1	0.9
758	22.3	2.7	9.2	65.8	1.8
838	28.7	6.0	11.3	54.1	3.7
838	32.8	8.0	12.1	47.2	3.3
861	36.5	11.0	13.3	39.2	5.3
954	44.4	32.7	5.7	17.2	6.3
1,010	47.3	48.2	1.5	3.0	6.2
1,060	48.8	46.3	1.3	3.7	9.8
1,125	50.7	48.3	0.6	0.3	11.3

Rate of Reaction Proportional to Product of Decomposition Products

Experiments show that in gaseous systems within a constant thermodynamic environment the rate of a chemical reaction is proportional to the product of the concentrations of the reacting molecular species, each concentration being raised to a power equal to the number of molecules of the corresponding molecular species entering into the reaction, as indicated by the equation expressing the reaction *as it actually occurs.* This is Guldberg and Waage's law[17] of chemical mass action as applied to rates of reaction. Where the reaction is reversible, as is the case with ammonia, then the *resultant* reaction rate at any time is the algebraic difference between the two opposing rates, the sign being considered positive when this difference is in the direction of combination, and negative when toward dissociation. These facts may be represented very clearly by the use of the calculus in the following equations:

$$-\frac{d[NH_3]}{dt} = K[NH_3]^2 \quad (12)$$

$$-\frac{d[H_2]}{dt} = \frac{d[N_2]}{dt} = k[H_2]^3[N_2] \quad (13)$$

$$\frac{d_r[NH_3]}{dt} = \frac{d[NH_3]}{dt} + \frac{d[H_2]}{dt} = K[NH_3]^2 - k[H_2]^3[N_2] \quad (14)$$

Here the square brackets represent the concentrations at the time t of the molecular species in question, expressed as equivalents per liter. The derivative of any concentration with respect to the time represents, of course, the rate of change of that particular concentration, and as the concentration progressively diminishes during a decomposition the sign of the differential is negative. However, as soon as the rate of combination exceeds that of decomposition, the sign changes to positive. This is evident from equation 14, which expresses the *resultant* rate of reaction.

A study of this equation also renders obvious the fact that an increase in the concentration of the hydrogen should cause a tremendous increase in the reaction rate (and this in the positive direction) since it is proportional to the cube of the hydrogen concentration, and that the rate of the decomposition[18] (or the reaction in the negative direction) will be comparatively very small because the concentration of the ammonia in the gases is exceedingly low, being less than 2 and usually not over 1 per cent by volume in carbonization at high temperatures with a liberal use of steam. Thus the net result, or the *resultant positive rate of reaction,* should be relatively high. These considerations furnish the most plausible explanation for the Tervet reaction and the production of additional ammonia by the use

[15] *Loc. cit.*

[16] Laggin, *J. Gasbel. u. Wasserversorg.*, vol. 41, p. 713 (1898).

[17] Nernst, Theoretical Chemistry, or any text on physical chemistry.

[18] See p. 1,149.

of steam during carbonization, when taken in connection with the high velocities of the gases through the zone of reaction and the natural slow rate of decomposition of the ammonia molecule.

CATALYTIC ACTION

Mention has already been made of the fact that the decomposition of ammonia into its elements is very slow, as is often the case with endothermic reactions. This has been shown experimentally by Perman and Atkinson,[19] and by Bodenstein and Kranendieck,[20] who have investigated the rate of isothermal dissociation at different temperatures and found that the rate of reaction is greatly affected by catalysts, which both accelerate the decomposition and lower the temperature of dissociation. It is the opinion of Bodenstein and Kranendieck that the reaction goes on entirely in the surface of the containing vessel, and not in the gaseous phase. The conclusions of Ramsay and Young[21] point in the same direction.

Table IV shows Bodenstein and Kranendieck's[22] determinations of the rate of decomposition of ammonia in a quartz tube at 780 and 880 deg. C. and at different initial pressures, by the manometric method. The

TABLE IV. RATE OF DECOMPOSITION OF AMMONIA

	Temperature, 780 Deg.				Temperature, 880 Deg.			
	P_1 = 145 6		P_1 235.6		P_1 = 225.5		P_1 = 614 6	
Time	(N_2 + $3H_2$)	dx/dt	(N_2 + $3H_2$)	dx/dt	(N_2 + $3H_2$)	dx/dt	(N_2 + $3H_2$)	dx/dt
0	00 0	0 0	00 0	0 0	00 0	0 0	00 0	0 0
5	46 4	4 65	48 8	4 95	60 0	6 0	100 0	10 0
10	69 6	2.30	81 0	3 20	115 1	5 4	197 9	9.8
15	84 4	1 48	102 2	2 12	...	.	283 0	8 4
20	94 3	1 00	119 9	1 78	196 7	4 0	352 8	7.0
25	103 1	0 84	133 4	1 36	....	....	....	..
30	....		144 7	1 14	255 7	3 0	464 3	5 6
40	121 0	0 61	164 8	1 00	292 4	1 9	540 5	3 9
50	129 6	0 44	180 7	0 80	316 8	1 2	596 3	2 8
60	136 7	0 36			...	..	641 5	2 3
70	143 4	0 34	204 4	0 60	....	.	681 4	2 1
80	...	..	212 1	0 39	..	..	721 0	2.0
90	....			.	.....	.	746 0	1 3
100	157 1	0 25	226 4	0 36	.	.	769 4	1.2
120	.....	. .	241 4	0 36	...	...	...	....
125	.....	....	....	...	386 8	0 40	....	....

greater rates obtained with the higher initial ammonia concentrations are noticeable at the lower, and very marked at the higher temperature, as would be predicted from the mass law.

The time expressed in minutes and the amount of $N_2 + 3H_2$ formed is expressed in mm. P_1 is the initial pressure in mm. of the ammonia at the beginning of the experiment, and dx/dt represents the rate of change in the ammonia concentration, or the rate of decomposition.

Analogous results were obtained by Perman and Atkinson,[23] who studied the dissociation in a porcelain vessel at temperatures from 677 to 1,111 deg. C. They showed, however, that a thin deposit of platinum black on the surface of the vessel caused a marked increase in the rate of decomposition, as well as a lowering in the temperature of decomposition. Iron had also a pronounced effect. In the absence of catalysts and at high temperature the reaction is shown to proceed as one of the first order, or



$$NH_3 \rightarrow N + 3H$$

The union of the atoms to form molecules is probably so quick that it is negligible when compared with the rate of decomposition of the ammonia molecule. This is similar to the decomposition of phosphine,[24] which has recently been shown to be a monomolecular reaction. The experiments at lower temperatures (about 800 deg.) as well as Bodenstein and Kranendieck's[25] work at these temperatures furnish definite evidence that the reaction is of neither the first nor the second order, since the values for the dissociation constant fluctuate too widely from that of a true constant. But this is to be expected when it is recalled that the walls of the retaining vessel exert a catalytic action on the dissociation rate. The curves of Perman and Atkinson[26] illustrate this point beautifully.

Bodenstein and Kranendieck[27] investigated also the rate of decomposition of ammonia in the presence of an almost equal concentration of its dissociation products. The results of this work indicate that the concentration of the ammonia in the mixture is of greater importance than that of the hydrogen and nitrogen, the decomposition rate being faster with higher ammonia concentrations, as would be predicted from the mass law. The hydrogen and nitrogen do not have the effect which would be expected. However, the deviations from the theory are quite satisfactorily explained in their paper on the basis of catalytic action, and need not be considered here.

In substantiation of the deductions already drawn from the works of a number of capable investigators, and the applications made thereof, the conclusions from the experiments of Ramsay and Young[28] on the decomposition of ammonia may be briefly reviewed. They point out that this decomposition begins at about 500 deg. C., but is very small at that temperature, and that the magnitude of the dissociation depends not so much upon the degree of heat as it does upon the rate of gas flow through the reaction zone and the nature and extent of surface with which the gases come in contact during their passage through this zone. These experimental facts, formerly opaque and obtained at a time when much of our present theory and knowledge was lacking, can now be applied to carbonization practice through the medium of our more recent knowledge of gas kinetics. The demonstration of this harmony between theory and practice is ever gratifying.

SLOW DISSOCIATION RATE

Application of the principles discussed herein to the explanation of the action of steam and inert gases on the ammonia yield during carbonization leads to the general deductions that at low temperatures the steam and gases act both to prevent dissociation of the NH_3 molecules by their presence and to remove them mechanically before material decomposition occurs. At high temperatures steam has also a synthetic action due to the production of large quantities of nascent hydrogen through its reaction with the hot coke and the union with some of the nitrogen contained therein to form new ammonia. The low percentage of this substance and the high per cent of hydrogen in the gases operate to quicken the rate of reaction to the left (equation 1) and, what is of more importance, to depress the rate of decomposition, which has been shown to be very slow. Although the depressing effect of the

[19] *Proc. Roy. Soc. London*, vol. 74, p. 110 (1904).
[20] Nernst-Festschrift, p. 99 (1912).
[21] *J. Chem. Soc.*, vol. 45, p. 88 (1884).
[22] Nernst-Festschrift, p. 113.
[23] *Loc. cit.*
[24] M. Trautz and D. S. Bhandarkar, *Z. [illegible]g. Chem.*, vol. 106, p. 95 (1919).
[25] *Loc. cit.*
[26] *Proc. Roy. Soc.*, vol. 74, p. 115.
[27] *Loc. cit.*
[28] *Loc. cit.*

hydrogen on the dissociation does not appear to be as great in the few cited cases as would be expected from theoretical considerations, its influence must be felt, since it is present in the gas mixture in amounts twenty-five to fifty times greater than that of ammonia. However, the very slow dissociation rate to the right (equation 1) is the real key to our exposition.

In concluding what may sometimes appear as unnecessarily detailed as well as irrelevant considerations, the author takes the further liberty of emphasizing a few general facts. In dealing with systems that contain such hosts of variables as do the present ones it must be remembered that any knowledge, however remote, which sheds even a tiny ray of light upon the subject is to be accepted gratefully and applied judiciously. There is no doubt that precise results could never be obtained for such cases as those discussed herein except by purely empirical experimentation with a given set of rigid conditions; nor does this paper make any attempt in this direction. The purpose is rather to assemble our pertinent knowledge with the view of arriving at certain definite generalizations and applying these to the elucidation and orientation of what before was to many a confusion of diverse and vacuous facts. If even a partial fulfillment of this purpose obtains, then the author will indeed be satisfied.

SUMMARY

The various factors and general laws that affect the ammonia equilibrium have been pointed out and each discussed in detail in connection with the experiments and conclusions of previous investigators.

The information so obtained has been applied to the exposition of the action of steam and inert gases on the yield of ammonia from the carbonization of oil shales and coal.

The integrity of the ammonia molecule at high temperatures and under the other conditions that obtain in retorting is explained by its very slow rate of dissociation, and the remoteness from equilibrium, a condition which is brought about by the presence of steam and inert gases, these removing the ammonia before decomposition can make any marked headway.

The steam is shown to have a synthetic action at high temperatures, and the *modus operandi* of the synthesis of ammonia from the nitrogen contained in the coke is elucidated.

The author takes this opportunity to express his profound gratitude to Dr. S. C. Lind for his many valuable suggestions and criticisms, and for his kindly aid which was always so gladly given.

Colorado School of Mines
Golden, Col

Production of Yacca Gum in South Australia

Prior to the war the gathering and shipping abroad of South Australian yacca gum was an important industry on Kangaroo Island, just off the south coast of South Australia, reports Consul H. P. Starrett, of Adelaide. As Germany was the largest user of this product, the industry was suspended during the first years of the war, and not until use had been found for it in the United Kingdom and in America during the latter part of 1916 did the production revive. In 1919 more than 10,000 tons was gathered, and as the Australian consumption is small the greater part of the output was shipped to Great Britain and to the United States. It is believed that further experiments in the use of this valuable product may develop a larger scope for its utilization and thus encourage the expansion of the industry at Kangaroo Island.

Uses Chemical Reactions

Before the war nearly two-thirds of the Australian output was bought by German firms. Local dealers have never been able to discover what use the Germans put it to, but it is believed that it was used in the manufacture of furniture polish and lacquer for metal ware. It should not be overlooked, however, that the product contains a high percentage of picric acid on nitration and it is not unlikely that it was also used by the Germans in the manufacture of explosives—a use to which it was put by the Allies in 1917 and 1918.

The gum from the species *Xanthorrhoea hastilis* is, of course, one of the oldest known sources of picric acid, yielding about 15 per cent by treating the gum with strong nitric acid. The gum has also been used in the manufacture of dyes. To quote a technical report on the subject: "The high yield of picric acid on nitration and of paraoxybenzoic on alkaline fusion indicates a chemical constitution for the resin of an oxygenated benzene derivative, and among such derivatives are numerous fine chemicals in daily use—viz., photographic developers and material used in the preparation of synthetic dyestuffs. The resin is also said to be of considerable importance in the manufacture of linoleum."

Experiments have shown that the gum is soluble in alcohol but insoluble in turpentine, linseed oil, benzene, molten paraffine, and hydrocarbon solvents generally. It dissolves readily in aqueous solutions of caustic alkalis to deep red solutions and, on the addition of acids, is reprecipitated more or less completely as a flocculent dull yellow precipitate. The gum is partly soluble in cold strong sulphuric acid to a deep red solution; on dilution of the sulphuric acid solution and cleaning, the brownish red solid separates. When filtered and freed from the sulphuric acid, this solid dissolves in water and is reprecipitated from its aqueous solution by the addition of a little sulphuric acid.

Destinations of Exports

The following table shows the amounts and values of the exports of yacca gum from the State of South Australia for the calendar year 1913 and the fiscal years (ended March 31) 1917-18 and 1918-19. The values have been reduced to American currency at the rate of $4 to the pound sterling:

	1913		1917-18		1918-19	
Destination	Hundredweight	Value	Hundredweight	Value	Hundredweight	Value
United Kingdom	5,234	$5,536	5,603	$12,648	7,022	$9,836
United States	600	600	2,004	2,404	651	848
Germany	14,100	12,484	....	....	.	....
France	1,212	1,540	....	....		
Belgium	392	360	..	..	..	..
Netherlands	105	88				..
Total	21,643	$20,608	7,607	$15,052	7,673	$ 0,684

The exports of yacca gum to the United States as declared at the consular office during the calendar years 1917, 1918 and 1919 were as follows: 1917, 2,979 hundredweight, valued at $4,977; 1918, none; and 1919, 7,600 hundredweight, valued at $37,970.

The market price in the city for yacca gum varies from $36 to $44 per long ton. Freight, insurance and handling charges amount to about $48 per long ton.

Adsorption by Silica Gel* —I

Basic Facts and Observations on Adsorption of Vapors by Silica Gel—Partial Vapor Pressure and Liquid Volume Relationships in Capillary Equilibriums at Different Temperatures—Data on Sulphur Dioxide

By E. B. MILLER

THE adsorption of vapors by certain porous bodies such as charcoal, kieselguhr, etc., has long been a matter of common knowledge. It was soon found that the retention by such adsorbents was not related to the chemical composition of the substance adsorbed, but was in some way connected with the ease of condensation of the adsorbed vapor. A rough parallelism was noted between adsorption and the boiling point of the vapor when condensed to a liquid.

Much of the uncertainty and inaccuracy of the early adsorption work was due to the difficulty of preparing adsorbents of constant properties. When it was found that adsorbents could be prepared from certain colloidal solutions in an easily reproducible manner it then became possible to study the phenomenon of adsorption with some degree of certainty. Furthermore, when it was found that these latter adsorbents possessed the power of adsorption equal if not superior to that exhibited by adsorbent charcoal the experimental study was made comparatively simple.

Silica gel, prepared from the coagulation of a colloidal solution of silicic acid, is such an adsorbent, and in many respects is an ideal substance for the study of adsorption. It is easily made under conditions that may be reproduced with considerable exactness. It is prepared from inexpensive raw materials, water glass, and either hydrochloric or sulphuric acid. Chemically, it is most inert and is therefore stable in air even at high temperatures.

The adsorption of a number of vapors by silica gel has been studied at different temperatures.

From the results of such experiments it has been possible to discover the factors that are of importance in determining the extent of adsorption.

Adsorption Dependent on Vapor Pressure

It was found that vapors of liquids of a high boiling point were more strongly adsorbed than vapors from a liquid of a low boiling point. Furthermore, adsorption decreased with increasing temperatures. Also, the greater the partial pressure of vapor being adsorbed the greater was the extent of the adsorption. All these facts suggested the idea of condensation of the vapor in the adsorbent. Pursuing this thought, we selected as a measure of the ease of condensation the ratio of the pressure of the vapor in equilibrium with the adsorbent to the vapor pressure of the liquid at the temperature of adsorption. This ratio is herein designated as the "corresponding" pressure. It was soon established that vapors of high corresponding pressure were more strongly adsorbed than those of lower corresponding pressure. The relationship, while qualitatively true, did not correctly represent the phenomena quantitatively.

It was then noted that when the corresponding pressure equaled unity—i.e., when adsorption was measured at the vapor pressure of the liquid, the volumes of the adsorbed liquid were in all cases the same. In other words, it is advantageous, inasmuch as it tends toward simplicity, to express adsorption in terms of volume of adsorbed liquid rather than in weight. The volume of adsorbed liquid was obtained by dividing the weight of the substance adsorbed by the density of the liquid at the temperature of adsorption.

This simple relationship was found to be true only in the case of measurements carried out at a corresponding pressure of unity. At lower corresponding pressures the volume of the adsorbed liquid was not the same at the same corresponding pressure. This discrepancy was attributed to the fact that the condensed liquid under corresponding pressures less than unity had a density smaller than the normal density. Furthermore, the greater the compressibility of the liquid the greater was the deviation of the density of the liquid in the adsorbent from the normal density. By taking these additional facts into consideration all of our experimental observations were quantitatively brought into complete harmony. We are therefore in position to say that the factors influencing adsorption are the corresponding pressure, and the compressibility of the adsorbed liquid.

We have yet to consider the properties of the adsorbent that determine its activity. Inasmuch as the chemical nature of the latter apparently is of no moment, we are forced again to a consideration of a physical property. All adsorbents are porous, and the internal volume is large and composed of exceedingly fine pores. Furthermore, capillarity tells us that a liquid in a small tube possesses a lower vapor pressure than the normal vapor pressure. In other words, it is easier to condense a vapor into a small capillary than on to a level surface. We have therefore in the above all that is necessary to characterize an adsorbent. It must possess as large an internal volume as possible and this volume must be made up of spaces of minimum dimension.

Partial Pressure

When we consider silica gel as an adsorbent for the vapor of a liquid at a given temperature, we have to take into account two things: (1) the partial pressure or concentration of the vapor to be adsorbed; and (2) its vapor pressure at the temperature of adsorption. Denoting the partial pressure by P and the vapor pressure by Po, we may define the "corresponding pressure" by the quotient $\frac{P}{Po}$. It has been found experimentally that the amount of a particular vapor adsorbed increases with increasing value of the ratio $\frac{P}{Po}$. Now for

*Paper presented before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

a given partial pressure, the value of $\frac{P}{Po}$ increases with decreasing temperature, and for a given temperature, the ratio $\frac{P}{Po}$ increases with the increase of partial pressure. Hence in practice, we have better adsorption the lower the temperature and the greater the concentration of the vapor to be adsorbed. Maximum adsorption, at a given temperature, will take place when $\frac{P}{Po}$ has its maximum value, which is unity.

Let us consider a few examples. We may adsorb water vapor at 30 deg. C. from air saturated at 30 deg. C. Under these conditions, $P = Po$ — 30 mm., and the gel will take up an amount of water corresponding to 25 to 27 per cent of its own weight.

If we consider a similar mixture of sulphur dioxide and air at 30 deg. C.—that is, a mixture in which the partial pressure of sulphur dioxide is 30 mm. (which corresponds to about 4 per cent by volume)—the ratio $\frac{P}{Po}$ is much smaller than in the case of water, due to the greater vapor pressure of sulphur dioxide. From such a mixture the gel takes up sulphur dioxide to about 6 per cent of its own weight.

If we use a mixture of carbon dioxide and air of the same concentration as above, the value of $\frac{P}{Po}$ at 30 deg. C. is quite small and only a slight amount of carbon dioxide will be adsorbed.

Temperature and Concentration Effect

From a mixture of sulphur dioxide and air containing 4 per cent by volume of sulphur dioxide (partial pressure about 30 mm.), the gel takes up 3, 6, 8.2 and 11.1 per cent sulphur dioxide by weight at 40, 30, 20 and 10 deg. C., respectively. The effect of concentration may be illustrated by the following: Working at 30 deg. C., the gel takes up 2.3, 6, 7.1 and 8 per cent by weight of sulphur dioxide from mixtures containing 1, 4, 6 and 8 per cent, respectively.

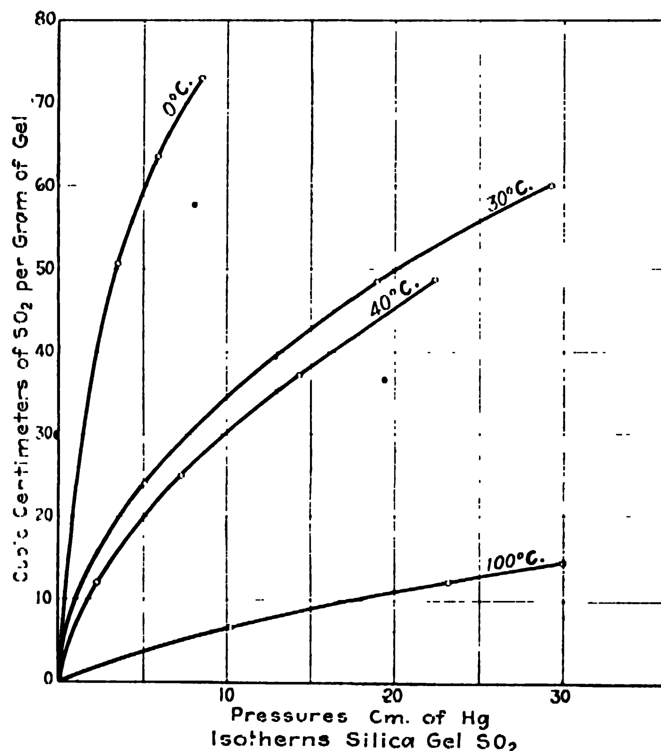


FIG. 1. ADSORPTION OF SO_2 IN C.C. AT 0, 30, 40 AND 100 DEG. C.

Inasmuch as the adsorptive power of silica gel does not depend upon any specific chemical action, but rather upon the physical properties of the vapor to be adsorbed, it may be used successfully at ordinary temperatures and atmospheric pressure to remove from air the vapors of any liquid mixed with air in any proportions, provided the liquid boils, under atmospheric pressure, above –10 deg. C. We must exclude, of course, any vapor which like hydrofluoric acid attacks silica.

From what has been said it will be obvious that lower boiling liquids may also be adsorbed, but it would hardly be practicable to do so efficiently at the ordinary temperature. The so-called permanent gases may be adsorbed at temperatures below their critical points, in their vapor phases, and it is quite likely that such a

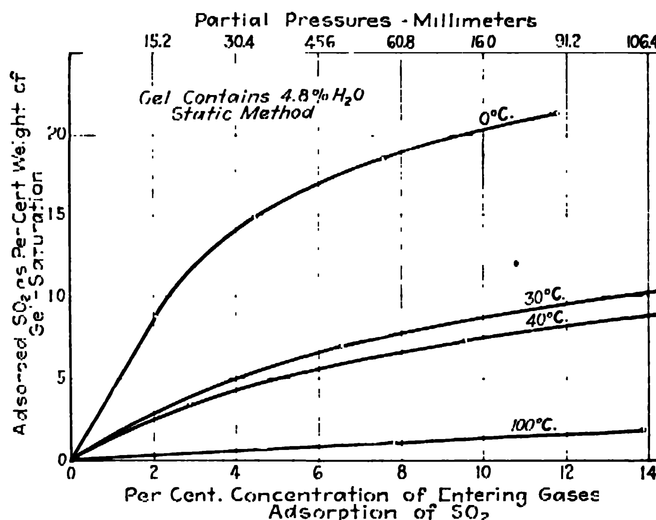


FIG. 2. ADSORPTION OF SO_2 IN PER CENT OF GEL WEIGHT

problem as the fractionation of liquid air into oxygen and nitrogen would be made easier by the use of silica gel.

From what was said above in the discussion of corresponding pressure the obvious procedure to follow in order to recover the adsorbed material consists in two steps: (1) raise the temperature, and (2) decrease the partial pressure of the vapor over the gel by evacuation or by displacement with air, steam or other gas or vapor.

Thus adsorbed water may be driven out by air at 115 deg. C., more rapidly at 125 deg. C., and still more rapidly at 150 deg. C. High boiling liquids may be adsorbed without difficulty, but require a correspondingly high temperature for recovery from the gel. Silica gel is almost ideally adapted to the adsorption and recovery of the vapors of liquids boiling between 30 and 150 deg. C. in that it takes up large quantities of these vapors at room temperature and gives them up readily at slightly elevated temperatures—that is, from 100 to 200 deg. C. This classification includes most of the important solvents, such as ether, acetone, methyl and ethyl alcohol, benzene, gasoline, methyl and ethyl acetates, and many others.

We shall see also that it offers a satisfactory means for drying air and for the recovery and concentration of the vapors of more volatile liquids such as sulphur dioxide.

A more detailed discussion of the theory of adsorp-

tion as applied to sulphur dioxide may be found in an article by John McGavack, Jr., and W. A. Patrick, in the *Journal* of the American Chemical Society, vol. 42, p. 946 (May, 1920).

Laboratory Results

Experimental results obtained on the laboratory scale, on the adsorption and recovery of sulphur dioxide, boiling point at —8 deg. C.; ether, +35 deg. C.; acetone, +56 deg. C.; benzene, +80 deg. C.; water, +100 deg. C., and gasoline will be discussed in the order named.

Sulphur Dioxide

The adsorption of sulphur dioxide by silica gel has been thoroughly studied both by the static and dynamic methods.

The static method consists in placing a convenient amount of the gel in a small apparatus which is then exhausted to the highest vacuum obtainable. To insure complete removal of air the vessel is heated to 300 deg. C., and this temperature maintained, with the pump in continuous operation, for six hours, or until no more air can be pumped off. The pump used is the Gaeda high vacuum mercury pump. The vessel containing gel is then placed in a thermostat and a known amount of sulphur dioxide introduced. After the system has come to equilibrum, which requires not over fifteen minutes, the pressure is observed and the quantity of sulphur dioxide adsorbed determined. Fig. 1 gives the results of four series of results obtained in this way at 0, 30, 40, and 100 deg. C. respectively. Fig 2 gives a recalculation of these results in which the ordinates express the adsorbed sulphur dioxide as per cent of gel weight instead of cubic centimeters per gram of gel.

The dynamic method consists in placing a convenient quantity of granular gel, usually 10 g., in a glass tube of 1 to 2 sq.cm. in section bent in the form of a U for convenience of immersion in the thermostat, and passing through the gel at a given temperature a definite mixture of sulphur dioxide and air. The air and sulphur dioxide are metered separately through carefully calibrated flowmeters similar to those used by the Chemical Warfare Service, passing first into a

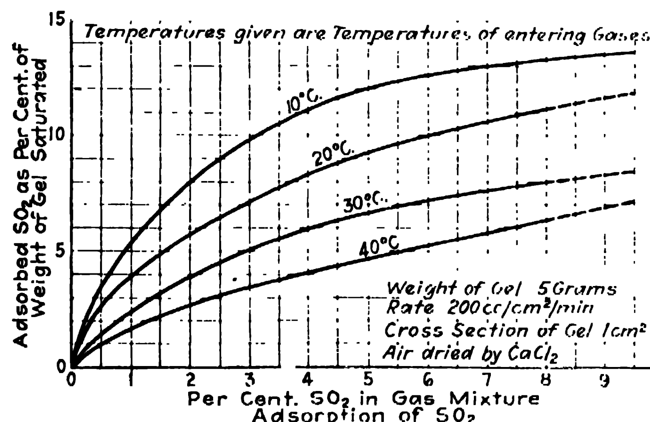


FIG. 3. ADSORPTION IN PER CENT OF SATURATED GEL WEIGHT

mixing chamber and thence over the gel. Under these conditions the gel adsorbs the sulphur dioxide completely for a certain period. At the end of this period a trace of gas begins to come through, the percentage of sulphur dioxide in the exit gas increasing rapidly, becoming finally equal to that of the entering gas. This corresponds to the point of saturation for this particular mixture and temperature. The results of a series of experiments in which the concentration of the sulphur dioxide-air mixture varied from 0.5 to 8 per cent by volume and the temperature varied from 10 to 40 deg. C. are given in Fig. 3. A comparison of Figs. 2 and 3 shows substantial agreement between the results given by the two methods. In other words, the presence of gas has, for practical purposes, a negligible effect upon the adsorption of sulphur dioxide vapor by silica gel.

The details of one set of experiments (at 20 deg. C.) are shown in Fig. 4, in which the results are shown as percentage efficiencies against time. The ordinates here express the sulphur dioxide adsorbed as percentage of the total being admitted to the gel. With regard to these experiments we desire to make the following comments.

The rate of flow of gas through the gel was 40 c.c. per minute per gram of gel, or 0.65 cu.ft. per minute per pound of gel. This means that the time of contact

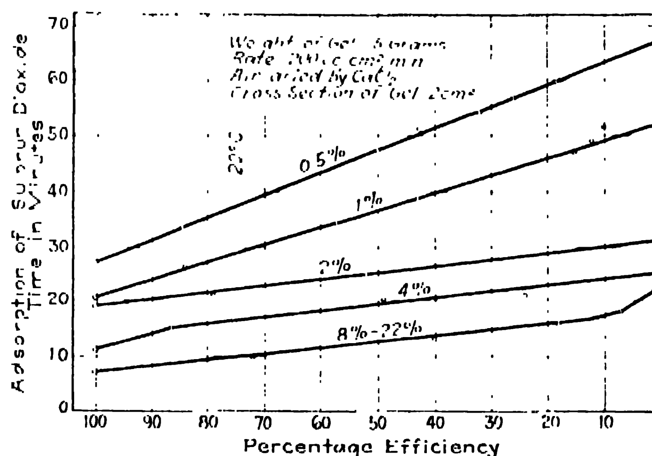


FIG. 4. PERCENTAGE ADSORPTION EFFICIENCY

of gas with gel was approximately 0.8 second. Notwithstanding this short interval allowed for adsorption, in each run no detectable trace of sulphur dioxide passed the gel for a considerable period. In other words, we had 100 per cent adsorption for a certain period, depending upon the concentration, after which the efficiency curve falls off abruptly to zero adsorption. We denote the time at which the first trace of sulphur dioxide comes through as the "break point." An examination of the curves at 20 deg. C. will show that for all concentrations the gel was not less than 57 per cent saturated at the break point.

As already stated the rate used in these experiments was 40 c.c. per minute per gram of gel, which allows about 0.8 second for contact. If necessary, higher rates may be employed.

Fig. 5 shows that for a 0.75 per cent vapor the slopes of the efficiency curves are very nearly the same for rates ranging from 25 to 75 c.c. per minute per gram of gel. A practical rate for adsorption in general is 50 c.c. per minute per gram of gel, which is approximately 0.8 cu.ft. per minute per pound of gel. This allows about 0.6 second for contact.

The gel granules used in all these experiments varied in size between 8 and 14 mesh. The size of the gel particles has a very practical bearing in two respects. In the first place, it is obvious that the larger the particles the greater the time necessary for the adsorbed material to penetrate to the interior and that, for ad-

sorption purposes, it would be desirable to reduce the size of particles as much as practicable. The final saturation value would not be changed, but the break point would occur later and the latter part of the efficiency curve would be steeper, which is advantageous. Clearly, however, for the type of absorber being considered, there is a practical limit to the size of particles that may be employed, for it is obvious that the smaller the size the greater will be the pressure required to force the gases through the gel bed. Resistance to gas flow will be discussed further under "Experimental Plant Results" in Part III.

Recovery

With respect to the recovery of adsorbed material, silica gel has marked advantages over other adsorbents. By reference to the curves already given it will be seen that the gel takes up very little sulphur dioxide at 100 deg. C., even with high concentration. These curves indicate the obvious procedure to follow in using the gel. Adsorption should take place at as low a temperature as is practical, and for recovery the whole should be heated to 100 deg. C. or more. The exact procedure to be used depends upon the concentration of sulphur dioxide desired.

Let us assume, for example, that we have a gas which is 4 per cent sulphur dioxide by volume, and that we

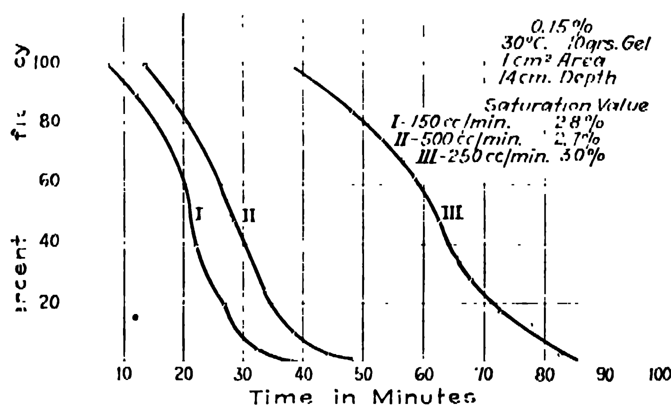


FIG. 5. COMPARISON OF EFFICIENCIES

wish to concentrate this to 8 per cent for use in the lead chamber process for making sulphuric acid. And let us assume an adsorption temperature of 30 deg. C. We see from the curves that using a 4 per cent vapor and working at this temperature, the gel will take up 6 per cent of its own weight of sulphur dioxide. After adsorption the temperature is raised to 100 deg. C. and the sulphur dioxide swept out by means of an air stream, the volume of air being so regulated to give the desired concentration. We may, if it is so desired, obtain in this way a much higher concentration than 8 per cent. It is possible to go from 4 to 30 per cent in one step by simple air displacement at atmospheric pressure. It is easily possible in this way to concentrate as lean a gas as 1 per cent to 8 per cent in one step.

If the object is to obtain high percentage, as for example in making liquid sulphur dioxide, air would not be used, but the adsorbed SO_2 liberated at 100 deg. C. or above, by evacuation. By proper regulation of temperature, pressure and volume of air admitted any desired concentration up to practically 100 per cent may be obtained.

Parts II and III will be published in subsequent issues.

Diatomaceous Earth

By Norris Goodwin

The last five or six years have witnessed a great awakening among the industrial minds of this country to the value of the so-called industrial minerals. Chief among these in variety of uses if not on actual volume of production is diatomaceous earth, or kieselguhr. The history of this material may be traced back to the sixth century A.D., when its use in the manufacture of lightweight fireproof brick and building material was certainly understood. Its use, however, passed into a long period of darkness, along with so many other useful arts known to the ancients, that have been brought back to the service of mankind in only comparatively recent times.

The immediate cause for the introduction of the material to modern trade seems to have been the rapid growth of the use of high-pressure steam for power and heat during the early part of the nineteenth century. The conveying of high-pressure steam to any distance from its point of origin made the use of some form of insulation essential, and the credit for adapting kieselguhr to this purpose appears to belong to the Germans, who about 1860 began to mine it near Luneberg, Hanover, and to market it as a steam pipe covering. So valuable a material could not be ignored in other lines, however, and its uses have gradually spread until today over one hundred and fifty separate and distinct uses for it could be enumerated.

Origin of Diatomaceous Earth

The material as it is quarried looks very much like chalk, and in fact it may supplant that material in the manufacture of blackboard crayons. Strictly speaking, it is composed of the siliceous skeletons of countless millions of diatomacea or infusoria of both fresh water and marine origin. So small are these skeletons that one cubic inch of the earth may contain fifty or seventy-five million skeletons. Microscopists have classified many thousand varieties of these dainty fossils; in fact they will remain one of the most fascinating fields of microscopic research.

Much interest attaches to large deposits of diatomaceous material, particularly in the West, by reason of its proximity to the known oil fields. In fact there seems little question that it is the primary source of the asphaltic petroleum of these regions. The theory is that by a process of decomposition under the influence of heat and pressure the bodies that originally inhabited these skeletons have been converted into the hydrocarbons comprising petroleum. So porous are the beds left behind that they would offer but little resistance to the displacement, by water or gravity, of the oil to the nearby strata. Strength is given to these conclusions by the presence in German kieselguhr of as high as 40 per cent of organic matter much resembling petroleum.

From a commercial standpoint the value of the material depends on the nature of its silica content and on the shape of the individual skeletons.

Just what condition the silica, that makes up from 75 to 95 per cent of the earth, is in, is not as well known as might be desired. Possibly it is a colloidal hydrated silica with proportions of the opaline variety which vary with the source, age and previous treatment of the particular earth in question. The main impurity, which

may run from 0 to 15 per cent, is clay, besides which lime, magnesia, iron oxides and organic matter may occur in minor proportions.

Geographically it is distributed in nearly every country of the world, but probably the largest single deposit of pure material is that at Lompoc, Santa Barbara County, Cal., where there are at present several companies engaged in actual production. Here the material occurs in thick beds, varying in color from pale brown to pure white and in texture from a soft clay-like mass to a hard flint-like diatomaceous shale. Gem opals are found at times in the bed of the mass. The mining is simple, open quarry methods being used. After quarrying, the material is allowed to stand in the air for some time to dry, after which it is pulverized and settled out of a current of air which grades it according to size.

USES OF DIATOMACEOUS EARTH

Without question, the two largest uses at the present time are for heat insulation and for filtration, both of which depend more on the physical than the chemical composition of the material. As a thermal insulator it is without peer, for, besides its ability to withstand a high heat and a corrosive atmosphere, its billions of inclosed air cells offer an almost perfect barrier to the passage of heat. Bonded with lime it is marketed in the form of brick and tile, while in the powder form it is packed loose in specially constructed furnace walls, or is mixed with small quantities of bonding materials for direct application as a plaster. At times small quantities of effervescing materials have been added with the bonding agent to increase its porosity.

As a filtrant it is used directly as a filter body and as an added filtering agent to maintain the filter cake in a porous condition. It also has some considerable decolorizing powers and has been applied either alone or mixed with fuller's earth to the filtering of vegetable and mineral oils, sugar solutions, and in fact wherever a mild decolorizing agent combined with an efficient filtering body is desired. To what particular property of the earth this decolorizing action is due is a disputed question. In the light of recent researches into the properties of silica gels, it might be thought that the answer was close at hand, yet many authorities with years of practical experience behind them stoutly maintain that the only criterion is the nature of the individual diatoms as shown by a careful microscopic examination. At least it appears that the small honeycomb-shaped diatoms have a greater decolorizing power than the long rod-shaped varieties, yet this may also be explained on the basis of the surface exposed.

The same qualities which go to make diatomaceous earth invaluable as a heat insulator and filtering agent also make it of value in many other ways. Mixed with lime or gypsum it has found use both as a building plaster and a fertilizer. L. Kern has found that when it is saturated with waste sulphite liquors it makes a good fertilizer (U. S. Pats. 1,144,905, 1,145,370). Peterson-Hviid has found it suited to the manufacture of casein glue in that when added to the freshly precipitated curd it renders uniform the drying and oxidation and makes the resulting products more easily soluble in alkali (British Pat. 1,016 of 1914 and Danish Pat. 18,160 of 1913). As a basis for plastic compositions its use is obvious. In the hydrogenation of vegetable oils some rigid yet porous support for the catalyzer is often a great advantage, and here again diatomaceous earth is more suited than any (U. S. Pat. 1,167,915). German Patent 291,792 of 1913 refers to the use of vanadic acid precipitated on kieselguhr in the manufacture of sulphuric acid by the contact process.

Since a considerable portion of the silica in diatomaceous earth is soluble in alkali it has been used to some extent in the manufacture of sodium silicate in place of the more difficultly soluble quartz. Only the purest grades free from iron are adapted to this purpose, however. The same fact is responsible for its use in the manufacture of ultramarine.

Many of the early dynamites were compounded with kieselguhr as an inert absorbent, and a list of the commercial products depending on it as a filler would include rubber, phonograph records, sealing wax, match heads, soaps—in fact any product where a light, cheap, inert filling agent is desired. Even the sacred realms of death itself have been invaded, for we have the word of O. Gangloff (D. R. P. 291,526 of 1914) that mixed with naphthalene and paraffine it makes a most serviceable covering for coffins.

The bibliography given herewith, although not as exhaustive as could be desired, mentions most of the important articles which have dealt with this interesting material in the last few decades.

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Defects in Steel Originating in the Ingot

Microscopic Appearance of Breaks and Inclusions of Non-Metals in Steel, Which Defects Originate During Pouring or Solidification—Various Deoxidizers and Their End Products Are Listed and Briefly Discussed

BY AUSTIN B. WILSON

DEFECTS may be defined as those substances and conditions in the metal which make for failure during normal fabrication or in service. Different classifications might be proposed in a systematic study, but in the present article the writer intends to deal with those defects in steel, as they appear under microscopic examination, which originate in the pouring and solidification of a steel ingot.

OVERHEATING MOLTEN STEEL

Under this heading those defects caused by overheating the molten metal would naturally come first. Aside from the danger of change in chemical composition due to loss through volatilization, oxidation or undesired reaction with the furnace lining or slag to which overheating may give rise, the ever-present danger of the finished steel containing oxidation products is greatly augmented. Under favorable conditions it will lead to the presence of oxides of silicon, manganese or iron in the finished steel, possibly in such amounts as to affect seriously the physical properties of the steel.

Absorption of gases is another of the ill effects which are promoted by the overheating of the molten metal. Of the gases absorbed during overheating, oxygen, hydrogen and nitrogen are by far the most important and the most commonly encountered. These gases may be present in the finished steel in any or all of the following forms: Mechanically entrapped either in blowholes or between the crystal boundaries; in solid solution in the steel; or as compounds such as oxides, nitrides, etc., either in suspension or in solution in the steel. It is noteworthy that these gases are more soluble the higher the temperature and that this solubility increases rapidly once the melting point is passed. Therefore the danger from overheating must be obvious. Hydrogen is known to cause brittleness and hardness in electrolytic iron, and nitrogen in the form of iron-nitride is the source of extreme brittleness in welds made by fusion with the oxyacetylene blowpipe or with the electric arc.

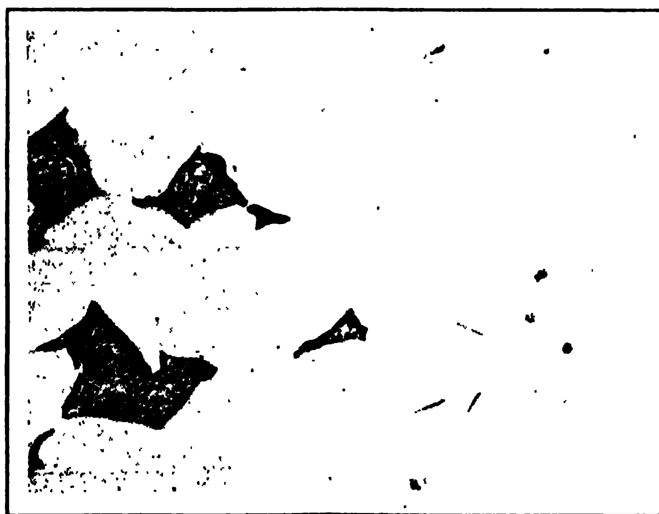


FIG. 1. EUTECTOID OF IRON AND IRON-NITRIDE. NEEDLES OF IRON-NITRIDE. X 400. ETCHED WITH HNO_3

No new constituent is directly traceable to the absorption of hydrogen. Nitrogen, however, is commonly found in the form of iron-nitride in acetylene and arc welds and in blown bessemer steel before the recarburizer has been added. Fig. 1 is of iron-nitride in a piece of nitrogenized iron wire. It shows isolated needles of iron-nitride and several areas of iron-iron nitride eutectoid.

The quantities of gases absorbed are exceedingly small when measured by weight, but when measured by volume in many cases they greatly exceed that of the steel—silver, for instance, having been known to absorb up to 200 times its volume of gases. Furthermore, when in their combined forms they furnish a very appreciable amount of impurity—for instance, 0.046 per cent oxygen in steel is equivalent to 0.2 per cent FeO, which is readily noticeable.

WILD HEATS

On casting overheated steel which has absorbed an excessive amount of gases a sudden evolution of gas is not unlikely, sometimes of such degree as to cause the metal to boil over in the molds. This may be due to evolution of hydrogen, nitrogen, etc., caused by the lowering of the solvent power of the metal for gases due to reduction of temperature or to the formation and giving off of CO or CO_2 formed through chemical reaction in the mold. Whatever the cause may be, the net result is blowholes and the production of unsound steel.

Wild heats are rare in good practice. Blowholes are almost always present in ingots, but may be so controlled that sound finished steel may be produced. "Killing" the steel in the furnace with ferrosilicon or by the addition of a little aluminum in the mold greatly reduces the liability to blowholes. This is not, however, good practice, as it is difficult to rid the steel of the oxidation products. It is thought that this reduction of blowholes is due to an increase in the solubility of the metal for gases caused by the silicon or aluminum additions. Blowholes which have become oxidized are not capable of being welded, but those with bright, unoxidized linings weld readily during forging or rolling.

An exceedingly high casting temperature should be avoided. This leads to unduly slow cooling, which in

turn results in a very coarse structure and excessive segregation. In castings it is quite liable to cause cracks due to shrinkage, and even if cracks do not result at once severe internal strains may be set up which will exert an unfavorable influence upon the serviceability of the piece in question. Fig. 2 is a shrinkage crack found in a casting poured at too high a temperature.

Although in forged or rolled material the original coarse grains are usually broken up and refined and the segregation more or less removed by suitable heat treatment, this is frequently not the case with castings. These are as a rule submitted to a single annealing. This annealing may produce the desired result in so far as carbon distribution is concerned and yet may fall far short of producing a sufficiently well-annealed casting. Particularly is this the case in castings of nickel steel, in which, as is known, the nickel is present in solid solution with the iron. During and immediately after solidification all constituents of the steel are entirely in a state of solid solution; therefore it follows



FIG. 2. SHRINKAGE CRACK IN STEEL CASTING. × 200

the laws governing freezing solid solutions—i.e., selective freezing takes place, producing the familiar cored dendritic structure with layers of varying composition. On cooling through the critical range pearlite is formed as usual, but so far as the metals which form solid solutions with iron when cold are concerned no change is produced. These metals are chromium, nickel, phosphorus, silicon, etc. Upon reheating above the critical



Fig. 3. Pearlite dark, ferrite light in nickel steel casting. Picric acid etching. × 300.
Fig. 4. Dendrites shown by etching with cupric chloride, same steel as in Fig. 3. × 15

point and allowing to cool either in air or the furnace we obtain a uniform structure of ferrite and pearlite, but still the original distribution of the nickel, phosphorus, etc., remains. To obtain the desired diffusion of this it is necessary to heat the metal to a high temperature for a long time, say 1,100 to 1,200 deg. for twenty-four hours, after which it is given the usual heat treatment to produce a fine pearlite structure. In Fig. 3 is shown the typical well-annealed pearlitic structure brought out with picric acid. Fig. 4 shows the coarse dendritic structure brought out with cupric chloride, the lighter areas being higher in nickel. Both are the same specimen of 3.5 nickel steel. and show the survival of a coarse dendritic structure even after proper distribution of the carbon has been attained.

NON-METALLIC INCLUSIONS

A prolific source of non-metallic inclusions in steel is in the admixture of foreign matter. This may be due in castings to loose grains of sand from the mold or from the abrading action of the stream of metal on the surface of the mold. In case of ingots for forging, rolling, etc., it may be due to insufficient cleaning of the molds.

An instance of this kind has recently come to the writer's attention. A slightly greenish substance (apparently some form of slag) was found in the center of a 4 x 4 in. soft steel billet. After polishing a microsection cut through this spot it was seen to have the appearance and structure shown in Fig. 5. The slag was composed of two constituents, one a light gray and the other a darker gray. The lighter gray spots were at first supposed to have been MnS, but a sulphur print showed little sulphur at that spot. It was de-



Fig. 5. Slag inclusion showing light and dark constitutents interspersed with globules of steel. Unetched. × 150.
Fig. 6. Same type of inclusion as in Fig. 5, after etching with nitric acid, showing lighter constituents eaten away. × 70.
Fig. 7. Grains of sand sintered together, found in steel casting. Unetched. × 150.

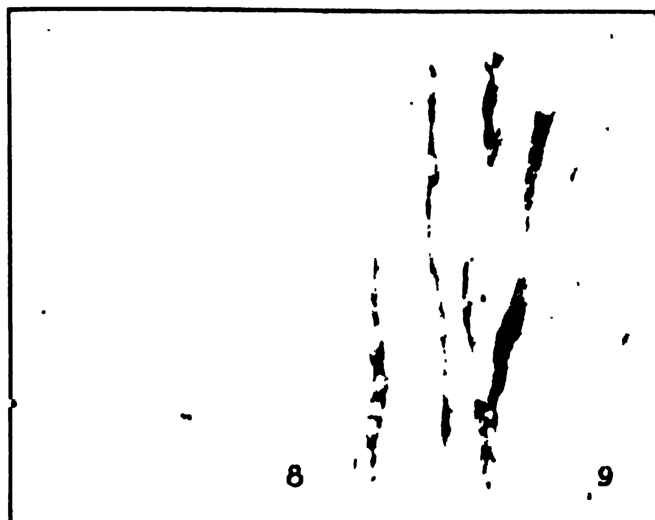


Fig. 8. Typical silicate inclusions in steel casting. Unetched × 150

Fig. 9. Typical silicate inclusions (darker) and MnS (lighter) in rolled steel. Unetched × 150

10

12

Fig. 10. FeS (lighter inclusions) segregated in skelp sample with a few dark pearlite patche[illegible] Etched with [illegible] 150

Fig. 11. Crack (black) extending through segregated MnS in a failed rail. Unetched. × 15

Fig. 12. MnS arranged around the grains in a steel casting. Unetched. × 150

cided that the darker constituent was some basic substance high in lime, as it was readily attacked by HNO_3, which is contrary to the behavior of silicates. Fig. 6 shows how the darker constituent was eaten away after etching it. It will be noticed that the slag is considerably broken up and evidently had been solid, not fused, at the time the steel entered the mold. The steel shows throughout as white masses. It was thought that this inclusion might have come from the lime wash used drying on the molds and then flaking off when the steel entered. Subsequent investigation proved this theory correct.

Foreign materials also very frequently enter steel by the abrasion or fluxing of the stopper rods and ladle linings. Fig. 7 shows a number of grains of sand sintered together found in an acid open-hearth casting.

In dealing with the subject of defects in steel naturally the use and abuse of deoxidizing agents assume prime importance, since it is generally held that the larger number of non-metallic inclusions in steel, or "sonims" as they are now called, arise from this source. Silicon, manganese, aluminum and titanium are the principal deoxidizers used in the manufacture of steel.

Silicon is used extensively in producing sound steel, especially castings. It is supposed to heighten the solubility of the gases in the metal and thus prevent blowholes. It has a high affinity for oxygen and oxidizes readily to silica (SiO_2), reducing most of the oxides in the steel to their metallic form. Steel "killed" with silicon sets quietly with little evolution of gases. It may be added in the furnace, in the ladle or in the mold, usually in the form of ferrosilicon. Silica is acid and combines with iron and manganese oxides to form silicate slags. These silicates are sometimes mechanically trapped in the steel, especially if the steel has been treated with an excess of ferrosilicon. They are extremely hard and brittle and form dangerous discontinuities in the metal. Figs. 8 and 9 are examples of silicates in steel. Fig. 8 shows an exceedingly dirty spot in a steel casting, the silicates being present in the globular form commonly found in castings. The ferrosilicon in this case was added in the ladle. Fig. 9 shows typical elongated silicates found in rolled and forged materials. The darker inclusions are silicates and the lighter manganese sulphide. This photograph was taken from a low-carbon plate which had been "killed" by the addition of ferrosilicon in the mold. As a rule little objection can be raised to the use of silicon as a deoxidizer if not used in excessive amounts, although the danger of segregation such as shown in Figs. 8 and 9 is ever present.

Manganese Sulphide

Manganese is a deoxidizing agent to the use of which no defects can be attributed. Rather can they be charged to the lack of this element. Enough manganese must be present to form MnS with all the sulphur, since if sufficient is not present the sulphur will combine with some of the iron to form FeS, which has an embrittling effect and which is the cause of "red-shortness" in the steel. Iron sulphide can be readily recognized under the microscope by its pale yellow color as distinct from the dove-gray color of MnS. Manganese to the extent of at least two and a half times the amount of the sulphur present is required to prevent the formation of FeS. Oftentimes, despite the fact that chemical analysis shows the presence of sufficient manganese, microscopic examination will reveal sections in which FeS predominates. This is due to sulphur segregating in one part of the steel to such

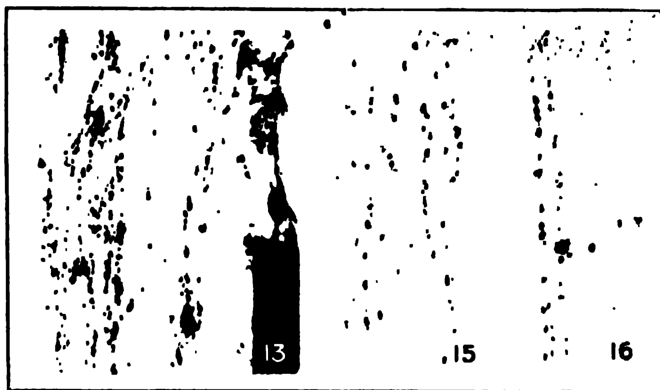


Fig. 13. Segregated alumina in web of failed rail, black area in corner is part of a crack. Unetched. × 100
Fig. 15. Alumina streak shown as surface defect in Fig. 14. Unetched. × 100
Fig. 16. Alumina streak found in piece of broken drill. Unetched. × 100

an extent that sufficient manganese to satisfy it is not at hand in that particular spot. Fig. 10 is an illustration of such a case found in a skelp sample which analyzed 0.06 sulphur and 0.27 manganese. The sulphides shown in the photomicrograph are practically all in the form of FeS and were the cause of extreme "red-shortness."

Nevertheless the presence of all the sulphur as MnS does not entirely remove danger. Although there is little cause to fear sulphides in the form of MnS if uniformly distributed, their segregation is to be watched for. A group of MnS inclusions will cause a brittle spot in the steel which may well be the starting point of a crack. In Fig. 11 is shown a crack extending through a group of segregated MnS spots. This photograph was taken from a rail which failed in service and in which the above segregated spot was the only defect which could be found, the steel being clean and its microstructure good.

Fig. 12 shows streaks of MnS arranged around the grains of a steel casting. This arrangement of the sulphides has a weakening effect upon the material, but at the same time it is of a type frequently met with in well deoxidized castings. In most cases, however, this condition is not widespread enough to have very serious effect.

Aluminum as a Deoxidizer

Probably the most detrimental as well as one of the most widely used deoxidizers is aluminum. The bad effects resulting from its use are so well known that many specifications, such as the A. R. A. specifications for rails, positively forbid it. Nevertheless, in many steel works it is still common practice to add a small amount either in the ladle or in the mold, although many of these plants when questioned regarding it deny its use in their works.

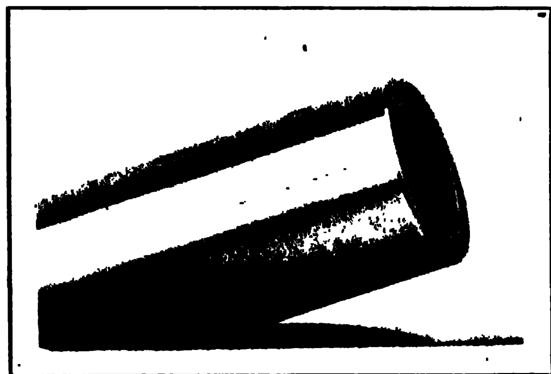


FIG. 14. SURFACE DEFECT ON WRIST-PIN OF AIRPLANE MOTOR. NATURAL SIZE

Aluminum is supposed to act in much the same way as silicon in producing sound steel—i.e., it increases the solubility of the gases in the metal. Aluminum, however, has a very marked effect in increasing the viscosity of the slag through its oxidation to alumina (Al_2O_3), which is an exceedingly infusible substance, its melting point being around 2,000 deg. C. Thus it can easily be seen that it solidifies immediately upon its formation, the temperature of the steel being at least 300 deg. C. lower than this. Fine particles of alumina do not readily coalesce and therefore in spite of their low specific gravity have no tendency toward rising and on mixing with the other small slag particles retard their rise and cause the bath to become thick and pasty, thus favoring the production of dirty steel.

If no other reason were forthcoming the above ought to be sufficient to inhibit aluminum's use, but that is

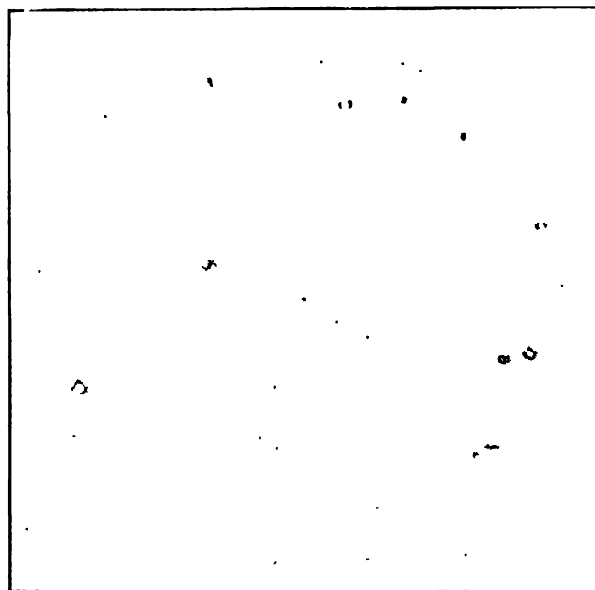


FIG. 17. TYPICAL TITANIUM-NITRIDE INCLUSIONS IN STEEL. UNETCHED. × 200

not all. Although aluminum apparently has some effect in preventing the segregation of the constituents normal to steel, the particles of alumina exhibit a strong tendency to collect in large groups or masses which greatly reduce the strength of the steel. This is especially the case in worked material where streaks of alumina are often found, the weakening effect of which amounts almost to that of a crack. Fig. 13 shows a crack extending through a segregation of alumina found in the web of a failed rail. Fig. 14 shows a type of surface defect found in several hundred piston wrist-pins intended for airplane motors. The surface was ground from several of these pins to a depth of about $\frac{1}{16}$ in. and, the streak still remaining, it was polished and examined. Fig. 15 shows the streak of alumina as found with the aid of the microscope. Fig. 16 shows another exceedingly bad streak found in a specimen of broken drill steel. It is possible that the use at times of a very small quantity of aluminum, say a few ounces per ton, may be permissible, but at the same time the fact remains that even this is questionable.

Ferro-Carbon-Titanium

Although some metallurgists disagree, titanium in the form of ferro-carbon-titanium has been shown by many tests to be superior to all others as the final cleanser in steel-making. It cannot altogether replace either silicon or manganese, but it can take their place whenever they are used purely for deoxidizing purposes.

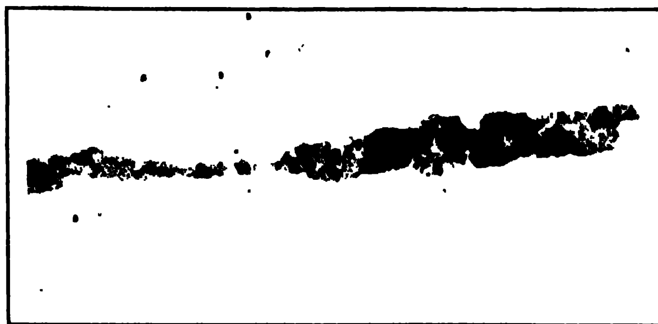
Titanium when added in the proper amounts makes the slag more fluid and acts as a flux for the various silicates. It has a high affinity for nitrogen as well as for oxygen, a property possessed by no other deoxidizer except possibly vanadium. It prevents segregation and does not itself segregate; in fact, except in high-carbon steels no microscopic constituent is found due to the titanium addition, and even in high-carbon steels it has never been known to segregate. When found in steels it is in the form of titanium-nitride, or rather titanium-cyanonitride, as it may be slightly contaminated with carbon. Fig. 17 shows typical titanium-nitride inclusions in steel.

In support of the views expressed above the writer quotes the following list of the properties of the various deoxidizers tabulated by Prof. Bradley Stoughton in the *Railway Age Gazette* of Feb. 7, 1913. The elements are given in the order of their effectiveness.

Prevention of blowholes 1, aluminum; 2, titanium; 3, silicon; 4, vanadium; 5, manganese.



Fig. 18. A. Left—Ingot laid on side before final solidification. B. Right—Ingot cooled in normal position



19. PIPE LINED WITH OXIDE, FOUND IN WEB OF AN "A" RAIL, UNETCHED. × 200

Removal of oxides of iron and manganese: 1, titanium; 2, silicon (weakly). Hindering this removal: 1, aluminum; 2, manganese.

Removal of all oxides and slag enclosures: 1, titanium. Hindering removal of all these enclosures: 1, aluminum.

Removal of nitrogen: 1, titanium; 2, vanadium(?).

Breaking up and removal of iron-sulphides: 1, manganese; 2, titanium(?).

Causing a pipe: 1, aluminum; 2, silicon; 3, titanium; 4, vanadium; 5, manganese.

Hindering segregation: 1, aluminum; 2, titanium; 3, vanadium. Promotion of segregation: 1, manganese; 2, silicon (sometimes).

Piping

During the solidification of ingots a certain amount of piping, segregation and formation of blowholes is almost sure to occur. It is not possible to prevent entirely all these conditions, but the difference in the degree to which they are overcome constitutes much of the difference between good and poor practice.

A "pipe" in an ingot is in reality a shrinkage cavity, caused by contraction in cooling. The metal at the bottom and sides is cooled first by the chilling effect of the mold, and as it contracts is fed by the fluid metal in the center and top, with the result that a cavity forms in the top portion of the ingot. If cooled equally on all sides the "pipe" will occur in the center of the top of the ingot. If the ingot is "capped"—i.e., has a cast-iron plate clamped over the top as soon as filled to cause immediate solidification of the top—the "pipe" may be some distance below the top of the ingot. That a "pipe" is a shrinkage cavity has been proved by laying an ingot on its side before final solidification has taken place. In this case the "pipe" was distributed on the upper side along the length of the ingot instead of being confined to the top part. Fig. 18 *A* is a photograph of an ingot which had been laid on its side before final solidification, as just described. Compare this with *B*, which shows the normal occurrence of a "pipe"—i.e., in the top central portion of the ingot. The use of aluminum, silicon or any deoxidizer which causes the metal to set quietly increases "pipe" and usually necessitates the scrapping of a proportionately larger amount of metal.

Theoretically it should be possible to cast steel without producing a "pipe." This would be done by casting the metal at such a low temperature that solidification would take place the instant the steel entered the mold, the shrinkage thus being taken care of as the mold filled. Practically such accurate temperature control is not possible. The metal must be at a high enough temperature when tapped from the furnace to

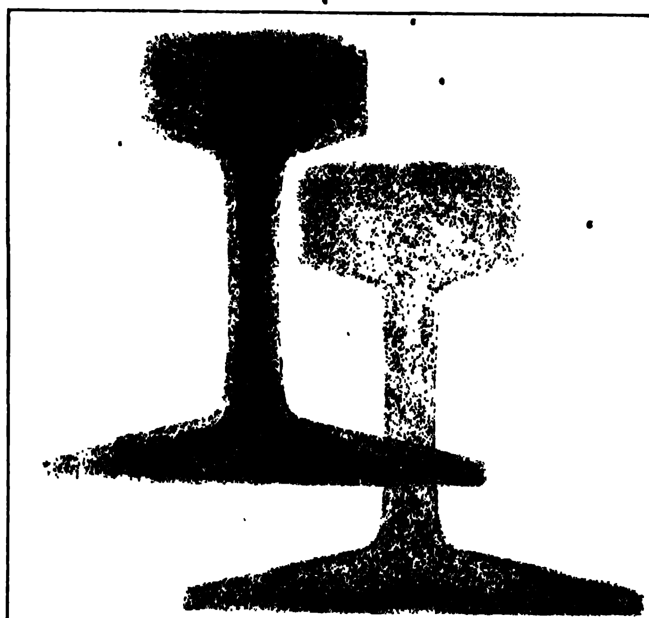


Fig. 20. Sulphur print showing segregation in "A" rail rolled from top of an ingot

Fig. 21. Sulphur print showing absence of segregation in "E" rail rolled from bottom of same ingot as "A" rail in Fig. 20

permit of teeming, and a safe margin must be allowed for any reasonable delay.

Blowholes can be so regulated that they occur only in places and under conditions which allow of their being welded in the subsequent forging or rolling operations.

Many ideas have been advanced for the production of sound steel ingots. Most of the plans put forward have been based upon the compression of the still liquid steel. Hadfield has suggested keeping the top of the ingot fluid by means of a charcoal fire and a blast of air, thus furnishing a "head" of liquid metal. Sound stéel has been produced by almost all the methods suggested, but various reasons, usually cost of equipment or operation, have militated against their adoption.

The most practical method yet devised is the use of "hot-tops." A hollow fireclay tile is fitted on the top of each ingot mold and when thè ingot is teemed this is also filled. As the tile does not have the same chilling effect as the sides of the mold the metal contained therein remains fluid and by gravity feeds the metal in the mold as it contracts. Thus the entire "pipe" is usually confined to the "hot-top" and is easily removed by proper cropping. Since "piping" occurs in all steel where metallic shrinkage is not balanced by gas evolution (blowholes) and must be removed by cropping, it will be easily understood that a defect called a "pipe" in the finished product is in reality due to insufficient cropping. Fig. 19 illustrates the remains of a "pipe" found in a sample of rail.

Segregation

Primarily segregation is due to the phenomenon known as selective freezing. This merely means that due to the various impurities it contains all portions of a steel ingot do not solidify simultaneously. When the liquidus of the particular alloy is first passed that part of the metal which is relatively more infusible solidifies. The more fusible portions—i.e., the portions containing the impurities—naturally solidify last and therefore are found in that portion of the ingot which is the last to freeze, usually the top central portion. Carbon, sulphur and phosphorus as well as most of the non-metallic inclusions tend strongly toward segregation when opportunity offers. Some of this segregation can be removed by proper heat treatment, but there is no remedy other than "cropping" for any serious segregation of non-metallic inclusions. The evil effects of segregation are many and will be encountered throughout the entire process if not properly dealt with.

Figs. 20 and 21 are sulphur prints of 90-lb. rails rolled from near the top and bottom respectively of the same ingot. Fig. 20 shows the typical segregation found at the top of the ingot. Fig. 21 shows a good homogeneous metal.

Fig. 22 illustrates the poor distribution of pearlite in a low carbon sheet-bar due to segregation in the ingot. At this stage of the manufacture it is impossible to correct this structure entirely, although it may to some extent be modified by suitable heat-treatment.

Niagara Falls, N. Y.



FIG. 22. SEGREGATION OF PEARLITE IN STRIP STEEL ETCHED WITH NITRIC ACID. X 100

World's Industrial Exhibition in London in 1922

Announcement is made of a world's industrial exhibition, to be held at the Crystal Palace, London, during the months of May to October, 1922, of the industries, products, arts, sciences and inventions of the leading manufacturing countries of the world. It will be on a co-operative basis, the capital being provided by the exhibitors and those otherwise connected with the exhibition (such as the guarantors of each nation who guarantee sufficient for the preliminary work connected with the exhibition of their nation), and the profits accruing from the various sources of revenue, such as contracts for advertising, catering, amusements, season tickets, gate receipts, etc., will be apportioned pro rata among the exhibitors in order to bring the cost of exhibiting to the lowest possible figure.

Each country will elect its own exhibition committee, which in turn will be represented on the general committee. The management will be under the control of a committee representing the exhibitors and guarantors generally.

Possibilities for Research and Development in the Field of Refractories*

A Review of the Main Economic and Technical Factors Which Are to Be Taken Into Account When Research Work Is to Be Pursued on Some Particular Phase of the Industry of Refractories

BY HOMER F. STALEY†

THE increasing use of refractories in well-known ways and the numerous demands for various kinds of refractories to be used for new purposes have created a demand for research. Moreover, the high price commanded by all sorts of refractories in the past few years has held forth the possibility of large pecuniary rewards as the result of successful research in this field. For these reasons there has been conducted of late a large amount of research dealing with refractories, some of which has been well planned and conducted along logical lines of procedure, but part of which has been ill-advised and from the very nature of the case doomed to produce no results of industrial importance.

It may be well then to make a brief survey of the field of refractories and to point out some of the phases of manufacture of these materials in which there is room for research and development.

ECONOMIC PHASES OF THE SUBJECT

If results of an industrial research are to be of large financial importance they must deal with some refractory which is or can be used in quantities with a high money value. In the accompanying table are given the value of the various refractories used annually in this country. It will be noted that out of the total of approximately $72,000,000 $11,000,000 represents the value of the clay refractories. Second in rank comes silica brick, with a value of $20,000,000. Third in rank are magnesite refractories, with a value of $6,500,000, while the bauxite and chromite refractories have a small annual value of about $650,000 each. Therefore from a monetary standpoint the big opportunities for research are in fields of clay, silica and magnesite refractories.

Of the clay refractories, firebrick represent an annual value of $36,000,000; glass pots and other glass house refractories a value of $3,000,000; chemical porcelain and chemical stoneware of a little less than $2,000,000; zinc retorts of a little over $1,000,000, while all other clay refractories, including stove linings, saggers, mantle rings, muffles and crucibles, pottery supplies and miscellaneous materials, have a combined value of only $2,000,000. It is evident, therefore, that the opportunities for research in clay refractories which may result in the saving of many millions of dollars annually lie in the possibility of improving the quality of firebrick, in lessening the cost of manufacture of these, or in producing a new product which can be used more economically. Research in other clay refractories or in finding substitutes for these may result in moderate pecuniary reward to the investigator, but the product will probably never have a large annual value. If improvements can be made in the method of manufacturing silica and magnesite refractories, or if more economic substitutes can be found for these, the results of such research may possibly have large financial importance.

It should be remembered that the cost of refractories to be used for a certain purpose cannot be stated in terms of cost for unit of service. For instance, in the steel industry the cost of refractories is measured as cost of refractories per unit of steel produced. The item "cost of refractories" includes cost of firebrick and mortar, cost of repairs, including the charge for tearing out old material and replacing it by new, and, when two materials are being compared, the cost of interruption to manufacture incidental to the necessity for more frequent repairs when using one material than when using another. In the same way in the pottery industry the actual cost of saggers is only incidental to the loss of ware and production caused by the breakage and failure of saggers. It may thus happen that an industry would be willing to pay more money for a refractory to use for certain purposes than it is now paying, provided the cost per unit of service with the new refractory is less than that with the one now being used.

ANNUAL PRODUCTION OF REFRACTORY PRODUCTS IN THE UNITED STATES

Product	Value
Clay refractories	
Firebrick	*$36,000,000
Glass house refractories	3,000,000
Chemical porcelain and chemical stoneware	1,750,000
Zinc retorts	1,200,000
Stove linings	675,000
Saggers	600,000
Potters pins, stilts and spurs	275,000
Mantle rings, electrical resistance units, etc.	250,000
Muffles, assay supplies and crucibles	150,000
Miscellaneous	100,000
	$44,000,000
Silica brick	$20,000,000
Magnesite refractories	6,500,000
Bauxite refractories	650,000
Chromite refractories	650,000
	$71,800,000

* This amount is the estimate of the U. S. Geological Survey for the year 1919.
† Estimate of the writer. The other amounts are rounded figures taken from those given in Mineral Resources of the United States, 1918, Part II.

In conducting a research to determine the probable life or service to be obtained from a new refractory care must be taken to consider the actual conditions of service in the industry. For instance, it has been demonstrated by laboratory tests that certain rather expensive sagger mixtures are more resistant to repeated heating and cooling and have higher transverse

*Paper presented at Chemical Exposition, New York City, Sept. 24, 1920.

†Chief Refractories Section, Bureau of Standards, Washington, D. C.

strength at high temperatures than those now in use. When these mixtures were tried out in actual practice in factories it was found that the breakage due to rough handling in setting and drawing kilns was so great that the estimated life of these saggers was reduced to the point where it was not profitable to use them. In another instance the use of fused alumina brick seemed to promise to be very satisfactory for the use of roof of electric furnaces. These brick were very refractory and showed marked ability to withstand sudden changes of temperature. However, when they were used in the roof of an electric furnace it was found that they failed, due to the fluxing action of lime vapors in the furnace.[1] There is no question that brick could be made from more expensive materials which would be more resistant than firebrick to the temperature conditions and the slags used in blast furnaces; but these brick would be subjected to abrasion the same as the cheap firebrick now being used, and for this reason probably would not prove economical in use. We may rather definitely assume, therefore, that under existing conditions in a well-established industry none of the refractories now in common use are liable to be replaced by new refractories with comparatively excessive first costs.

On account of the importance of the practical and economic phases of research in refractories makers and users of these materials should work in conjunction with scientific research men. A rather ideal body for the formulation of research programs is one similar to that of Committee C-8 of the American Society for Testing Materials, which is composed of an equal number of representatives of manufacturers of refractories, of users of refractory wares and of men from research laboratories.

Improvement in Clay Refractories —Phase-Rule Investigation

Fireclays are essentially silicates of alumina carrying varying amounts of free silica in the form of sand and small amounts of potash, soda, lime, magnesia, iron and titanium. The phase-rule diagrams showing the effect of most of these materials on aluminum silicate have been worked out sufficiently to enable us to say that little is to be learned in regard to the practical utilization of clays done for refractory purposes by further application of phase rule studies.

The most important information obtained from these studies has been that calcined kaolinite must be considered as one point on the sillimanite-silica diagram. The eutectic between sillimanite and silica consists of 84 per cent silica and 16 per cent sillimanite, corresponding to 90 per cent silica and 10 per cent alumina.[2] It follows that the amount of silica-alumina eutectic in a clay is found by multiplying the percentage of silica in the calcined clay by $1\frac{1}{9}$. We can thus calculate that even in pure kaolinite 60 per cent of the calcined clay will melt at the eutectic temperature. The work of Montgomery and Fulton[3] and other investigators has shown that the eutectic between silica and sillimanite is the dominating one in clays and that the effect of other impurities is simply to lower the eutectic temperature and to increase the amount of eutectic without materially altering the ratio of silica and alumina entering into the eutectic. We may thus say that whenever the temperature is reached at which the silica-sillimanite eutectic becomes active the clay refractory consists of at least 60 per cent of melted material carrying the remainder of the refractories as unmelted material. The clay mass as a whole then gradually softens and becomes useless in refractory construction. The temperature at which this occurs varies with the composition of the clay and the structure of the mass, and the type of construction in which the material is used. In general we may say that clay refractories are not suitable for continuous use under load at temperatures above 1,350 deg. C., nor for use in structures where they are not subjected to load at temperatures above 1,450 or 1,500 deg. C.

[1] F. A. J. FitzGerald, Chem. & Met. Eng., vol. 22, No. 10, p. 129 (1920).

[2] Shepherd, Rankin and Wright, *Am. J. Sci.* (4th ser.), vol. 28, p. 293 (1909). See also *Collected Writings* of Herman A. Seger, p. 515 (pub. by Am. Ceram. Soc., 1902).

[3] *Trans.* Am. Ceram. Soc., vol. 19, p. 303 (1917).

Permanence of Volume

All clay refractories shrink during firing and when used in comparatively high temperatures are liable to continue to shrink. This lack of permanence of volume in use is one of the most flagrant defects of different types of clay refractories. In most cases it cannot be overcome, as is commonly assumed, by firing the refractory to a temperature equal to or slightly above that at which it is to be used. This shrinkage in use can be minimized by proper firing temperature, by selection of clays, by selection and preparation of grog material, and by variation in methods of manufacture. There is room for considerable research in developing clay refractories that will be permanent in volume up to temperatures of 1,350 to 1,450 deg. C.

Glass House Refractories

During the past few years active research work has been done by a number of laboratories and by various individuals in connection with the improvement in glass house refractories. The most profitable line of research has dealt with the selection of clays, the preparation and sizing of grog and methods of manufacture. It is hoped that this work will be continued.

Zinc Retorts

In microscopic study of used zinc retorts it has been shown that when clay retorts have been used for some time they are converted into what is essentially a mass of zinc spinel crystals. The possibility of making retorts from zinc spinel should be investigated.

Saggers

As stated above, while the annual charge for saggers in the pottery industry does not amount to a large sum, yet the loss of ware and production due to breaking of saggers is an important item in the pottery industry. It has been demonstrated that considerable improvement can be made in the length of the life of saggers by proper selection of clay both for bond clays and for grog and by proper sizing of grog. The use of such materials as sillimanite and carborundum for saggers is worthy of further study.

Chemical Porcelain

While some of the chemical porcelain that has been made in this country has been of excellent quality, some has not. As far as use of clay ware for this purpose is concerned it seems that research and development should deal in this field of true high fire porcelain with glazes maturing at high temperatures. Since the

amount of body material used in this type of ware is small compared to the value of the finished product the use of some of the more rare and expensive materials in place of, or in combination with, clay has interesting possibilities.

Mantle Rings, Electrical Resistance Units and Similar Specialties

While these are commonly classed as clay refractories, the use of pure magnesia and other special refractories in these in combination with clay is quite common, and there seems to be an opportunity for development of the use of various refractory oxides in these fields.

Kaolin Refractories

Up to the present time practically all the clay refractories manufactured in this country have been made from fireclays. The use of kaolin as a refractory has been tried in an experimental way, and it has been shown that it can be employed to make a very high-grade clay refractory. The use of this material should be investigated further.

Sillimanite Refractories

As stated above, calcined clay represents one point in the silica-sillimanite eutectic series. By adding alumina to clay it is possible to get a composition that corresponds essentially to the mineral sillimanite $Al_2O_3SiO_2$. The most simple way of making sillimanite is by adding an ore of alumina to clay so as to bring the silica-alumina ratio up to that of sillimanite and then to burn the mixture in a kiln at a temperature not less than cone 18. Sillimanite can be made also by fusing a mixture of clay and coke in a cupola furnace and volatilizing the excess silica. This method has been used by Lacesne[4] in France and Malinovszky[5] in this country. Since with many ores of alumina there is a shrinkage in the formation of sillimanite in the kiln process, when these are used sillimanite must be made in one firing and the resulting material must be ground and mixed with a binder for the formation of wares which are then subjected to firing. Raw sillimanite mixture is a suitable binder for sillimanite made in this way or by the furnace process. A few ores of alumina, notably certain varieties of the diaspore clays found in Missouri, have so low fire shrinkage that it is possible to use them in connection with clay of low fire shrinkage for the manufacture of sillimanite wares in a one-fire process.

These sillimanite refractories have very desirable properties. The melting point is above cone 34, they do not soften at temperatures much lower than the melting point. When properly made they have permanent volume at elevated temperatures and resist sudden changes in temperature well. Up to the present time practically the only commercial use that has been made of this refractory has been in the manufacture of pyrometer tubes from what is known as Marquardt porcelain. There is a possibility of these refractories being used successfully for making saggers and crucibles and other refractories to be used at temperatures above those at which clay refractories give satisfactory service. For use in electric-furnace construction they have the advantage over silica refractories in that they are not subject to destruction through volume changes. They are superior to carborundum refractories in that they do not deteriorate when they are used either under oxidizing or reducing conditions at high temperatures.

Silica Refractories

The manufacture of silica brick in bulk shapes for furnace construction is the only important use of silica as a refractory in this country. We do not class fused silica ware, commonly called quartz glass, as refractory material. The making of silica brick has long been conducted successfully in this country by empirical processes, and the theoretical foundation of these has been studied thoroughly in the last few years.[6] These have shown that the fundamental necessity for firing silica at high temperatures is due to the necessity for converting quartz into cristobalite and tridymite so as to avoid the volume changes undergone by quartz in heating and cooling. The one inherent defect of silica brick is that the cristobalite, which comprises their bulk constituent, is subject to sudden expansion when heated above 230 to 270 deg. C. and contraction when cooled below that temperature range. Therefore silica brick are not suitable for structures which are to be cooled periodically to atmospheric temperatures, but are very satisfactory for structures which are to be held continuously at high temperatures.

It is not probable that any improvement of marked commercial importance will be made by researches in silica brick manufacture. New uses can probably be found for these brick in structures that are to be held continuously at high temperatures. A promising field for study of uses for silica brick is in the construction of car-tunnel kilns.

Magnesite Refractories

Magnesite refractories are used for construction of those parts of metallurgical furnaces which come in contact with basic slag. The properties and processes of manufacture of these brick are fairly well understood. Their use is limited largely by the fact that they do not stand sudden temperature changes well and also are liable to shrink when held at high temperatures for long periods of time. Both these objections can be overcome by use of electrically fused magnesite with temporary organic binders or a small amount of raw magnesite as binder. This has been tried out on a small scale and the wares produced have been quite permanent in volume when exposed to high temperatures for long periods of time. Above 1,800 deg. C. they deteriorate by volatilization. It is probable that the use of electrically fused magnesite as a refractory will be employed for a special high-priced construction for the linings of electric furnaces.

Another magnesite refractory that shows promise of development is that of magnesium spinel, $MgO.Al_2O_3$. This spinel can be made by calcining at high temperatures a mixture of magnesite and alumina ore. The calcined product can be made into wares by using small amount of the raw mixture as binder. Wares made in this way do not soften or deform below 1,800 deg. C. and do not deteriorate due to the volatilization of magnesia in the same way as pure magnesia refractories. The making of such refractories has been tried on a laboratory scale, and their use for the making of

[4]J. Am. Ceram. Soc., vol. 3, p. 40 (1920).
[5]J. Am. Ceram. Soc., vol. 3, p. 160 (1920).
[6]C. N. Fenner, Am. Jour. Sci. (4th ser.), vol. 36, p. 339. D. W. Ross, Tech. Paper, Bureau Standards, 116.

small quantities of special comparatively high-priced refractories such as crucibles and pyrometer tubes seems a possible development.

Carborundum Refractories

In the past few years the use of carborundum refractories has reached a certain amount of commercial importance. The first attempts were made to bind the carborundum with clay, but lately it has been found possible to manufacture carborundum articles simply with the use of a temporary binder such as linseed oil, gluten or pitch. When the wares thus formed are fired to a high temperature, the temporary binder is burned out and the grains of carborundum are bound into a hard mass by the formation of carborundum crystals. Wares made in this way do not melt at any temperature, but dissociate and oxidize into silica and carbon very rapidly at 2,200 deg. C. This dissociation and oxidation are noticeable under oxidizing conditions at 1,500 deg. C. and under reducing conditions at temperatures above 1,700 deg. C. This refractory has the advantage over silica and magnesia refractories in that it is inert to basic and acid slags and that it is very resistant to all temperature changes. It can be used continuously at higher temperatures than either silica or calcined magnesite refractories. The heat conductivity is very high, which is an advantage for some purposes and a disadvantage for others. It has been used with satisfaction for the roofs of electric furnaces, but in such cases it has been necessary to cover the roof with a heat-insulating layer of firebrick and arrange to avoid contact of electrodes with any part of the roof. This latter caution has been found necessary on account of the high conductivity for electricity of carborundum refractories at high temperatures. It is probable that other uses will be found for this material.

Alumina Refractories

At present about the only use of bauxite brick is for the lining of the hot zone of rotary cement kilns. The factor that militates against its general use is the tendency to shrink continuously when exposed to high temperatures.

The use of fused alumina has been experimented with in the last few years. Products made from this material have constant volume and a high melting point. One difficulty has been to find a satisfactory binder. Clays have been used but the wares softened and deformed at the melting point of the clay used as binder. The use of raw mixtures which will form alumina compounds, such as magnesia spinel, as binders for this sort of material has been tried with promising results. Fused alumina materials up to the present have been used for making special small high-priced refractory pieces such as parts for electric tube furnaces, crucibles for chemical work, etc. There seems to be a field for this material in such uses, but it is not probable that it will ever be used for heavy refractory wares.

Zirconia Refractories

Zirconia refractories have attracted a large amount of attention in the past few years. Zirconia ore from South America containing about 75 per cent ZrO_2, the chief impurity being silica, has been used for making crucibles, brick and other refractories. Clay was tried as a binder at first, but it reduced the melting point of the refractory very remarkably. At present finely ground ore is being used successfully as a binder. These wares must be fired to quite a high temperature if they are to be permanent in volume when exposed continuously to heat. The use of zirconium silicate, which is found in commercial quantities in this country, also gives promise of development. Attempts have been made to use pure zirconium oxide as a refractory for special purposes. In order to secure materials that do not crack in firing and change in volume and use, it has been found necessary to calcine the zirconium oxide at a very high temperature. In fact, the simplest method seems to be to fuse the zirconia in an arc. Since zirconia has a very high melting point, its use to a limited extent for refractories to be used at exceedingly high temperatures seems to be worthy of investigation.

Carbides and Nitrides

Of course, for continuous use under certain conditions it is essential that a refractory element be in a chemical combination which is stable under those conditions. For instance, in electric-furnace work it has been found that many of the refractory elements such as magnesium, titanium and aluminum form carbides when in contact with carbon or carbon vapors and that other elements under certain conditions at high temperatures form nitrides. This has logically led to researches having for their object the use of carbides and nitrides for refractories under the conditions stated. The employment of none of these materials has reached the stage of commercial importance at present, but active research along these lines is being conducted and should be continued.

Refractory Coatings

The technical literature in the patent records for the past few years has been full of references to attempts to use comparatively high-priced refractory materials for coatings for cheaper refractory materials. Some of these have been technically rather foolish -for instance, the use of thin coatings of carborundum to protect other refractories from the effect of heat. The conductivity of carborundum refractories is so high that the thin coating offers practically no protection against heat. Other futile attempts have been made to put coatings on refractory material when the coefficient of expansion or the shrinkage in use of the two materials varies materially. Another instance is the use of coatings or paints to produce a glazed surface on refractory materials. All such glazes reduce the refractoriness of the material so coated. Quite often the glaze is produced by the use of sodium silicate, which of course is a very effective flux. Such coatings may improve density and mechanical strength of the surface and thus protect the refractory against abrasion, the cutting action of flames, or against penetration by slag, but they certainly do not make the ware more resistant to heat. Similar compositions have been used for mortars in the building of refractory structures. There is no doubt that in some respects there is room for improvement over the common practice of using a fireclay chosen simply for its refractory properties. As mortars in structures subjected to cutting action of flames or corrosive action of slags, a vitrifying mortar would be more satisfactory. In any structure a vitrifying or semi-vitrifying mortar gives a structure that is stronger from the standpoint of mechanical strength. However, the composition of the material used for vitrifying mortar should be studied with care. Some of those

that have been proposed have been found injurious. There is room for research in the question of mortars for refractory structures.

Insulating Materials

At present the use of refractory material is in many cases dependent upon the fact that part of the refractory is kept comparatively cool by radiation. An instance is the use of refractories in the roof of metallurgical furnaces and ceramic kilns. Of course this radiation involves loss of a large amount of money. On account of the increase in cost of fuel in the past few years, the use of insulating materials for refractory structures has received considerable attention. It has been found in a number of cases that when the structure was insulated against loss of heat and the refractory materials thus became heated to a high temperature, they immediately failed. It is probable that if the use of heat-insulating coatings for refractory materials becomes common, the whole status of the use of various refractories in such structures will be materially changed and a revolution in the manufacture and use of refractories will take place. It will probably be necessary to use more expensive refractories and to develop the more general use of those now used but little. In certain cases it has been found that when insulating materials were used, the interior of the furnace walls became so hot that the insulating material failed, not by fusion, but by shrinkage. In connection with the use of some of the very high-grade refractories, there is need for the development of an insulating material which will function satisfactorily at high temperatures. In fact, it may be said that the whole question of the construction of electric furnaces with the use of high-grade refractories waits on the development of such an insulating material.

Summary

Several factors must be taken into account when considering the possibilities for research in a particular phase of refractory industry or the development of the use of a new material as a refractory. The technical questions are the ones that are liable to seem most important to the research man, but the economic phases of the subject are fully as important. A certain amount of prevision is essential in considering such problems. A change in economic conditions or in modification of the methods of use of refractories may alter entirely the whole question of the manufacture of refractories and the possibility of the economic development of new refractories.

Improvement of Shantung Silk

An international committee for the improvement of Shantung silk has been organized at Chefoo, according to advices from Commercial Attaché Julean Arnold. For this purpose the Chinese Government has sanctioned the use of part of the export tax on silk from Chefoo, so that a sum of 150,000 taels ($200,000) will be available annually for development and improvement work. Five hundred thousand mulberry trees are being purchased to aid in the development of mulberry silk. It is the aim of the association to improve both mulberry and tussah silk, which is produced by oak-leaf-fed silkworms, and it is hoped that through improved methods of reeling and the Pasteur method of egg selection greater market possibilities in America may be opened.

The Canadian Starch and Glucose Industry

The starch and glucose industry in Canada embraced twelve establishments in 1918, and the same number in 1917. The value of the total assets of the industry increased from $3,670,806 in 1917 to $3,784,664 in 1918, or 3 per cent. Included in this total, reports Consul Johnson, of Kingston, Ont., is the value of lands, buildings, fixtures, machinery, tools, materials on hand, stocks in process, finished products, fuel and miscellaneous supplies, which decreased from $3,218,216 in 1917 to $3,112,311 in 1918.

This leaves the increase in the cash and trading accounts at $219,763, or 48.5 per cent.

Employees and Wages—Miscellaneous Expenses

In 1917 there were seventy-six salaried employees in this industry, who received a total of $92,312, of which $48,865 was paid to managers. In 1918 there were seventy-one in this class, receiving in the aggregate $98,595, managers receiving $49,440. This gives a per capita payment to salaried employees of $1,215 in 1917 and $1,389 in 1918. The average number of wage earners employed increased from 615 in 1917 to 633 in 1918; the total payment in wages rose from $428,723 in 1917, to $541,550 in 1918, or a per capita rating of $697 in 1917 and $856 in the succeedng year.

Miscellaneous expenses other than fuel, power, labor and raw materials, chargeable against manufacturing operations, rose from $268,938 in 1917 to $339,763 in 1918.

Raw Materials Used

Approximately $5,000,000 worth of raw materials was consumed by the industry in 1918, the chief items being as shown in the following table:

Corn (139,974,408 lb.)	$3,858,312
Potatoes (9,923,279 lb.)	106,064
Cornstarch (503,950 lb.)	32,495
Sugar and syrup for mixing (1,657,082)	113,399
Containers of all kinds	750,560
Chemicals	44,763
All other miscellaneous materials	87,112
Total	$4,992,705

Cornstarch was used in one factory to make dextrine exclusively, but in three other plants it was used for the manufacture of both glucose and dextrine, so that it is not possible to determine the amount of starch utilized in the manufacture of either of these products. The principal commodity in the item "chemicals" is hydrochloric acid, which is used principally for the manufacture of glucose by the hydrolysis of starch.

Products of the Industry

The industry's output in 1918 was valued (at the factory) at $7,620,864, starch of various kinds and glucose forming $6,327,515 of this total, as the following table shows:

Products	Quantity	Value
Cornstarch, lb.	19,041,506	$1,445,324
Laundry starch, lb.	4,820,377	391,456
Potato starch, lb	2,055,472	177,353
Chinese starch, lb	1,263,227	122,284
Glucose (including all syrups), lb	64,803,113	4,191,098
Grape sugar, lb	688,378	37,392
Corn oil, gal	242,451	404,[illegible]59
Stock feed, tons	14,510	796,[illegible]49
Dextrine, lb.	655,070	54,949
Total		$7,620,864

Effect of Fittings on Flow of Fluids Through Pipe Lines

DEAN E. FOSTER presented the accompanying pipe-fitting equivalent tables and steam flow chart at the annual meeting of the A.S.M.E., New York, Dec. 7-10. To illustrate, an example may be taken of a 6-in. steam line 1,000 ft. long, containing five gate valves, three angle valves, twenty standard tees and ten standard elbows. From the lower table for vapors, these fittings are found to be equivalent to 332.10 ft. of 6-in. pipe, as follows:

5 Gate valves @ 4.81...	24.05
3 Angle valves @ 17.35...	52.05
20 Standard tees @ 6.35 ...	127.00
10 Standard elbows @ 12.90...	129.00
Total allowance...	332.10
Actual pipe length ...	1000.00
Equivalent total length	1332.10

The chart shows that with an initial pressure of 150 lb. and a total loss of 5 lb. pressure or 0.375 lb. per 100 ft. this line will transmit 225 lb. of steam per minute. If the effect of the valves and fittings had been ignored, the calculation would show a capacity of 260 lb. of steam per minute.

The upper table for liquid flow is used in conjunction with standard tables, Cox's flow of water through pipes, etc., in a similar manner. In both formulas,

L_e = feet of pipe equivalent to fitting.
d = diameter of pipe in inches.
r = factor of resistance.

STANDARD PIPE EQUIVALENTS TO ALLOW FOR FITTINGS IN CONDUITS CARRYING NON-VISCOUS LIQUIDS

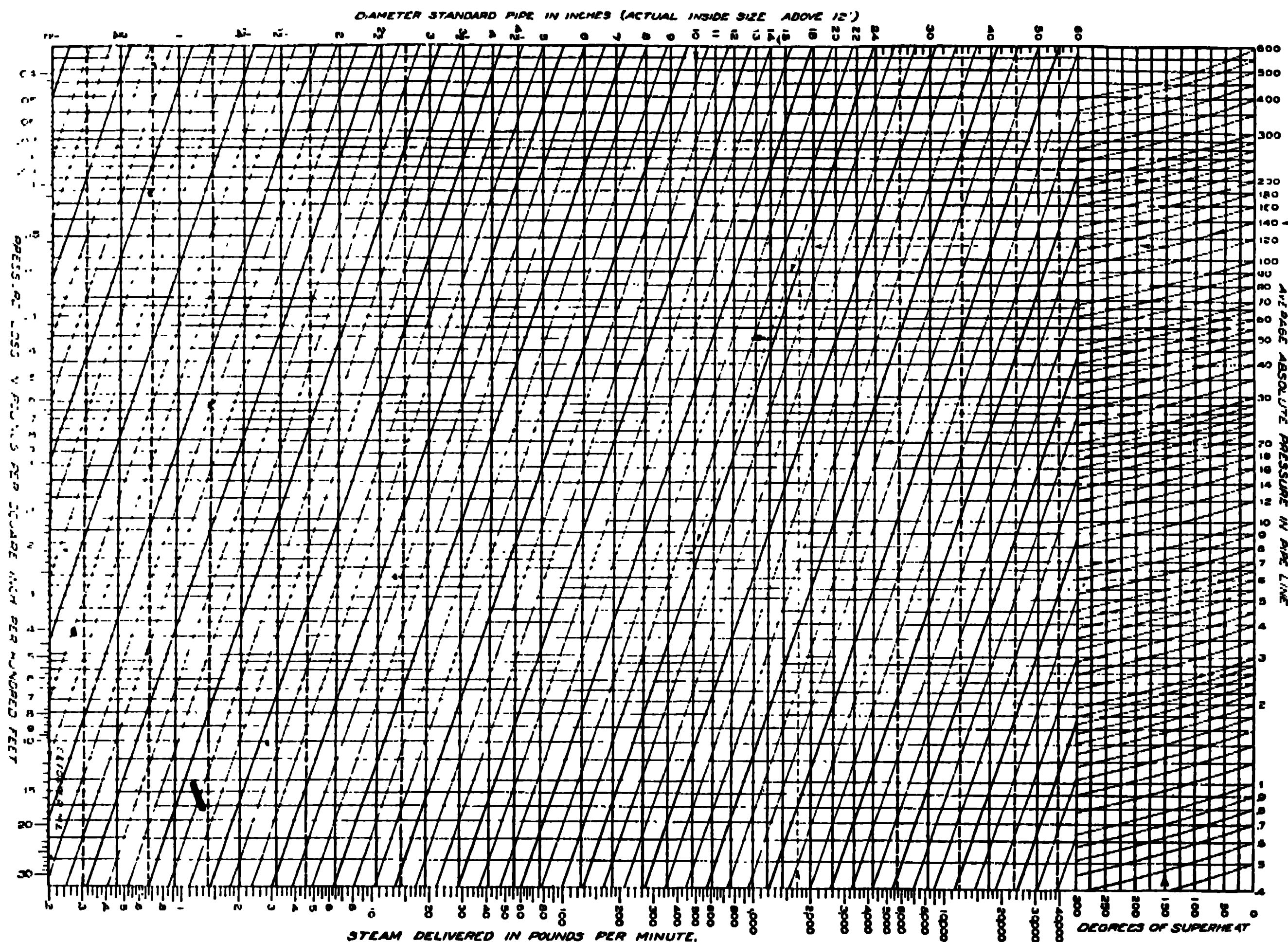
Formula Used: $L_e = 53.75rd^{1.25}$

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep El. or Standard Tee	Medium-Sweep Elbow or Tee Reduced in Size 1/4	Standard Elbow or Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance...		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
3/4	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1 1/4	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1 1/2	1.61	1.09	1.43	1.83	1.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2 1/2	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3 1/2	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4 1/2	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.20	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.60	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.09	64.80
10	10.020	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

CONDUITS CARRYING VAPORS OR GAS

Formula Used: $L_e = 43.7rd^{1.2}$

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep El. or Standard Tee	Medium-Sweep Elbow or Tee Reduced in Size 1/4	Standard Elbow or Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee Through Side Outlet	Globe Valve
Factor of Resistance...		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
3/4	0.824	0.044	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1 1/4	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1 1/2	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2 1/2	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.54	11.40	17.08
3 1/2	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4 1/2	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40



GRAPHICAL SOLUTION OF BABCOCK'S FORMULA FOR FLOW OF STEAM IN PIPE LINES

Determination of Atmospheric Impurities—II

A Description of the Nature of Atmospheric Impurities With Special Reference to Salt Lake City, Utah, Conditions—Methods and Apparatus Used for Their Determination—Results Obtained—Physical Character of the Solid Atmospheric Impurities*

BY OSBORN MONNETT

A SUMMARY of the results of atmospheric analyses of Salt Lake City, as described in Part I, showing concentration of solids, carbon dioxide and nitrous acid together with accompanying weather conditions is set down in Table I.

SOOT FALL STUDY

Twenty locations for the placing of soot fall jars were selected. During September, October and November earthenware butter crocks about 5 in. in diameter were used. The crocks were easily broken by rain water freezing in them and the glaze tended to chip off and contaminate the soot collected. Enameled ware pails 6.5 in. in diameter were then substituted. Care was taken to set the pails at a sufficient distance from stacks to avoid local contamination. At intervals of about one month clean pails were substituted for the exposed pails, which were taken back to the laboratory for weighing and analysis of the soot. Some trouble was experienced from the chipping of the enamel on the pails and it is believed that a copper vessel would be more suitable where freezing weather is experienced.

The soot was filtered from the water on a weighed ashless paper. After drying, the paper was weighed again and the gain in weight calculated to tons of deposit per square mile per annum.

The papers were then ignited and again weighed in order to determine the amount of combustible matter in the soot. The amount of soot collected was insufficient for further chemical analysis—e.g., determination of tar or composition of ash.

Table II shows the soot fall in Salt Lake City from Sept. 5, 1919, to April 20, 1920, calculated to tons per square mile per annum.

Interpretation of Results. The following general conclusions may be drawn:

1. Total solids and total combustible matter are low during the heating season—i.e., November to February.

2. The per cent of combustible matter in the deposit is, however, higher during the heating season, rising from 30 per cent to 40 per cent.

3. The amount of material deposited is highest in the center of the city and in the vicinity of the railroad yards, being about 200 tons in the residence district and probably 800 tons in the business district and railroad yards.

4. The per cent combustible matter is highest in the center of the city and in the vicinity of the railroad yards, being about 40 per cent, as against about 30 per cent for the residence district.

5. Average figures for the part of the city covered over the entire period are: Total solids, 349 tons per square mile per annum; combustible matter, 122 tons per square mile per annum; per cent combustible matter, 35. Average figures during the heating season are: Total solids, 250 tons per square mile per annum; combustible matter 95 tons per square mile per annum; per cent combustible matter, 39.

It is evident that a large part of the material caught in the soot fall jars is of non-fuel origin. The amount of solids in the jars seems to vary with the wind velocity, decreasing from November through February and then steadily rising until in April the amount is over three times as large as in December, January or February. Microscopic examination of the precipitates collected during September, October, March and April shows large quantities of soil and organic matter, while the solids collected during November, December and January are practically all of fuel origin. This is borne out by the figures for percentage of combustible matter in the solids. This averages about 30 during September, October, March and April and rises to 40 during December and January.

Analyses were made of the water in soot fall jars for the periods Dec. 18, 1919, to Jan. 24, 1920, and Jan. 24

TABLE I SUMMARY OF ATMOSPHERIC ANALYSES

Da		Lo tion	Av. Te	Wind — Ve	Wind — Di	Re Hu mid.	Vol Air Filtered	Conc., Mg per Cu In — So	Conc., Mg per Cu In — C	Conc., Mg per Cu In — H
Nov.	18	University......	44	4	N W	64	10 5	0 9	285	0 013
Nov.	24	3d W. 1 No......	40	5	SW-NW	54	7 1	0 4	385	0 009
Nov.	25	8 So Main......	33	5	N W	73	6 5	0 5	400	0 0018
Nov.	28	344 S. State...	37	7	N W.	63	10 1	1 0	340	0 0107
Dec.	3	Boston Bld.....	48	6½	N W	47	5 4	0 9	430	0 0125
Dec.	4	Boston Bld.	54	5	SE-NW	56	12 6	1 2	385	0 0163
Dec.	10	Boston Bld......	38	20	SE-SW	49	15 0	0 1	276	0 0052
Dec.	12	344 S. State ...	17	9	N W	78	7 3	0 7	315	0 011
Dec.	16	2 S & 5 E	21	3	SE-W	71	8 6	1 9	270	
Dec.	17	5 W & 1 No.....	23	4	SW-NW	75	9 1	1 1	415	0 0118
Dec.	22	344 S. State ...	28	4	N W	72	7 1	2 3	330	0 0322
Dec.	26	530 W 1 No ...	35	7	SE-NW	61	10 1	1 2	380	0 0132
Dec.	29	164 S 9th E... .	17	4	N W.	96	10 8	1 8	380	
Dec.	30	1650 S. State	18	5	N W	94	11 3	0 9	360	0 009
Jan.	2	43 W. 4th So	29	4	SE-NW	70	11 1	1 4	340	0 012
Jan.	16	344 S. State	36	4	S-SE	63	3 5	2 5	380	
Jan	18	164 S. 9th E	48	4	W-NW	55	12 1	1 7		
Jan.	27	344 S State	49	4	SW-W	52	10 6	0 9		
Jan.	28	580 W 1 No	45	3	N W.	59	13 4	1 5		
Jan.	29	344 S State .	41	3	NW SE	68	10 4	1 7		
Jan	30	580 W 1 No	43	4	N W	77	9 1	1 3		
Feb	11	344 S. State . .	37	4	W-NW.	51	10 0	0 8		
Feb.	12	344 S. State	44	4	S W	37	9 6	1 0		
Feb.	16	344 S. State .	44	8	N W	54	11 1	0 9		
Feb.	17	905 S State .	40	6	SW NW	50	11 7	0 2		
Feb.	18	344 S State .	48	5	SW NW	30	8 8	1 1		
Feb.	19	164 S 9th E	50	15	SE-SW	26	9 3	0 3		
Feb.	26	344 S. State .	40	7	S W	49	10 1	0 5		
Mar	5	344 S State	40	12	N W.	51	3 8	0 5	320	
Mar	8	344 S. State .	52	8	S W.	34	6 7	0 7	270	
Mar	12	Boston Bld......	48	8	S.W	37	6 3	0 1	270	
Mar	16	344 S State ...	42	10	S E	29	5 9	0 3	350	
Mar	19	164 S. 9th E.....	41	8	N.W.	49	11 2	0 9	350	
Mar.	22	164 S 9th E.....	47	17	S W	39	3 9	0 1	425	
Mar.	25	980 W. 2 So...	50	22	S SW	43	5 7	0 1	340	
Apr.	6	164 S 9th E	48	4	SE-SW.	54	15 0	0 7	340	
Apr	7	1646 S State.. .	57	9	N W.	56	8 2	0 2	285	
Apr.	8	905 S. State..	50	11	N W	83	11 6	0 3	285	
Apr.	9	580 W. 1 No ...	60	19	S-SW	27	11 7	0 2	310	
Apr.	10	344 S. State	.	.	......		8 0	0 1		

*For Part I see CHEM. & MET. ENG., vol. 23, No. 23, p. 1,117.

EDITOR'S NOTE: This is a chapter of the smoke-abatement report made by the Bureau of Mines in June, 1920, on its work in Salt Lake City, where it had the co-operation of the city and State University authorities. Published by permission of the Director of the Bureau of Mines.

TABLE II. SOOT FALL IN SALT LAKE CITY. CALCULATED IN TONS PER SQUARE MILE PER ANNUM

	Location	Sept 5–Oct. 15			Oct. 15–Nov. 4			Nov. 4–Dec. 18			Dec. 18 Jan. 24		
		Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible
1	756 N. 8 West	189			86	.	.	124	37	30	113	51	45
2	3 N. and Grant	272	95	35			..	173			161	73	45
3	914 W. 2 South	841			145		.	863	380	44	627	275	43
4	558 S. 4 West	446			371		.	735	286	39	671	302	45
5	3d W. and 1st N.				379	.		849	517	61	981	470	48
6	Main and N. T.	666	220	31	285			.			251	98	39
7	Federal Bldg	606											
8	8th S. and Main	351				.		306	77	25	75	53	71
9	1450 S. 4th E.	415	.		110		.	100	14	14	86	14	32
10	3d S. and 3d E				230	69	30				15	3	20
11	89 D St				189			156	34	22	93	32	34
13	425 E St	336	.		102			122	16	13	170	39	23
14	418 K St	137						118	26	22	51	.	
15	721 2nd Ave	221	58	26	196	58	30	133	.		103	58	57
16	735 S. 9th E.	190	44	23	129	35	27	76	17	22	113	36	32
17	318 S. 9 E	73			148			82	15	18	63	21	33
18	859 Emerson	152			152	..	.	213	42	20	92	39	42
19	University of U		.								580	128	22
20	120 H St		.		214	64	30	188	62	33	15	8	54
	Average by months	349	104	30	195	57	29	303	117	39	226	98	43

	Location	Jan. 24–Feb. 21			Feb. 21–Apr 1			Apr. 1–Apr. 20			Average by Location		
		Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible	Total Solids	Combustible Matter	Per Cent Combustible
1	756 N. 8 West	104	53	51	286	72	25	243	59	24	172	46	27
2	3 N. and Grant	160	72	45	252	83	33	..	.	.	218	82	38
3	914 W. 2 South		.		1,053	263	25	450	122	27	798	283	35
4	558 S. 4 West	817	335	41	900	315	35	829	315	38	780	300	38
5	3d W. and 1st N.	362	145	40	1,362	667	49	1,582	602	38	1,015	498	49
6	Main and N. T.				189	51	27	1,474	354	24	567	155	27
7	Federal Bldg	1,800	540	30	1,800	540	30	7,163	6,750	94	3,020	1,960	65
8	8th S. and Main	.			.				..		200	66	33
9	1450 S. 4th E.	94	30	32	330	106	32	378	136	26	184	53	29
10	3d S. and 3d E	368	110	30		.		.	...	.	172	51	30
11	89 D St	224	54	24	413	95	23			.	222	54	24
13	425 E St	80		.	295	35	12	1,042	125	12	308	42	14
14	418 K St	75	8	11	621	248	40	592	102	17	308	104	34
15	721 2nd Ave	137	33	24	490	284	58	533	165	31	275	116	42
16	735 S. 9th E.	106	17	16	266	.		407	94	23	152	37	24
17	318 S. 9 E	87	14	16	248	57	23	269	54	20	122	31	25
18	859 Emerson	142	17	12	348	69	20	559	106	19	248	52	21
19	University of U	.						248	136	55	467	131	28
20	120 H St	229	80	35	399	112	28	1,101	243	32	302	86	29
	Average by months	213	74	33	513	175	34	727	191	26	349	122	35

to Feb. 21, 1920. These are set down in Table III. Snow samples collected Dec. 15, 1919, at several locations in the city were also analyzed. The results have been set down in Table IV.

Physical Character of the Solid Matter Encountered in Smoke Abatement Study as Seen Under the Microscope

The solid material collected in soot fall jars, which were placed in various parts of the city, was examined microscopically in order to determine the physical condition of the individual particles. Since this material had been exposed to the elements during the period of deposition, the jars contained more or less water when collected which necessitated filtering and drying. During the filtering and consequent drying, the fine particles of soot and ash became so thoroughly imbedded in the mesh

TABLE III RAINWATER ANALYSES

Water Co[illegible]ted in Soot Fall Jars Calculated in Tons per S[illegible] Mile per Annum

18, 1919, to Jan. 24, 1920

Jar No.	Location		HNO_3	NH_3	Cl_2	H_2SO_4
2	3d N. and Grant Av	161	0 09	1 54	trace	24
3	914 W 2d South	630	0 79	1 56	0 07	74
4	558 S. 4th West	670	1 08	32 60	0 05	104
5	3d W and 1st North	980	0 53	6 15	0 04	138
6	Main and N T.	250	0 05	1 36	0 28	00
8	8th S and Main	75	0 19	1 74	0 03	31
14	418 K St ..	50	0 07	2 43	0 26	00
	J[illegible]920. to Feb 21, 1920					
2	3d N and Grant Av.	160	0 05	2 23	trace	
4	558 S 4th West	820	0 11	5 20	trace	
	3d W and 1st North	360	0 09	0 79		
	418 K St	75	0 06	0 62		

of the filter paper that only the coarser granular matter was available for microscopic examination. This coarse material was examined by means of the binocular microscope, the finer material being disregarded for the time, separate samples composed entirely of soot and ash being collected separately. It may be stated in a general way that the solid material collected in the soot fall jars is more or less similar in regard to the physical characteristics of the component particles. Practically the same class of solids was found in the jars from the different localities, although there was a noticeable difference in the amounts of the several classes of constituent grains and their size. When examined under the microscope the contents of the jars were found to contain clinker or fused material, coke, ash, soot, woody fiber, dust or siliceous material, organic matter and lint.

Clinker. The material designated as clinker comprises that portion of the solid matter which shows evidence of having been fused. It appears in varying amounts in all the soot fall jars and presents some interesting features when viewed under the microscope. There are three types of the fused material: (1) the hollow type, (2) the globular solid type, and (3) the irregular shaped, slaglike mass type.

TABLE IV. IMPURITIES IN SNOW

Snow collected Dec 15, 1919; from 1 sq ft. area to a depth of about 1 in This gave about 2.3 liters of snow, which melted to about 0.6 liter of water. Snow on ground seven days.

Jar No.	Location	Solids (Tons per Square Mile per Annum)	HNO_3	NH_3	Cl_2	H_2SO_4
1	756 N 8th West	88	0 69		.	..
3	914 W. 2d South	267	0 69	1 18	0 52	. .
4	558 S. 4th West	450	31 85	15 00	1.17	...
5	3d W and 1st North	2,100	21 65	1 18	....	134
14	418 K St.	40	0 74	6 00	....	...

1. The hollow particles are black in color and have a somewhat rounded irregular form or shell. Owing to the thin shell, they are quite easily broken, especially so since the shell is quite brittle. In the case of the larger particles these shells have one or more openings which, from their appearance, have been caused by the sudden release of gas from within while the slag or clinker was in a somewhat semi-molten or viscous condition.

2. The globular or glassy appearing particles range in color from that of a clear glass, through pearly white and various shades of brown to a slag black. They are of all sizes and all are apparently solid.

3. The small particles of irregular shaped clinker present no particular features of interest, although it may be stated that many of the black slag-like grains are attracted by the magnet, due to the presence of a small amount of iron.

Coke. The particles under this head are not true coke, although they resemble it in appearance. They are partly consumed particles of coal which have been carried up and out of the flues by the hot gases before the process of combustion has been completed. Shaking the grates and raking the furnace fires would tend to dislodge material of this nature together with quantities of ash.

Soot and Ash. As before stated, the wetting received during exposure to the weather made it a difficult matter to examine the soot and ash content of the soot fall jars. The presence of these two constitents was apparent, however, since the rains and snow had washed them into the pores of the coke and irregular shaped particles where they could be distinguished under the microscope.

Woody Fiber and Dust. Salt Lake City has no wood block paving and the woody material found in the soot jars consisted largely of the débris of various types of vegetable matter such as grass, straw and dried vegetation in general, together with partly burned splinters of wood and charcoal. Siliceous particles and other mineral grains were noted under the microscope, although they comprise but a relatively small portion of the solid matter found in the jars. The presence of this material in the jars can be attributed to the action of wind and air currents which have carried it upward into the atmosphere, whence it settled. The amount of this material in the air diminishes to practically nothing during the winter months, when the ground is covered with snow for the greater part of the time. The charred wood and charcoal are of stove and furnace origin and small quantities of these two constituents are present throughout the smoky season.

Organic Matter. The organic matter in the samples consisted chiefly of the remains of dead insects, some of which had undobutedly met their end in the jars, while in other cases their bodies had been deposited there through the agency of wind and air currents. The presence of this type of material is mentioned only as a matter of interest and merely shows that the air we breathe is laden to some extent with solids of many varieties.

JAR CONTENTS FROM DIFFERENT LOCALITIES

For the purpose of comparison, the solid matter collected may be considered under three heads: (1) Railroad yards and warehouse district, (2) business district and (3) residence district. The quantitative comparison, by weight, of the samples collected in the different localities has already been discussed.

The particles from the railroad yards and warehouse districts are as a rule larger in size than from either of the other districts and apparently contain a greater amount of unconsumed fuel or coke-like material. It is also noticeable that the relative amount of wood fiber, in the form of straw and grain husks, is greater than in the downtown and residence sections. While the bomb-like and slaggy clinker material occurs in the jars from all three localities, the particles from the railroad district are larger in size than in the residential section. The greater size of the individual grains, together with the predominance of partially consumed material in the downtown and warehouse districts, constitutes one of the most noticeable differences in the soot fall samples from the three districts. There is apparently less ash in the warehouse and railroad samples than in the samples from the downtown and residence portions of the city.

SOLID IMPURITIES SUSPENDED IN THE ATMOSPHERE

The solid particles described represent the material which is of such size and weight that it does not remain suspended in the atmosphere for any great length of time. It settles out within a comparatively short interval after emanation from stacks and himneys. There is another type of solid which has not yet been considered and which constitutes a considerable portion of the atmospheric pollution during the winter months. Soot or carbon particles in the air form a very annoying form of nuisance. They are present at practically all times when the atmosphere is smoke laden and exist in all sizes from the large flakes which are visible to the naked eye to particles which are only resolved under a high-power microscope. Many of these soot particles are of sufficient size and weight to settle in a comparatively short time after their introduction into the atmosphere. Others which are of microscopic size will remain suspended almost indefinitely, depending on size, humidity, air currents, etc. Samples of this finely divided soot were obtained by the use of the Hill Dust Counter, and when examined under the microscope show the presence of many particles of carbon or soot which range from 25 microns (1 micron one one-thousandth of a millimeter) in size down to particles which are just barely visible at high magnifications.

TABLE V. SOOT FALL IN SALT LAKE CITY COMPARED TO THAT IN OTHER CITIES

	Min	Max	Mean	Coal Consumpti
Leeds	25	539	220	1,500,000
London	58	426	260	16,000,000
Glasgow			1,325	3,250,000
Hamburg	345	690		3,000,000
Pittsburgh	595	1,807		
Salt Lake City	15	980	250	510,000

TABLE VI. ATMOSPHERIC IMPURITIES IN OTHER CITIES COMPARED WITH SALT LAKE CITY

City	Population	Coal Consumption, Tons per Annum	No. Particles per C.c.	Milligrams per Cubic Meter	Soot Fall Tons per Sq. Mile per Annum	Carbon Dioxide Parts per Million	Sulphur Dioxide Parts per Million	Total Sulphur Acids: [illegible] per Cu. Meter	Total Sulphur Acids: Tons per Sq. Mile per Annum	Chlorine: Milligrams per Cu. Meter	Chlorine: Tons per Sq. Mile per Annum	[illegible]	Ammonia: Milligrams per Cu. Meter	Ammonia: Tons per Sq. Mile per Annum
				Solid Impurities		Gaseous Impurities								
Manchester	725,000	3,000,000		...	240	311 403								
Leeds	..	1,500,000	32,000 228,000	..	25 539				63		38			4
London	....	16,000,000	400,000		58 426	345 439	0 0 6 0		69		26			41
Glasgow		3,250,000	228 000		1,325	336 502								
Berlin	2,100 000	3,150,000	...	0 06 0 31		307 402	0 5 0 7			1 3 3 0				
Hamburg	1,000,000	3,000,000	...	0 03 0 15	345 690	.		0 062 0 512						
Paris	2,700,000					243 422								
Cleveland	500,000	2,800,000		1 5 39 9		352 452		33 02						
Chicago	2,185,000	17,500,000		0321-1 958		317 374 Max 472		0 069 1 104		0 0253 0 2434		0 00153 0 01576	0 0055 0 0224	
Pittsburgh					595-1807									
Salt Lake City	140,000	510,000	....	0 0 2 5	15 980 Av 220	270 430 Av. 335	0 0 0 8 Av 0 1	0 1	62	0 002 0 034	0 1	0-009 0 032	0 001 0 080	7

It has been shown by investigators of mine dust that comparatively few particles of dust larger than 10 microns reach the lungs and the same condition probably obtains with regard to the soot particles. That a considerable amount of soot particles are taken into the lungs is evidenced by the examination of the lung tissue of deceased persons who had lived in a smoke-polluted atmosphere. Sections of lung tissue of such persons show clearly the presence of particles of carbon when examined under the microscope. The amount of the carbon particles in the lung tissue depends largely on the length of time which is spent in a smoke-laden atmosphere, but it is certainly a fact that long residence in a smoky city results in the deposit of an appreciable amount of carbon in the lungs.

Comparison of Atmospheric Pollution of Salt Lake City With That of Other Cities

Data for other cities are somewhat scanty and are not always expressed in units which admit of comparison with data obtained in Salt Lake City. The Chicago Smoke Abatement Commission[1] made a very thorough review of the literature on the subject of atmospheric pollution. The data here given have been taken from the above report.

Soot Fall. Comparison with results obtained in other cities is not easy owing to the difficulty in accurately estimating the composition of material collected in the soot fall jars. Obviously sand, soil and organic matter should be considered separately from that part of the solids which is of fuel origin. Except by laborious microscopic methods it is difficult to distinguish between coal ash and other mineral matter or between carbon from coal and that from organic matter.

In the winter in Salt Lake, with low prevailing winds and the ground covered with snow, it is safe to assume that the majority of the soot fall is of fuel origin. It is evidently these winter-time figures rather than the abnormally high spring-time figures which should be used in comparison with other cities where in general the smoke nuisance is not confined to one season as in Salt Lake. Such a comparison is made in Table V.

The mean soot fall for Salt Lake is as low as for any of the cities in the table. The maximum soot fall is higher than any with the exception of Pittsburgh and Glasgow. In comparison with its coal consumption Salt Lake shows a higher soot fall than any of the cities in the table, even if the smaller area be taken into account.

Other Impurities. In Table VI a summary of all data comparable with those obtained in Salt Lake City has been set down.

The table shows the concentration of solid matter in milligrams per cubic meter to be higher in the winter than for any other city with the exception of Cleveland.

Carbon dioxide does not differ much from the amount found in other cities.

Sulphur dioxide in Salt Lake is lower than in the other cities.

Sulphur acids in rain water and snow are about equal in amount to that found in Leeds and London.

Chlorine is low in comparison.

Nitrous acid is lower than in Chicago.

The maximum ammonia concentration is higher than in Chicago. Figured in tons per square mile per annum, the ammonia is about one-seventh that of London.

[1]Report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals, W. F. M. Goss, chief engineer. Rand, McNally & Co., Chicago, 1915, pp. 10-18.

Summary

A study of the character and amount of atmospheric impurities in the air of Salt Lake City has been made. This has included: 1. Estimation of the solids and gases present, including sulphur dioxide or smelter gas. 2. A soot fall study in which the amount of material settling at different locations has been measured and analyzed by months.

The results of this study show:

1. The concentration of solids in the atmosphere varies from less than 0.1 mg. per cu.m. to 2.5 mg. per cu.m. The highest concentrations occur during the heating season and in the business district. In the heating season these solids are practically all of fuel origin.

2. The total soot fall during the heating season averages about 250 tons per square mile per annum; 95 tons or about 40 per cent of this material is combustible matter.

3. Sulphur dioxide determinations showed an average concentration of 0.15 part per million during December and January and 0.01 part per million during March. The gas present is due to combustion of coal in the city. It is a negligible factor in the smoke nuisance.

4. The smoke concentration and soot fall is as high as that observed in cities consuming five to ten times as much coal yearly.

5. The results obtained afford a basis to judge the improvement made in future years.

Notes on the German Chemical Industry

Our correspondent in Germany reports on conditions in that country as follows:

The German dye trust, consisting of eight of the largest German chemical works, like the Badische Anilin- und Soda-Fabrik, Farbenfabrik Bayer & Co., Farbwerke vom. Meister, Lucius & Brüning, have decided to extend the life of its agreement, which was to run to Dec. 31, 1965, for another thirty-five years—i.e., up to the end of this century. Provision is thus made for a continuation of the present conditions for eighty years ahead. The firms in this trust have further decided to form a company with a capital of 500,000,000 marks to exploit the nitrogen industry. This company will take over the two nitrogen works in Oppau and Merseburg belonging to the Badische Anilin- und Soda-Fabrik. It is reported that the works at Oppau are fairly well employed. Of the normal number of workmen -8,400—6,000 are fully employed, while the remaining 2,400 will get full employment in the near future.

During the war the distribution of the total soda and potash production of Germany has been regulated officially by one of the so-called war companies. This state of affairs has now been terminated and the distribution has been given over to the trade again. This new step does not include the export and import, which are still tied to official licences.

The export of soda and caustic soda is still embargoed.

The demand for sal ammoniac has slackened considerably. The prices, which are regulated by the government, remain unchanged.

The demand for tar products is very strong. The demand for pitch, which was lifeless for a time, has now revived. Orders for benzene are still coming in with great pressure and can only partly be executed. The demand for cumaron has slackened and prices are going down.

Legal Notes

BY WELLINGTON GUSTIN

Directors Held Liable for Paying Unwarranted Dividends

The United States District Court, Eastern District of Pennsylvania, has decreed the directors of the American Galvanizing Co. to be personally liable for the debts of the insolvent corporation. Suit was brought against them by the United States Smelting Co. with the Picher Lead Co., Canada Metal Co. and Adam Hope & Co. as interveners. The case was before the same court in 1917 on a motion to dismiss the bill. The motion was dismissed and now a decree is entered against the directors. (261 Fed., 547.)

The American Galvanizing Co. had been in existence about nineteen months and was yet to declare its first dividend, when the directors declared a 500 per cent dividend. Almost immediately afterward the company by the act of these same directors was declared to be insolvent. It appears the company had entered into a number of contracts which began to mature and ripen into debt obligations payable about the time or shortly after the dividend was declared. It had outstanding contracts for the purchase of spelter, the raw material which it used in its manufacturing processes. These contracts proved the undoing of the company, as the drop in the price of spelter entailed a destructive loss upon it.

The company had done prosperous business and was in a prosperous condition at the time of the declaration and payment of the dividend. Including the contributions to its capital it had net assets valued at $71,134.99, and a surplus applicable to the payment of dividends of $58,940.85. Its capital stock was $10,000. It was contended by the directors that at the time the dividend was declared there was not only nothing to indicate the imminence of a loss, but, on the contrary, much to expect in the way of profit on its spelter contracts, because the spelter market was trending upward at the time. However, the court found that the market at the dividend date was so feverish and fluctuating and the general conditions such that there could not be said to be any stable market, and difficulty of securing supplies was so great that there was uncertainty as to future market conditions and an even greater uncertainty as to the manufacturing business.

On the date of the dividend the matured payable debts of the company did not exceed $2,200, but at the time of bankruptcy, a few months afterward, the total was many thousands, existing in the form of obligations resting upon executory contracts in the form of purchases of spelter for future delivery.

The court said that if there be actual fraud in the declaring of the dividend, then the statute of Pennsylvania making directors liable for the debts of the corporation if they declare and pay a dividend when the corporation is insolvent, or the payment of which renders it insolvent, need not be resorted to. The statute extends to cases beyond those of actual fraud. The measure of responsibility visited upon directors can be more readily sensed than expressed in a formulated rule of conduct. Because this is true, said the court, no honest director need be troubled with doubts whether he should favor or protest the declaration of a dividend. "No board of directors by the declaration of a dividend insures the solvency of the corporation. Such directors are held in the discharge of their duties only to the standard of the bona fide exercise of their best judgments."

There was no finding of fraud in the case, but only of facts upon which the law visits upon the directors a legal liability to pay the company's indebtedness.

The Ornstein Process of Chlorinating Water Upheld in Federal Court

A highly beneficial chemical process, as regards the public, is discussed in a patent suit of the Electro Bleaching Gas Co. against William G. Miller and another in the United States District Court at Kansas City, Mo. The Electro company is the assignee of George Ornstein, the inventor of process patent 1,142,361, for antisepticizing water. The invention "comprises a method wherein chlorine in determined amounts is uniformly distributed through and absorbed by a minor body of water flowing as a continuous current, and said minor body is then uniformly distributed through a major body of water, also flowing as a continuous current, all said operations being conducted without pause sufficient to allow disappearance of any substantial amount of said chlorine as free chlorine prior to exercising its antiseptic action."

DETAILS OF THE PATENTED PROCESS

It is said that the apparatus by which this process is made operative comprises an absorption tower, through which the minor flow of water passes downward to absorb an upwardly moving current of chlorine gas. The chlorine is supplied from a tank of compressed and liquefied chlorine gas, from which a pipe leads into the lower part of the tower. The tank is provided with a shut-off valve, and the supply pipe with a pressure-reducing valve and a regulating valve. Water is supplied to the tower from any suitable source, giving a substantially constant head through a pipe which leads into the top of the tower, and is provided with a shut-off valve and a regulating valve. The water-supply pipe is also provided with means for measuring the water flowing through it to the tower. For this purpose a suitable meter for indicating the quantity of water which has passed through may be used. The chlorinated water from the tower is discharged through a pipe to be united with the body of flowing water to be treated. The minor flow of water, after being chlorinated in the tower, is discharged directly into the water to be treated.

The absorption tower is formed of a vertically set shell of earthenware or other suitable material resistant to chlorine, filled, or substantially filled, with broken stone, coke or other suitable distributing material, adopted to film out the water and cause it to present an extended area of surface for contact with the ascending current of gas. The chlorine admitted to the minor flow of water is measured in determined proportion to the amount of water to be treated, but not necessarily with exactness in proportion to the minor flow. By this method a better and more effective solution is obtained, and better diffusion and distribution in the water to be treated, resulting in more complete and satisfactory sterilization of the water to be treated, less waste and

loss of chlorine, and less injury to the metallic part of the structure through the destructive action of the chlorine than can be accomplished by direct methods of introduction of the chlorine into the main body of the water to be treated; also excessive chlorination, with its attendant disagreeable features, is avoided.

The two main elements of the invention are the minor continuous flow of water and the regulation of the current of chlorine gas introduced therein in an amount predetermined according to the volume of water to be treated. The first of these employs as its vehicle the absorption tower with its appurtenances; the second element the pressure-reducing and regulating valves, with their attendant mechanism commonly called "regulator."

The defendants in the case manufacture the "Miller chlorine gas pressure regulator." It appears that the Miller regulator had been used by the city of Chicago and elsewhere to replace the corresponding part in the Electro company's apparatus. Contributory infringement of the process was predicated upon this use, charging the process of antisepticizing water which constitutes the invention by substitution of the vital element performed by the regulator.

Defenses to the Suit

There were two defenses to the suit: (1) That the alleged improvements set forth in the said letters patent were not novel and patentable when produced by Ornstein, and the patent is accordingly invalid. (2) Even though the patent be upheld, respondents are protected by the right of use, enjoyment, repair and improvement in the purchasers of the apparatus.

No Anticipation, Says Court

The first defense rested on an earlier patent by Darnell, No. 1,007,647, which was claimed to anticipate Ornstein's process and thereby rob the latter of novelty necessary to invention. The Darnell patent does deal with sterilization of water by treating with chlorine gas. But the court found that it deals with the direct communication of the chlorine to the body of water to be purified as distinguished from the indirect method by means of a minor flow, which is the distinctive achievement and advance accomplished by the Ornstein process. The court found further that the indirect method was both disclaimed and discredited in the Darnell patent, which says:

"The chlorinated lime or soda, or the chlorine gas, has usually been mixed with a certain quantity of water, and determined amounts of this chlorinated water have been introduced into the effluvia to be disinfected. This is not an efficient method of using chlorine, because in the process of fluid sterilization by chlorine the principal disinfecting agent is not the chlorine itself but the oxygen liberated from water by the action of chlorine on the water. . . . When, therefore, chlorinated lime, chlorinated soda or chlorine gas is admixed with a quantity of water and this water is afterward used to disinfect or purify large quantities of other water a great loss of efficiency is the result."

Mere Reference to Indirect Chlorination Discloses No Process

The court said the mere reference to indirect chlorination, without description and coupled with the declaration that such a method is inefficient, discloses no process and cannot anticipate even by suggestion. Darnell, in this very language, discloses that the vital principle of the Ornstein process remained unperceived. He says the chlorine gas had usually been mixed with a certain quantity of water and determined amounts of this chlorinated water had been introduced into the body to be disinfected. In the methods with which he had been familiar, if any, says the court, it would appear that chlorine gas was admixed with a quantity of water and this water was afterward used to disinfect or purify. It had never occurred to those who were studying this problem and who were endeavoring to get successful and satisfactory distribution and conservation of the disinfecting property of the chlorine that a predetermined amount of chlorine, in exact proportion to the body to be purified, might be introduced into that body through the instrumentality of an active minor flow to the volume of which the amount of chlorine used need bear no fixed ratio.

The idea of chlorine in determined amounts being uniformly distributed through a major body of water by means of a minor body flowing as a continuous current and carrying the chlorine in solution had not yet been conceived, it was said. This was the pregnant contribution of Ornstein to this art. One witness in the case, Prof. Jackson, stated in substance that "Ornstein discovered a principle that accomplished a result which all scientific students of the art had been vainly seeking for years and which converted previous uniform failure into pronounced success. Since this invention, the Ornstein method is rapidly displacing other methods of water purification and has given abundant evidence of its utility." Therefore the court concluded that the patent was not anticipated in any prior patent or scientific publication, and that same is valid and of great value to the public.

Charge of Contributory Infringement Upheld

Passing to the charge of contributory infringement, the court stated the rule to be that "where a person furnishes a machine, composition of matter or other article which is particularly adapted to be used in performing a patented process and which the person furnishing the same intends shall be thus used, that person is liable, as a contributory infringer, for any infringement which afterward occurs in accordance with his intention."

The right of replacement, improvement, substitution or resupplying of an element of a patented apparatus depends entirely on whether the purpose is legitimate repair in the sense of restoration of worn-out or broken parts, said the court. And in this case, where the owners of a process patent for purifying water licensed its use by purchasers of the apparatus by which it was made operative, defendants, who sold a device to two of such purchasers, one of whom assisted in installing it in place of one of the parts of the patentee's apparatus, were held guilty of contributory infringement, where the substitution was not made because the part was worn out, and where the parts supplied were not small and trifling in character. Neither did the fact that the device was adapted to other uses, or was not identical in size or form with the corresponding element in complainant's machine, relieve from contributory infringement. Further it was said that where a patentee of a process licensed its use in connection with machines sold by him, the continued right to use it could not accompany any radical transformation of his machine by repairs.

Graphic Calculation of Neutralization of Caustic Liquors With CO_2

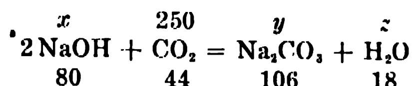
BY JOSEPH C. DITTMER

IN THE case for which the following method of calculations was originated, it was necessary to neutralize caustic soda liquor with carbon dioxide, the amount of liquor required for a given amount of gas being originally calculated by the foreman. As it was desired to have a simple method of calculation and one which the average process-man could work, the following graphical method was devised.

There are three factors capable of variation: the amount of carbon dioxide, the amount of caustic liquor, and the NaOH contents of the liquor. The amount of sodium hydroxide in the liquor is difficult to control, so that to keep its quantity constant is very inconvenient, but the amount of carbon dioxide is easily regulated, as it is usually taken from weighed cylinders. The amount of carbon dioxide will temporarily be fixed at 250 lb., and the two other factors will be permitted to vary according to conditions.

CAUSTIC LIQUOR EQUIVALENT TO 250 LB. OF CO_2

The chemical proportions of caustic and carbon dioxide may be taken from the reaction:



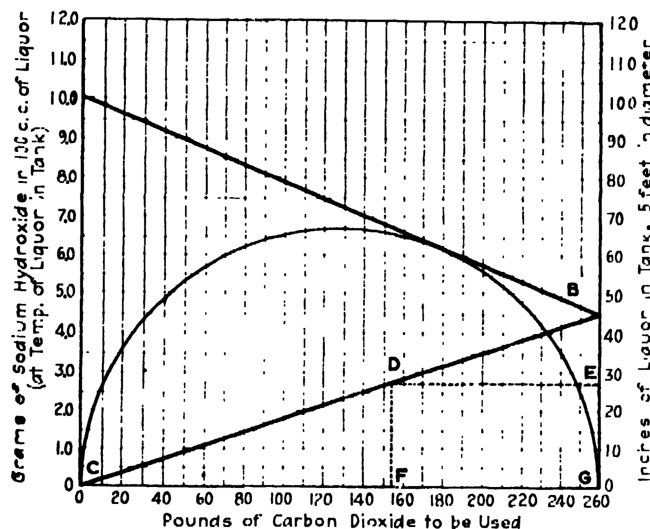
$$\begin{matrix} x & & 250 & & y & & z \\ 2\,NaOH & + & CO_2 & = & Na_2CO_3 & + & H_2O \\ 80 & & 44 & & 106 & & 18 \end{matrix}$$

from which the amount, x, of NaOH which 250 lb. of CO_2 will neutralize, is calculated as follows:

$$80 : 44 = x : 250 \text{ or}$$

$$x = (250)\ (80) \div 44 = 454.5 \text{ lb. of NaOH}$$

An analysis of caustic liquor gives 10.0 g. of NaOH in 100 c.c.; specific gravity 1.238.



The total amount of liquor needed to supply 454.5 lb. of NaOH is calculated from the proportion

$$10.0 : 123.8 = 454.5 : x$$

$$\text{or } x = (454.5 \times 123.8) \div 10 = 5{,}626.71$$

As the tank measures 5 ft. in diameter, the volume of 1 in. in depth is:

$$0.7854\ (5^2) \div 12 = 1.63625 \text{ cu.ft.}$$

The weight of this volume of liquor is:

$$(1.63625)\ (1.238)\ (62.5) = 126.6 \text{ lb.}$$

The number of inches of liquor needed is:

$$(454.5)\ (123.8) \div 10\ (102.26)\ (1.238) = 44.45 \text{ in.}$$

of liquor from 5-ft. tank to neutralize 250 lb. of CO_2. Ten times 44.45 gives 444.5, which may be used as an equation constant for 250 lb. of CO_2, a 5-ft. diameter tank and a test sample of 100 c.c. at the temperature of the liquor in the tank. Dividing this constant by the grams of NaOH in 100 c.c. of the liquor, the inches of liquor required for 250 lb. of CO_2 is obtained.

For more or less than 250 lb. of CO_2—e.g., 150 lb.—the following relation holds:

$$44.45\ (150) \div 250 = 26.67 \text{ in. in 5-ft. tank.}$$

GRAPHICAL SOLUTION

To find the number of inches of liquor from a 5-ft. tank corresponding to grams of NaOH per 100 c.c. graphically, a curve from which these values can be obtained is developed as follows:

Using a base line equal to the diameter of a circle with a radius equal to $\frac{1}{2}\sqrt{44.45}$, or 3.333 u., a perpendicular line is erected at each end, the vertical line at the left being used for plotting grams of NaOH (1 g. = ½ u.), and the line at the right inches of liquor (10 in. of liquor = ½ u.). Connecting each value in grams of NaOH with the resulting value in inches of liquor by a line, a half circle is determined to which these lines are tangent.

If x = grams of NaOH in 100 c.c. of liquor and y = number of inches of liquor for 250 lb. of CO_2, then $444.5 = xy$, as has been shown above.

For a value of x giving a line tangent to the curve and parallel to the base line: x_1 must equal y_1. As the values of y, as plotted, are ten times those of x, $y_1 = 10x_1$. Substituting this value in the equation $444.5 = xy$, gives $x_1 = 6.667$. As $y_1 = 10x_1$, $y_1 = 66.67$.

As the values of x are plotted according to the scale 1 g. = ½ u., a half circle drawn with a diameter of 6.667 u. will give the curve to which lines connecting "grams of NaOH" and their corresponding number of inches of liquor are tangent.

The diameter of the circle, 6.667 u., is based on calculations using 250 lb. of CO_2 and is shown in the accompanying figure.

To determine graphically how many inches of liquor are required for more or less than 250 lb. of CO_2, connect the value of inches of liquor (e.g., point B on the accompanying diagram) with the origin (point C) by a line forming a right angle triangle. Erecting a perpendicular at the point of the amount of CO_2 to be used (e.g., 152 lb.) and extending it to meet the line BC at D, the length of this line DF or EG will give the amount of liquor required for the amount of gas taken (152 lb.).

This method of calculation can also be used when the amount of caustic liquor is constant and the amount of CO_2 is variable. For example, with liquor testing 10.0 g. NaOH per 100 c.c. and given 26.7 in. of liquor, draw the tangent AB and the line BC. From the value 26.7 in. of liquor extend a line to meet the line BC and where it intersects at D, drop a vertical line, DF. The value at F gives the amount of CO_2 needed to neutralize this amount of liquor.

Using chlorine as the neutralizing agent, 250 (70.96) ÷ 44 lb., or approximately 403 lb., would be required to do the equivalent amount of work. Putting the base line equal to 403 lb., it is a simple matter to calculate the amount of liquor required for a greater or lesser amount of this gas.

Static Notched-Bar Testing Machine

A NUMBER of notched-bar testing machines using the impact method for determining the quantitative measurement of the brittleness and ductility of steel and other metals have been designed. These differ largely in the method of applying the impact blow, of supporting the specimen, size of test-piece, shape and size of notch. The following is a description of the machine recently devised by J. C. W. Humphry.

In breaking a notched-bar test-piece there are two governing factors at each moment: the angle to which the specimen is bent and the resistance which it offers to the external bending force. If a notched-bar specimen is broken slowly by static pressure the work expended is comparable with that measured by a dynamic impact machine and is much more effective in distinguishing between brittle and ductile metals.

The test-piece *A* (Fig. 2) is gripped in the vise *B* so that the jaws of the vise are in line with the notch in the test-piece. The socket *C* is attached on the projecting end of the test-piece and is a reasonably close fit. A bending stress is applied to the test-piece by means of the winch *D* and the wire *E*. The inner end

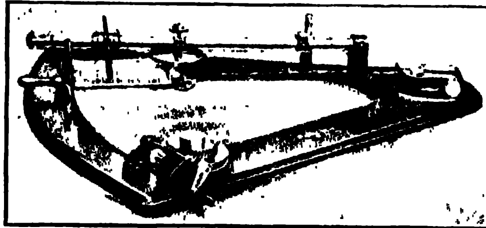


FIG. 1. STATIC NOTCHED-BAR TESTING MACHINE

of the spring bar is firmly fixed to the socket *C*. The outer end of the spring bar is supported by two rollers *G* and G_1. The socket *C* also carries a rigid bar *H*.

The deflection of the spring bar *F* is a measure of the bending moment applied to the test-piece. Since the rigid bar *H* is not subjected to any bending moment it will move through the same angle as the socket *C*, and this movement will therefore be a measure of the bending of the test-piece. The pen *J* slides upon the rigid bar *H*, its position being determined by the thin wires or cords *K* and *L* which are kept taut by a light spring *M*. One end of the wire *K* is attached to a post *N*

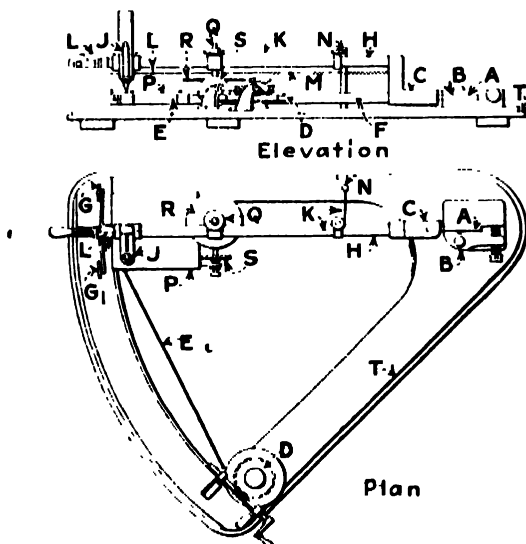


FIG. ELEVATION AND PLAN

so that as the rigid bar *H* moves in consequence of the bending of the test-piece the wire *K* will draw the pen to the right. The point of the pen marks upon a calibrated chart *P* carried on the spring bar *F*; therefore if the test-piece offers no resistance whatever to bending force the pen would draw on the chart a

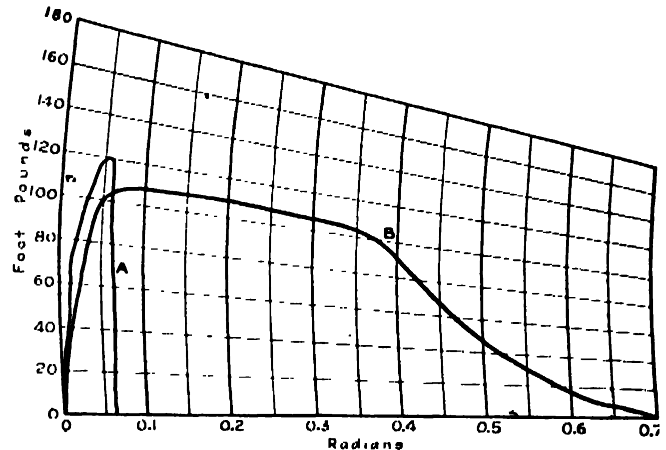


Fig. 3. A—Curve showing brittleness of nickel-chrome steel which has been made brittle by cooling from the tempering temperature. B—Curve showing ductility of a specimen of soft brass.

horizontal line, the length of which is proportional to the angle through which the test-piece is bent. However, as the test-piece does offer resistance to bending there will be resulting motion between the spring bar *F* and the rigid bar *H*.

Assuming the test-piece was infinitely rigid and did not bend at all under applied force, the pen would draw a vertical line on the chart, the height of this line representing the bending moment applied.

In actual practice, however, both of these effects are operative at the same time, with the result that with a brittle test-piece we get a curve represented in Fig. 3 by *A*, and with a ductile sample a curve shown by *B*.

The total energy absorbed in the breaking of the test-piece can, of course, be calculated easily from the diagram or graph. The machine is also fitted with an integrating device. This device is shown in Figs. 1 and 2. The wire *K* passes round a pulley *Q*. The pulley *Q* is attached to a spindle having at its lower end a friction disk *R* so that the bending of the test-piece, which results in the movement of the pen to the right, also results in a proportionate rotation of the friction disk *R*.

The lower face of the friction disk *R* rests upon the edge of the friction wheel, not shown. The spindle of the friction wheel is carried with the chart plate upon the spring bar *F*. When the bending moment is zero the friction wheel is at the center of the friction disk, but as bending moment is applied and there is therefore relative motion between the spring bar F and the rigid bar *H* the friction wheel travels toward the circumference of the friction disk and is consequently rotated. The rotation will be proportional to the product of the bending moment applied and the angle of bending of the test-piece, and this device will therefore integrate the total energy absorbed in breaking the test-piece. Mounted upon the outer end of the spindle which carries the friction wheel is an index disk *T*, which can be calibrated to read direct in foot-pounds.

The whole machine is mounted upon a rigid and heavy metal base *T* and is arranged for convenient and rapid operation by relatively unskilled users.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Vulcanizing India Rubber.—India rubber in solution is vulcanized by the addition of sulphur and small quantities of nitrosobenzene or a similarly constituted nitroso-hydro-carbon of the cyclic series. In an example, 10 g. of rubber and 1 g. of sulphur are dissolved in 150 g. of carbon disulphide. There is added 0.6 g. of nitrosobenzene and the solution shaken. In about thirty minutes the solution sets to a jelly which on evaporation of the solvent yields vulcanized rubber, insoluble in the solvents for raw rubber. (Br. Pat. 146,734—1919; S. J. PEACHLEY, Davenport, Stockport, Sept. 22, 1920.)

Separating Dust From Gases.—A device for removal of dust from gases evolved in the roasting of ores consists of a chamber in which the current of gas passes at right angles through curtains consisting each of several parallel rows of chains which may be magnetized, the curtains being separated by spaces forming depositing chambers; the chains of consecutive rows of a curtain being disposed so as to split the current up as much as possible. The chains of a row may be fastened together, while the chains of the rows forming a curtain are connected to wires by which they may be shaken at intervals when no gas is passing. Dust falling to the bottom is carried outside the chamber by a screw conveyer. The chains of successive rows of a curtain may be disposed in echelon vertically or horizontally. (Br. Pat. 147,020—1919; MANUFACTURES DE PRODUITS CHIMIQUES DU NORD, Establissements Kuhlmann, Paris, Sept. 22, 1920.)

Phenol Aldehyde Condensation Products.—In the production of insoluble infusible condensation products from phenols and formaldehyde or its polymers, the phenol is first condensed with the formaldehyde in the presence of an ammoniacal catalyst (ammonium carbonate or phenate) and the product is heated at 75 to 80 deg. C. until its viscosity has considerably increased; it is then mixed with an acid catalyst, particularly ethyl hydrogen sulphate, and converted into the final product at ordinary or only slightly raised temperature. The ethyl hydrogen sulphate may be added in alcohol solution and the product employed as a varnish. The product of the first stage of the process may be acetylated by treatment with acetic anhydride, and the acetylated product then treated with ethyl hydrogen sulphate. The acetylated products may be mixed with acetone solutions of cellulose acetate. (Br. Pat. 147,173—1919; J. FIHOL, Lyons, France, Sept. 29, 1920.)

Treating Cellulose-Containing Materials.—To avoid the deleterious effect of alkalis, acids and salts on cellulose fibers and also on the byproducts resin, tannin, carbohydrates, etc., due to the high temperatures obtained in the ordinary methods of treating wood and other cellulose-containing materials under pressure, the pressure is produced externally and independently of the temperature used, by forcing or pumping air or other gas or suitable liquids, such as that used for treating wood, into the apparatus in which the material is being treated. Fifty atmospheres pressure or more may be used. The apparatus may be first exhausted, and alternate vacuum and pressure may be applied repeatedly. The process may be applied to reagents used for other purposes such as saccharification. (Br. Pat. 147,232—1919; ZELLSTOFFFABRICK WALDHOF, Mannheim, Germany, Sept. 29, 1920.)

Precipitating Bath for Artificial Threads.—A precipitating bath for artificial threads, etc., more particularly of viscose, consists of the crude mixture of carbohhydrates, etc., obtained on hydrolyzing wood or other cellulose-containing materials with mineral acid; the acid in the bath may be partly or completely neutralized, and other reagents such as ammonium sulphate, sodium bisulphate, formic acid, lactic acid and alum, may be added. In an example, sawdust is kneaded with 80 per cent sulphuric acid, left to stand, diluted with water, and the mixture heated; the hydrolyzed mass is concentrated, partly neutralized, filtered and treated as above, or it may be completely neutralized and concentrated to a sirup or to crystallization. (Br. Pat. 147,416—1919; ZELLSTOFFFABRICK WALDHOF and V. HOTTENROTH, Mannheim, Germany, Oct. 6, 1920.)

Hydrogenating Naphthalene.—Naphthalene is hydrogenated by treating while in the fused state and at a temperature above 100 deg. C. with hydrogen in the theoretical quantity and in the presence of a catalyst. Decahydronaphthalene or other less highly hydrogenated products are obtained, and these products are suitable as lamp, motor and lubricating oils, etc. In an example, naphthalene is purified by fusion with fuller's earth or other porous material, after separation mixed with a catalyst consisting of finely divided nickel precipitated on a porous material, and the spongy mass so obtained treated at a temperature of 120 to 150 deg. C. with hydrogen under 3 to 100 atmospheres pressure. (Br. Pat. 147,474—1919; G. SCHROETER, Berlin. See also Br. Pats. 147,476, 147,488 and 147,580—1919. Oct. 6, 1920.)

Alkali Hypochlorites.—A stable preparation for bleaching and disinfecting is prepared from alkali bicarbonates and solid basic magnesium hydrochlorite. In the form of tablets, the mixture remains undecomposed for an indefinite time, and on adding to water, the alkali bicarbonate (potassium bicarbonate is preferably used) attacks the basic magnesium hypochlorite, forming a hypochlorite solution. As this reaction takes place at a continually decreasing velocity, the content of available chlorine, after a short time, tends to remain constant, for the loss due to spontaneous decomposition is partly counterbalanced by the generation of a further quantity of soluble hypochlorite. In the first of two examples dry sodium bicarbonate is mixed with one-third of its weight of basic magnesium hypochlorite, and in the second, this mixture is agitated with water. (Br. Pat. 147,535—1919. G. KERESZTY and E. WOLF, Budapest, Hungary, Oct. 6, 1920.)

Disinfecting Air.—Air is disinfected by passage through a packed tower in counter-current to a solution of ozone in water containing substances serving to increase the solubility of the ozone and to bind it in solu-

tion, prepared according to the process described in German Specification 297,335. The solution, after use, is treated with ozone in a second tower so that it may be used again and the process rendered continuous without the addition of further fresh solution. A portable apparatus may be used and the treated air is stated to be free from ozone and to be suitable for use in the treatment of wounds and of diseases of the breathing-organs. (Br. Pat. 147,566—1919. A. WOLF, Berlin, Oct. 6, 1920.)

Treating Textile Materials.—Textile fibers, such as wool, hair or other animal fibers, cotton, linen or other vegetable fibers, are mixed with a cellulose solution adapted to be converted into artificial silk by treatment with water, acids, ammoniacal copper oxide, zinc chloride or other suitable substances. Artificial fibers may be mixed with a cellulose solution of different composition. A solid mass is thus produced in which fibers are distributed. The fibers may be added while the artificial silk is being formed. The mixture may be allowed to dry in mass and may be reduced by cutting or otherwise to threads, bands, films or non-coherent fibers which may be spun, or the mixture may be molded into cord-shaped masses which may be comminuted to obtain fibers suitable for spinning. The mixture may be forced through tubes and on being introduced into a fixing agent may be drawn out to form threads or films. Bands or films may be formed by mechanical pressure and then treated with fixing agent and dried, the dry films, bands and threads being reduced to spinning fibers by well-known comminuting methods, or the bands may be twisted direct. (Br. Pat. 147,585—1919. E. CLAVIEZ, Adorf, Germany, Oct. 6, 1920.)

Utilizing Waste Rubber.—To recover textile material in a form suitable for spinning or paper making and rubber from waste rubber fabric, such as old cycle or motor tires, the fabric is cut into coarse fragments and treated with solvent under the influence of heat in a closed drum. The fragments are kneaded or agitated mechanically in the solvent until the whole of the rubber has passed into solution. The rubber solution is then run off and distilled to obtain the rubber, and remaining fragments of textile material washed with a fresh lot of solvent, which may be used afterward to treat the next charge. (Br. Pat. 147,628—1919. F. WAITZ, Bremen, Germany, Oct. 6, 1920.)

Preparation of Zinc Sulphide.—Anhydrous zinc sulphide is prepared as described below from the hydrated sulphide obtained by treating zinc hydroxide, heated to 90 to 100 deg. C. by means of steam, with sufficient sodium sulphide. The resulting caustic soda is decanted off and is used to prepare a fresh amount of zinc hydroxide from zinc sulphate. Periodically it is necessary to purify the caustic soda by crystallization and to reject the mother liquor which becomes charged with impurities. The precipitation of the zinc hydroxide is performed hot, to avoid the formation of a gelatinous product of low density, and the sodium sulphate simultaneously produced is used to prepare barium sulphate and sodium sulphide from barium sulphide. The latter is obtained by the reduction of barium sulphate by means of carbon, thus completing the cycle in which zinc sulphide and precipitated barium sulphate are obtained from zinc sulphate, barium sulphate and carbon. The hydrated zinc sulphide after being washed free from alkali is filtered and dried at 100 deg. C. or in a vacuum. It is then mixed with sulphur and heated to 450 to 500 deg. C. in a muffle furnace, thereby volatilizing any cadmium sulphide, and is allowed to cool with exclusion of air. To prepare a lithopone, the precipitated barium sulphate after washing and drying is mixed with the desired proportion of zinc sulphide in an iron revoluble horizontal cylinder and finally passed through a fine sieve. (Br. Pat. 147,658—1919. J. DE COPPET, France, Oct. 6, 1920.)

Preparation of Hydrofluoric Acid. — Hydrofluoric acid is prepared from sulphuric acid, preferably in the form of monohydrate, and a natural fluoride such as fluorspar by thoroughly mixing equivalent quantities of the two substances with a solid such as finely-ground anhydrous calcium sulphate and heating to 200 to 300 deg. C. By feeding the material into a muffle furnace of the Mannheim sulphate type which is provided with mechanical stirring and discharging devices, the process becomes continuous and the handling of the resulting calcium sulphate charged with hydrofluoric acid is avoided. The hydrofluoric acid may be collected as such, or it may be absorbed by means of alkalis, thereby yielding alkali fluorides. The residual calcium sulphate is used in the preparation of fresh charging material. (Br. Pat. 147,711—1919. VEREIN CHEMISCHER FABRIKEN, Mannheim, Germany, Oct. 6, 1920.)

Oxidizing Oils.—In the oxidation of oils by exposure to oxygen, air or other gas containing oxygen a large reacting surface and easy separation of the viscid or solid product is obtained by mixing the oil with a dispersive medium or diluent that melts at a lower temperature than the product and so is separated by pressure or by centrifuging, or with one from which the product is separated by dissolving out the diluent or the product. Accelerators of the reaction, such as lead or manganese compounds of resinous acid or other siccatives may be added, and linoleum cement may be made directly by addition of gum kauri, colophony or other matters usually added to the oxidized oil. Dispersives or distributors mentioned are neutral or basic salts, such as sodium sulphate or chloride, which are removed from the finished product by washing with water, and tallow, Chinese tallow, paraffine wax, ceresine, stearine, colophony and fully hydrogenated sunflower oil, which are melted to dissolve the oil, the solution being then sprayed or allowed to set and crushed or scraped to obtain a fine powder; or a porous form is obtained by blowing in air during setting if this porosity is not formed naturally. In an example, 750 kilos completely hardened sunflower oil, 22.5 kilos of manganese resinate, and 250 kilos of linseed oil are melted together, allowed to set, powdered, turned over mechanically for about eight hours, melted and pressed. In another, 650 kilos sodium sulphate and 350 kilos train oil are mixed and treated with a current of air in a rotary drum that may be heated up to 110 deg. C. until oxidation is complete. The sulphate is removed by lixiviating with water, or the oxidized oil is extracted by a solvent. In a third example, 800 kilos perfectly hardened sunflower oil, 200 kilos linseed oil and 6 kilos manganese resinate are melted, and air is driven into the mixture as it sets until it is pasty. It is then poured into molds and the porous slabs allowed to stand for twenty-four hours, melted and pressed. (Br. Pat. 147,661—1919. G. SCHICHT AKT. GES., Aussig, and A. EISENSTEIN, Leitmeritz, both in Czechoslovakia, Oct. 6, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Minerals Separation Loses Its Appeal

On Dec. 9 the Circuit Court of Appeals in Philadelphia handed down an opinion in which it most fully sustained Judge Morris' several orders, by which the District Court in Wilmington had dismissed several applications of Minerals Separation of various supplemental bills, in which it sought to have the Miami Copper Co. found in contempt of court and enjoined from continuing to operate its present flotation methods.

Minerals Separation had appealed these orders upon the ground that the District Court had erred in refusing injunctive relief by virtue of its orders of July 23, 1920, and as interpreted and supplemented by an opinion filed July 29, and an order of the court entered Aug. 11, 1920. (See CHEM. & MET. Eng., Aug. 11, 1920, pp. 221 and 254.)

The Circuit Court of Appeals finds that the trial court did exercise its discretion as to proceedings in contempt, and as it held "that the facts set up by the petition are not of the character required to sustain a judgment in contempt," the present opinion infers that the District Court evidently meant that the modification or changes were not plainly mere colorable equivalents of the procedures found to infringe, and that it did not abuse its discretion, adding, "He arrived at the same conclusion at which we would have arrived if we had been in his place."

The opinion of the Circuit Court of Appeals goes thoroughly into the questions as to whether the trial judge rendered his judgment upon a wholly wrong comprehension of the facts or the law, and whether, accordingly, he abused his discretion, "the only respect in which an appellate court will disturb such an order."

This opinion not only most positively asserts that the trial judge has not made any of these errors, but, in ending, adds: "We would have made the same disposition of the case had we been sitting in the District Court."

Conference Committee to Hold Hearings On Patent Office Bill

Plans were perfected on Friday, Dec. 10, for a conference immediately after the holiday recess of Congress on the Nolan Patent Office bill. Contrary to the usual custom, the Conference Committee will conduct hearings, at which further testimony in regard to the bill will be taken.

Section 9 of the Nolan bill adds to the measure the bill originally drafted by Dr. F. G. Cottrell authorizing the Federal Trade Commission to administer patents granted to Government employees. There is considerable opposition to section 9 and it is understood that Dr. Cottrell, Dr. Andrew Stewart and other proponents of the section are unwilling to have it jeopardize the remainder of the Patent Office bill.

Senator Norris, chairman of the Committee on Patents of the Senate, and Representative Nolan, chairman of the Patents Committee of the House are not inclined to eliminate section 9, it is reported.

Meeting California Section, A.C.S.

The annual meeting of the California Section, A.C.S., was held on Dec. 3 at the Engineers' Club in San Francisco. Officers were elected for the ensuing year as follows: Chairman, Dr. W. C. Bray; vice-chairman, B. S. Drake; secretary-treasurer, L. W. Chapman; councillors, Dr. L. H. Duschak, R. A. Gould, Dr. Joel Hildebrand and Dr. R. E. Swain.

Two interesting papers were presented. Prof. S. W. Young of Stanford University discussed the efficiency of the various laboratory types of still-heads used in fractional distillation and described a new type by which it is possible to obtain increased efficiency.

Ludwig Rosenstirn, of the Great Western Electrochemical Co., reviewed the history of the chlorine industry and its relation to the alkali industry, discussing the present status and the effect of the development of the electrolytic process for the production of chlorine and its compounds upon the chemical processes; thus pointing out the importance of a thorough understanding of related industries in the successful conduct of present-day chemical manufacturing.

To Try to Pass Dye Bill

After a conference among those interested in the dyestuffs tariff bill, held in the office of Representative Longworth of Ohio, it was decided to make every effort to secure tariff legislation on dyestuffs at this session of Congress. It was stated at the conference that the failure to enact tariff legislation is having a most untoward effect on the dye industry. Unless this legislation is obtained promptly it was predicted that all but the low-cost producers would be forced to suspend operations. Senator Watson, the acting chairman of the Finance Committee of the Senate, is willing that the dye bill be taken up at the earliest possible moment. Due to the fact that the appropriations bills have right of way and to the fact that there is very determined opposition to the dye bill now on the calendar, it would not be difficult for its enemies to prevent its enactment.

Chlorine May Have Therapeutic Value

The fact that workers in the chlorine cell room at Edgewood Arsenal have been singularly free from any diseases of a pulmonary or bronchial type leads officers of the Chemical Warfare Service to believe that this gas has therapeutic properties. This fact was first noted during the influenza epidemic. Outside of the chlorine room there were numerous cases of influenza, in some rooms amounting to one-third of the number employed. There was not a case in the chlorine room. Since that time the matter has been a subject of some observation, but no technical study has been made of that particular property of the gas. The belief that the gas may have this value is strengthened by the report of the Surgeon General of the Army showing that practically none of the gas casualties were followed by tuberculosis.

Mechanism of Catalytic Processes

A meeting which brought together the New York Sections of the American Chemical Society, American Electrochemical Society, Société de Chimie Industrielle and the American Section of the Society of Chemical Industry was held in Rumford Hall Friday evening, Dec. 10.

A letter from Dr. Parsons conveying to the Section the resolution and recommendation adopted by the Committee on National Policy in regard to the Nolan Patent Office bill was read by the secretary.

Officers of the New York Section, A.C.S., for 1921 were elected as follows: Chairman, John E. Teeple; vice-chairman, Martin H. Ittner; secretary-treasurer, Herbert G. Sidebottom; executive committee, D. W. Jayne, C. H. Herty, C. A. Browne, R. H. McKee.

Dr. Parsons then called attention to the position of the dye bill. It is highly important, he said, that action should be taken during this session of Congress, as the passage of a peace resolution in the spring will jeopardize the dye industry unless protection is assured. Members were asked to send telegrams or to write to their Senators urging immediate action.

Mechanism of Catalytic Processes

Prof. Hugh S. Taylor of Princeton in a paper on "The Mechanism of Catalytic Processes" reviewed the theories which have been advanced in explanation of the phenomena of homogeneous and heterogeneous catalysis and presented the results of research designed to test experimentally the rival hypotheses.

Homogeneous Catalysis

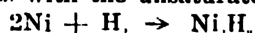
While examples of homogeneous catalysis—such as the hydrolysis of esters and the inversion of cane sugar—have been known for many years, few attempts were made to study the mechanism of the process until comparatively recently. A constantly increasing mass of evidence points toward the formation of intermediate compounds as being the correct explanation. Thus in the case of ester hydrolysis, ester and acid form a binary compound which in turn unites with water to form an unstable ternary complex, capable of breaking down to from either the original substances or the reaction products of hydrolysis. It has been demonstrated that aqueous solutions of an ester and an acid contain definitely measurable quantities of such complexes. A very recent theory involving the absorption of infra-red radiations has not been satisfactorily studied from an experimental point of view.

During the war there was in some European countries a simultaneous demand for fats and glycerine. By the application of homogeneous catalysis it was found possible to replace the glycerine in fats by mannitol and thus obtain both fat and glycerine. The possibilities of such ester exchange are but little realized.

Heterogeneous Catalysis

Four theories as to the mechanism of heterogeneous or contact catalysis have received careful consideration. Taking the hydrogenation of unsaturated compounds in the presence of nickel as an example, the theories may be summarized as follows:

Sabatier believes that the nickel forms a hydride which then reacts with the unsaturated compound.



$$2Ni + H_2 \rightarrow Ni_2H_2$$



$$Ni_2H_2 + C_2H_4 \rightarrow C_2H_6 + 2Ni$$

Bancroft believes that there is selective adsorption of the reaction products but admits that this hypothesis fails to explain the increased yield of ethylene obtained when steam is mixed with alcohol vapor before being passed over alumina.

Armstrong maintains that the nickel forms a loose complex with the carbon-containing substance, which then reacts with the hydrogen.

The effect of infra-red radiations is held by Lewis to account for the adsorption of hydrogen by nickel, the hydrogen molecule dissociating in the presence of these radiations to form hydrogen atoms.

Experimental Investigation

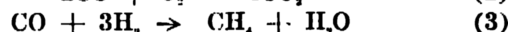
In order to get at the facts, Prof. Taylor devised a series of experiments to test out the following reactions:



$$2H_2 + O_2 \rightarrow 2H_2O \quad (1)$$



$$2CO + O_2 \rightarrow 2CO_2 \quad (2)$$



$$CO + 3H_2 \rightarrow CH_4 + H_2O \quad (3)$$



$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O \quad (4)$$



$$C_2H_4 + H_2 \rightarrow C_2H_6 \quad (5)$$

A glass tube containing nickel precipitated on Nonpareil brick was evacuated and the amounts of nitrogen, hydrogen, carbon monoxide, carbon dioxide and ethylene required to fill the tube at different temperatures were carefully measured. Plotting temperature as abscissa and c.c. of gas as ordinate, some very interesting curves were obtained. Nitrogen which was used as the reference gas gave a line approaching the temperature axis with increasing temperature. CO_2 and H_2 gave lines lying above the N line in the order given, and parallel to it. Since CO forms nickel carbonyl at low temperatures and decomposes into CO_2 and C at high temperatures, only one point could be obtained on this curve (175 deg. C.), but this was above the curve for H_2. Similarly C_2H_4 gave a point still higher at 175 deg. C. This would indicate that Ni adsorbs C_2H_4 in preference to H_2.

In similar experiments with copper, the H_2 and CO_2 lines were found to coincide with the N_2 line within the limits of experimental error, while CO and C_2H_4 were markedly adsorbed at low temperatures. At higher temperatures these curves also coincide with the N_2 curve.

Further studies with mixtures of these gases have led to the conclusion that a bimolecular reaction in the gas phase may become a monomolecular reaction on the surface of the catalyst. The catalytic oxidation of SO_2 to SO_3 is an example of this phenomenon. With high concentrations of SO_2 and O_2 the reaction is not termolecular as required by the law of mass action, but toward the end of the reaction series the reaction does become termolecular.

Experiments are now being made using the reaction products of equations 1 to 5 where these have not already been studied.

C.W.S. Asks for $4,457,376

Congress has been asked by the Secretary of War to appropriate $4,457,376.20 for the Chemical Warfare Service during the coming fiscal year. Approval was not forthcoming for twice that amount, which General Fries had estimated for the thorough conduct of the work of the next year. This curtailment of the appropriation will limit greatly the plans for quantity production of gas masks. In addition $35,000 is asked for the maintenance of Chemical Warfare Service schools.

Bureau of Standards Appropriations

Among the appropriations asked by the Bureau of Standards for use in pursuing its work during the next fiscal year are the following:

For metallurgical research, including alloy steels; properties of aluminum alloys; development of metal substitutes; investigation of new metallurgical processes, $70,000. This is an increase of $45,000 over the current appropriation.

For apparatus, machinery, appliances, laboratory supplies, furniture for laboratories and cases for apparatus, $90,000. Increase, $15,000.

For testing varnish materials, soap materials, inks and chemicals, $50,000. Increase, $20,000.

To develop color standards and methods of manufacture and of color measurement, with special reference to their industrial use in standardization and specification of colorants such as dyestuffs, inks and pigments, $12,000. Increase, $2,000.

To study methods of measurement and technical processes used in the manufacture of pottery, tile and other clay products $35,000. Increase, $10,000.

For the investigation of the problems involved in the production of optical glass, $40,000. Increase, $15,000.

To investigate textiles, paper, leather and rubber in order to develop standards of quality and methods of measurement, $40,000. Increase, $25,000.

For the standardization and design of sugar-testing apparatus, $40,000. Increase, $10,000.

High-temperature measurement investigation, $15,000. Increase, $5,000.

To determine experimentally important physical constants of materials, $25,000. New appropriation.

For purchase, preparation and distribution of standard materials to be used in checking chemical analyses and in the testing of physical measuring apparatus, $15,000. This is a new appropriation.

For investigation of the problems involved in the electro-deposition of metals, $15,000. New appropriation.

For the equipment, maintenance and operation of a low-temperature laboratory and the production of liquefied gases, $15,000. This is a new appropriation.

For an investigation of radio-active substances and the methods of their measurements and testing, $15,000.

Tariff Hearings Begin Jan. 6

So as to expedite the revision of the tariff, the Ways and Means Committee of the House of Representatives plans to complete its hearings during the present session of Congress, so that the bill may be drafted and its consideration begun promptly after Congress meets in extra session.

Schedule A, which consists of chemicals, oils and paints, will be the first one taken up. Jan. 6, 7 and 8 will be devoted to hearing testimony as to the need of revision of the tariff covering commodities under those heads. Schedule B, which consists of earths, earthenware and glassware, will be considered at the hearings Jan. 10 and 11. The metal schedule is to be considered Jan. 12, 13 and 14. Sugar and manufactures thereof is scheduled for hearing Jan. 18 and 19.

Consulting Chemists' Appointments Approved

The Secretary of War has approved the appointment by General Fries of the fifteen members of the American Chemical Society's advisory committee as consulting chemists of the Chemical Warfare Service.

Personal

Dr. J. F. Carle, until recently chief chemist at U. S. Nitrate Plant No. 2, Muscle Shoals, Ala., resigned from the Nitrate Division on Nov. 1 to become president of the Southern Testing Laboratories, with headquarters at Birmingham, Ala.

Colonel C. W. Exton, who recently was transferred to the Chemical Warfare Service, to take charge of the training section, has been designated as assistant chief of the Chemical Warfare Service.

T. G. Hageman, formerly chief engineer of Norsk Hydro-Elektrisk Kvaelstofaktieselskab (Norwegian Hydro-Electric Nitrogen Co., Ltd.), Christiania, Norway, has started his own business as a consulting engineer for the nitrate industry. His office address will be Ths. Heftyes gate 44, Christiania.

Robert B. Hitchcock has resigned his position as chief chemist at the coke plant of the Youngstown Sheet & Tube Co., Youngstown, Ohio, to accept a similar position with the Woodward Iron & Steel Co., Woodward, Ala.

Frederick P. Keppel is on his way to Paris to take up his work as American Administrative Commissioner at the headquarters of the International Chamber of Commerce.

Dr. R. B. Moore, chief chemist of the Bureau of Mines, announces the selection of the following staff for the cryogenic laboratory which is to be conducted at the Bureau of Mines under his supervision: John W. Davis, mechanical engineer; C. W. Seibel, chemist, and Dr. Leo Finklestein, chemist. Mr. Davis has been connected with the faculty of the Leland Stanford University, Mr. Seibel with that of the University of Kansas, and Mr. Finklestein with the University of Chicago.

E. C. Morse, director of sales, War Department, is terminating his connection with the Government on Dec. 31, and for his work in connection with disposing of the hundreds of millions of dollars of surplus war stock has been awarded the Distinguished Service Medal, which was presented to him by Secretary of War Baker in the latter's office in Washington on Dec. 7.

Benjamin Schneider, of Dryenforth, Lee, Thritton & Wiles, spoke before the Chicago Chemists' Club on Dec. 7 on "The Law of Secret Processes."

At the annual meeting of the American Engineering Standards Committee held in New York on Dec. 4 A. A. Stevenson, a representative of the American Society for Testing Materials, was re-elected chairman for 1921, and George C. Stone, a representative of the American Institute of Mining and Metallurgical Engineers, was re-elected vice-chairman.

Obituary

Regis Chauvenet, president emeritus of the Colorado School of Mines, Denver, and widely known throughout the country as a chemist and metallurgist, died on Dec. 5. He was seventy-eight years old.

Gustave Drobegg, a consulting chemist and a director of several dye manufacturing companies, died in the Swedish Hospital, Brooklyn, N. Y., on Dec. 6 in his sixtieth year. Mr. Drobegg had been connected with the firm of Charles Pfizer & Co. in Manhattan and Brooklyn for twenty-five years and was one of the most prominent men in the work of creating the American dye industry during the war. He was a native of Coblenz, Germany, and studied chemistry at the University of Munich. He was a member of the

Chemists' Club, Society of Chemical Industry and other societies.

EDWARD HERMS of North Tonawanda, N. Y., passed away on Nov. 4, after a prolonged illness with heart trouble. For a number of years he was chemist for the Commonwealth Steel Co., St. Louis, Mo., then superintendent of the Strong Steel Foundry, Buffalo, N. Y., superintendent of the open-hearth department of the Pittsburgh Steel Foundry and at the time of his death was employed as chemist of the Buffalo Bolt Co., North Tonawanda, N. Y.

ERNEST MCAULAY, manager of the Mines & Smelter Supply Co., El Paso, Tex., died on Nov. 20.

Book Reviews

THE MODERN ELECTROPLATER. By *Kenneth M. Coggeshall*. New York: Norman W. Henley Publishing Co. Price $3.

The actual work that is being done by the electroplater of today is too little understood and a story of the "Modern Plater" would make interesting reading. The author fails to keep to his subject, and shows that he is not in touch with and even discredits the knowledge and ambitions of the modern plater when he states: "It is not necessary that an electroplater be a careful student of either electricity or chemistry. A technical discussion of laws relating to electrochemistry would undoubtedly have but little interest for even an expert plater." He is consistent, however, as he measures up to his own foot-rule when he endeavors to discuss the technical or practical part of electroplating, standing on tiptoes to keep his head above water.

The modern plater is growing beyond "rule-of-thumb" methods, regulation of amount of metal deposited by the voltage and trying to determine the metal and chemical content of a plating solution with a hydrometer all of which are recommended in this book.

The author has been a careful student of trade catalogues, and gives in brief the story of what is needed in a plating and polishing room which may be of interest to a novice. The practical part offers nothing but what is generally known and with some of which the author is just about on speaking terms.

Silver can be and is deposited with a current density of 5 amp. per sq.ft., which is twice the rate given, and when a silver "strike" is used, "The work is (*not*) dipped for a moment in a hot potash bath and then transferred, without rinsing, to the 'strike' solution" (p. 185). Even a "careful student" would soon get into trouble if that method was followed.

For making a nickel solution a definite formula is recommended: Water, 1 gal.; nickel ammonium sulphate, 14 oz.; boric acid, 2 oz., and then it is recommended that "The nickel ammonium sulphate is dissolved in hot water, then a quantity of the latter is added to the solution until a hydrometer reading shows a density of about 7 deg. Bé." The author probably does not mean boric acid by "the latter." Fourteen ounces of nickel ammonium sulphate in a gallon of water will give the density of 7 deg. Bé. That is above the point of saturation at ordinary plating room temperature during the winter months, and crystallization will result.

That aluminum is violently attacked by a caustic alkali is well known, and the author is incorrect in stating, "Aluminum wire baskets or trays, for example, are affected to *some extent* by both potash and muriatic acid . . . and are nevertheless quite popular . . ." Aluminum baskets can be used in "bright dips" but not in "potash" solutions.

Common high brass, such as is commercially used, generally consist of about 64 per cent copper and 36 per cent zinc and not 60-40 (p. 163). Gold when alloyed to make any carat is not alloyed with copper alone (p. 172).

In "A Manual of Electro-Metallurgy," James Napier, 1853, it is stated that the electroplating of iron with zinc from a zinc sulphate and a zinc cyanide solution was done at that time, yet the author states, "Until recently a process known as hot galvanizing was employed in all instances where this film of zinc was required."

Nothing of any value has been added to modern electroplating practice in bringing out this book, and it will soon take its place among those of which there are now already too many. GEORGE B. HOGABOOM.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 13, 1920.

The chemical market showed flashes of activity during the past week and it was apparent that the prolonged period of readjustment has brought the industry into a healthier position. Inquiries from northern Europe were noted in more volume of leading chemicals, although domestic consumers still showed the same conservatism in their operations. Several interests close to the pulse of trade asserted that the new year will occasion a renewal of buying activity. They are consequently looking forward to its advent. When business assumes normal dimensions there will be a lack of inflation and prices will adhere more to the law of supply and demand than at any time in recent years.

Small sales of *zinc sulphate* are reported to tanneries, textile mills and paint factories, but business has shown no real punch of late. Producers hold carload lots at 3½c. per lb. and smaller quantities up to 4c. per lb. Factors in *zinc chloride* are booking business in the granular grade at prices ranging from 12c. to 14c. per lb., the inside figure being for carlots. Fused material is bringing 9@11c. per lb. according to quantity. *Sulphite of soda* producers report sales of crystals at 4c. per lb. in large quantities and up to 4½c. per lb. in smaller lots. Moderate inquiries were reported.

Large sellers of *carbonate of potash* quoted the market at 12½c. per lb. spot for the 80-85 per cent grade in large lots and 13c. per lb. in smaller quantities, with only quiet trading. Supplies appear fully adequate to take care of prevailing inquiry.

Some sales of *arsenic* were reported to manufacturers of insecticides, but the principal movement at present is against old contract orders. Small lots of white powdered are on the market at 12@13c. per lb. The red variety is quoted by producers at 15c. per lb. Dealers reported sales of *bleaching powder* for domestic consumption at 3c. per lb. f.o.b. New York. Resale material at the works was quoted at the same figure. The movement has remained quiet since the recent sharp decline of this article. A feature of the market was the brisk trading noted in *oxalic acid*. Surplus spot stocks on the market have been entirely cleaned up and leading factors were quoting prices ranging from 19c. to 21c. per lb. All indications point to a strong market with fluctuating prices.

Supplies of *peroxide of soda* continued scarce and the market is quoted firm at 35c. per lb. Producers are not very eager to quote at present and the only quotations heard are from dealers. Spot *bichromate of soda*, standard brands, was generally quoted at 9¾@10c. per lb. December shipments of resale stock were quoted at 9½c. per lb. f.o.b. works. The tone of the market remained quite steady.

COAL-TAR PRODUCTS

The coal-tar products market is slowly but surely approaching the period where a strong demand must take the place of the present stagnancy. While there is not very much indication on the surface to warrant such a condition, there is, nevertheless, an undercurrent of feeling in many quarters that point to a much better business shortly after the first of the year. Color manufacturers are steady in their views on an improvement in the demand over next year and while prices are sagging in their industry through the natural law of lack of demand at this time, opinions seem to be of a more optimistic nature. The situation as regards

a steady supply of crude products seems good as to raw material, coal and working conditions at the various plants.

Consumers are showing very little interest in *xylene* at present and only routine trading is heard with figures quotably unchanged at 45@50c. per lb. There are not many sources of supply on *monochlorbenzene*, although the market is said to be fairly easy on supplies at a range of prices from 17c. to 18c. per lb. Producers stated that a limited quantity is moving into various consuming channels.

A slightly better demand for *aniline oil* was reported in some directions, although sales were confined mostly to small quantities. Supplies are plentiful in second hands with prices ranging from 24c. to 26c. per lb. Manufacturers are still quoting 28@30c. per lb. and are waiting for a real demand to set in. The *aniline salts* market is quiet in all quarters. Producers are firm in their views and quote 32@34c. per lb., depending on quantity. Very little *benzidine base* is moving into domestic channels, where there is some inquiry reported from foreign consumers. Available supplies of the base and sulphate material are quoted at $1.05@$1.15 per lb. Factors in the *dimethylaniline* market find the call reduced to a minimum. A fair amount of supplies is available, but no heavy offerings are noted. Prices range from 70c. to 85c. per lb., depending on seller.

Growth of the Coal-Tar Industry

A recent report of the United States Tariff Commission stated that the production of coke and the byproducts obtained from coal distillation in 1919 showed a slight decrease in the amount of tar distilled and a large decrease in the output of pure benzene and especially of pure toluene. A great significance is attached to the future of the coal-tar industry in the fact that the productive capacity of byproduct coke ovens in the United States increased over 17.2 per cent during 1919. There is no doubt that, with the exception of anthracene, sufficient supplies of the basic materials of coal-tar origin will be available from American sources for the growth of the industry.

Considerable progress has been made during the past year in the case of anthracene, but the problem of securing adequate supplies is still unsolved. In 1919 the output was three times as large as in 1918, or about 800,000 lb., and a much larger quantity was refined than in 1918. Although this showed a greater and more encouraging progress, a larger increase in output must be secured before there will be enough American anthracene available to supply the dye industry. It is believed that the 1919 production of crude anthracene contained less than one-quarter the amount which would be required to supply the American demand. The real difficulty is not primarily an actual lack of anthracene in the tar or purely technical difficulties, but rather the fact that its removal leaves the pitch so hard that it does not find a ready market under American conditions.

Production of Intermediates

As was expected, there was a sharp decrease in the output of several intermediates needed primarily for explosives. The most noticeable case was phenol, which showed an enormous production—100,000,000 lb. in 1918—but fell to less than 1,500,000 lb. in 1919, nearly all of this being obtained from coal tar. Another example was the case of monochlorbenzene, which had an output of 20,000,000 lb. in 1918 and 4,000,000 lb. in 1919. There was also a considerable decrease in several intermediates required for making dyes used for army uniforms. For example, there was a marked decrease in the output of metatoluylenediamine, which was used for making a khaki dye for cotton uniforms, and a tremendous drop in metanitraniline, which was used for making a khaki dye for wool uniforms.

A comparison of the intermediates produced in 1918 and 1919 shows a considerable increase in the number of intermediates. In 1919 there was almost twice as many different intermediates produced as in 1918. Intermediates which had a strong demand and whose manufacture had been well established by 1918 showed comparatively little change in 1919. Nitrobenzene gained about 10 per cent, the 1919 output amounting to about 42,000,000 lb. Aniline production was about 25,000,000 lb., a gain of 1 per cent. The output of U.S.P. benzoic acid increased from about 175,000 lb. in 1918 to over 600,000 lb. in 1919, with a drop in price from $3 per lb. to 75c. per lb. Orthotoluidine increased from 650,000 lb. in 1918 to a little over 1,000,000 lb. in 1919. The general increase in the output of intermediates derived from toluene is due to relaxation of the restriction in the use of toluene during war times. Progress among anthracene derivatives is of special interest. In 1919 there were ten intermediates derived from anthracene, against only five in 1918. The output of anthraquinone, which is the most important, because it serves as raw material for the manufacture of nearly all other intermediates derived from anthracene, was about ten times as great in 1919 as in 1918.

Vegetable Oils

The market on vegetable oils remained quiet and has shown no tendency of firmness for the past few weeks. Trading was practically of a hand-to-mouth nature. Resale offerings of *coconut oil* on the Coast brought out sharply lower prices for manila oil. Offerings were heard at 10c. per lb. sellers' tanks, December shipment, and 10¼c. per lb. January shipment. Ceylon grade oil was offered in barrels at 13½c. per lb. New York. The market for *corn oil*, crude, held around 9½c. per lb. with no business being reported. Oriental *peanut oil* was easier and sellers called for bids around 8½c. per lb., sellers' tanks, December shipment from the Pacific Coast. Buyers' ideas were about ½c. under this basis.

Buyers and sellers were apart from their views on *soya bean oil*, with the result that no business was placed. December shipment from the Coast closed at 6c. per lb. January-March shipment closed at 6¼c. per lb. sellers' tanks, f.o.b. Pacific Coast. The spot market was nominal at 9½c. per lb., no sales being reported. The market for *cottonseed oil* was a featureless affair, demand being only of a moderate nature. Prime summer yellow was quoted at 9½c. per lb., with only small inquiries noted for European ports. *Crude oil* held at 6¼c. per lb. f.o.b. mill.

The Chicago Market

Chicago, Dec. 8, 1920.

It seems there is no degree of quietness to which the chemical market can attain which is not immediately outdone by more pronounced quiet. The fact is that the past ten days have been more excessively dull than any foregoing period in the year. On all hands production has been curtailed and yet demand does not absorb supply. Low prices seem to have no attraction and normally heavy buyers content themselves with small routine purchases, ignoring opportunities to stock up at prices which, a few weeks ago, would have looked like real bargains.

The attitude of consumers is that anything is possible in regard to prices in the immediate future and they are going to stay out until the market is stabilized. Bona fide buyers are able to get goods at practically their own terms and nothing like heavy buying is seen in any line.

Heavy Chemicals

A lowering in price on various items and a lack of interest on the part of all buyers are outstanding features of the past two weeks. Sales of *bleaching powder* have been reported as low as 2½c. per lb. and offers at around 3c. for spot goods are plentiful. Some future business is reported at 3½c. *Caustic soda* is likewise hard to sell, 4c. being the prevailing price on the small lots going. Stocks are light but demand is absent. Bottom is being approached on *soda ash*, offers at $1.85 failing to produce business. Buyers could probably secure concessions from this figure. *Sal soda*, held at $2 per 100 lb., is quiet.

Alcohol, with prices firm, is experiencing a lack of demand. Ethyl grade, 190 proof, is quoted at $5.15 per gal.; methyl grade, 97 per cent, at $1.95, and denatured, 96 per cent, at 85c. Holders of resale stock show a disposition to shade these prices. Depression in consuming trades is weakening this market. Output of *glycerine* is remarkably light, but at that is more than equaling demand. The c.p.

grade, less drums, has changed hands in small quantities at 18c., and dynamite grade is offered at 17c.

Low prices prevailing in the copper market have carried *blue vitriol* down to $6.75@$6.85 per 100 lb. for 99 per cent grade, which prices are firmly held by a good demand. *Salt cake*, with consuming demand steady, holds firm at $31 per ton. *Ammonia* is weak and uncertain, small lots only being taken at from 10@11c. per lb. for 26 degree. Producers' quotations are unchanged.

The acid market, in common with other chemical lines, shows lack of interest. *Sulphuric* is off in price as well as demand, 66 degree being offered at $22 per ton. Some transactions are reported at $1@$1.50 below this figure. *Nitric*, in a dull market, is offered by producers at $7.75@$8 per 100 lb. for 42 degree. The fact that Government supplies of *carbolic acid* are held at 12c. per lb. has had no effect on the market, sales from stock being made at from 7@7½c. per lb. Plentiful supply is available. Business in *acetic acid* is dull, the glacial being offered at 10c. and the 28 per cent at $3 per 100 lb. in barrels.

Vegetable Oils

While the trading in *flaxseed* has been stimulated somewhat by bullish reports from Argentina, no effect has been felt in the *linseed oil* market. Low prices are not operating to stimulate demand, business being practically confined to small lots. It would seem as though the bottom had been reached, as bulk is offered in tanks as low as 70c. per gal., with but few takers. Oil in barrels, carload lots, is 77c., and dealers are selling 1- to 5-bbl. quantities of stock at 97c.

Cottonseed oil, offered at 6c. per lb. in sellers' tanks at point of production, is a drug on the market. Consuming demand is notable for its weakness and prime summer yellow, offered in tanks, delivered, at 7c. per lb., has few takers. *Coconut oil*, Manila variety, is offered f.o.b. Coast in sellers' tanks at 10¾@11c. per lb. and the refined edible kind is quoted here at 16¾c. in barrels. Curtailed production of *corn oil* has been equaled by lower demand, and recent transactions have passed at 6½c. per lb. in cars f.o.b. Chicago. The edible refined now brings 12½c. per lb. in barrels.

Naval Stores

Gradually lowered prices are still the feature in naval stores, notwithstanding the fact that the producing season is closing with stocks below normal. Demand is light, but dealers do not attribute recent price drops to this so much as to the habit naval stores prices have of taking a December slump. Curtailed activities on the part of consuming buyers have permitted a little drop in prices of *pine oil*, the pure steam distilled now being quoted at $1.60 and the destructively distilled at $1.50. *Rosin oil*, first rectified, is offered at 66c. and commercial *pine tar oil* at 47c. *Turpentine*, weak under poor demand, is quoted at 90c. per gal.

The St. Louis Market

St. Louis, Dec. 10, 1920.

The inactivity of heavy chemical demand has become even more pronounced here during the past two weeks and the amount of spot business has become negligible. New contract business has slowed up considerably also, but shipments on contracts still average close to normal, according to producers, and a good many contracts are being renewed. Producers report that consumers are buying only for their immediate needs and that their needs are being decreased materially by the depression in other lines. Little change in this situation is looked for before the first of the year and no impressive upturn is expected then. In spite of the quiet market producers are holding both spot and contract prices at the levels reported previously and feel that they will not be forced to alter them materially in the near future.

There is still some call for the 66 deg. *sulphuric acid*, this coming mainly from the oil fields where production and refining show no signs of slackening. Prices hold firm at $22 per ton and 1¾c. per lb. carload lots. Demand is slow for the 98 deg. sulphuric acid. A quotation of $25 per ton f.o.b. works is being maintained. Inactivity marks the 60 deg. sulphuric acid market and producers are asking $16.50 per ton and 1½c. per lb. in carboys. *Oleum* is slow at $28.50 per ton.

Producers are still keeping their supplies of *muriatic acid* low, though demand has been very quiet, and prices are firm at 1¾@2c. per lb. and $25 per ton in bulk.

Sodium bisulphate (niter cake) is slightly more active than two weeks ago, with prices being maintained at $7@$8 per ton.

Both inquiries and orders for *nitric acid* continued to fall off, but producers report deliveries on contracts about normal. This is taken to mean that consumers' needs have not decreased materially, but that where they must re-enter the market for supplies they are buying from hand to mouth. Quotations are $7 per 100 lb. for the 36 deg. test and $10 per 100 lb. for the 42 deg. test. *Standard mixed acid* is quoted at 1½c. per lb. of sulphuric content and 11½c. per lb. for unit of nitric acid.

The Iron and Steel Market

Pittsburgh, Dec. 10, 1920.

In the past week the independent market on sheets has declined to the Steel Corporation or Industrial Board level: Blue annealed sheets, 10 gage, 3.55c.; black sheets, 28 gage, 4.35c.; galvanized sheets, 28 gage, 5.70c. Previously there had been similar reversions in tin plate, bars, shapes, plates and wire products. Of the important steel mill products pipe alone remains as presenting a higher market on the part of the independents than the Steel Corporation level. The exception is not especially important in itself, for the reason that the large delivery premiums formerly obtained by independents have practically disappeared, leaving the independent market on the regular independent list, which is only 3½ points or about $7 a ton above the Steel Corporation schedule. The exception is of importance, however, in this respect, that alone of all steel products pipe is in good demand, with heavy requirements against contracts and a moderate amount of new buying. The pipe mills are comparatively busy, in general, while the leading interest has difficulty in meeting customers' requirements, although for two or three weeks past it has been shipping up to its loading capacity, or at about 30 per cent above production, which is substantially at capacity. During the period of car scarcity a stock was accumulated equal to about a month's production.

Market Stagnant

The stagnation in the finished steel market continues. The price reductions by independents have had no appreciable effect, although it should be understood that there was no definite hope that much business would be developed, at least at the outset, by the reductions. The independent mills simply abandoned a position that had become untenable and that they knew would have to be abandoned some time.

The Steel Corporation continues to operate to the physical limit in nearly all departments. The supply of coal and coke has improved and a few additional blast furnaces have been blown in, so that the corporation is probably operating at a slightly heavier rate than a couple of months ago. The independents, on the other hand, have steadily dwindling operations. Not a few are closed entirely, though probably not permanently, as some orders may accumulate for a run of a week or two. Others are operating at 60 to 75 per cent, and the general average is probably under 50 per cent.

The independents having reduced their prices to the Steel Corporation level, the next point is whether they will shade the Steel Corporation prices. There seems to be practically no doubt that some of them will. The present stagnant market is no test, since there is no incentive to make special prices. The real test will probably come in January, when in the course of events there should be somewhat more buying. Buyers cannot indefinitely stay so completely out of the market as they are at present.

Inasmuch as common expectation is that there will be no full demand for steel for many months, sufficient to engage all the capacity, the question is discussed whether, or when, the Steel Corporation will itself reduce prices. At present it has well-filled order books, apparently sufficient to

enable it to maintain approximately the present rate of operation until some time in the second quarter of the new year. Judge Gary's statement three weeks ago today, to the effect that the corporation would not alter its prices, had the specific qualification "unless and until it becomes necessary and proper to make changes to meet altered conditions." The immediate bearing was that the corporation would not advance its prices, as for a long time the independents had hoped, but it is plain that if demand for steel remains light for a period of months there is a prospect of business in general undergoing such a general readjustment that the corporation's costs will be reduced, and that would furnish a basis for reduced prices. As long as the corporation was operating at a much higher rate than the independents it would hardly reduce prices because of price cutting by independents. With a fair operation the Steel Corporation prices should prove quite profitable, unless to independents who have saddled themselves with extra costs during the period when prices were so high that costs were a minor consideration. It must be remembered that the Steel Corporation's total profits have been much larger than the net earnings reported, by reason of various heavy deductions and allowances being made for contingencies.

Semi-Finished Steel

There is no market at all in semi-finished steel, and prices are altogether nominal. It is assumed that if any important business were offered some at least of the independents would meet the Steel Corporation prices of $47 on sheet bars and $57 on rods, these prices being $5 above the Industrial Board schedule by reason of advances the corporation made in August and September. The corporation does not seem to have advanced its billet price above the $38.50 figure of the Industrial Board schedule, and there is no doubt that no independent would name that price. In some quarters it is doubted whether the corporation will continue its present prices on sheet bars and rods, there being a possibility of its going back to the old prices.

November Production

The thirty companies making monthly reports for their ingot production to the American Iron and Steel Institute showed an output in November of 2,638,670 tons, against almost precisely 3,000,000 tons in each of the three preceding months. All four months had twenty-six working days each. The report shows a decrease of 13 per cent in output in November. The reporting companies made about 84 per cent of the total output in 1918 and about 85 per cent in 1919. Ordinarily it may be assumed that the producers not reporting had approximately the same variations in output from month to month as the companies reporting, but in the case of November such an assumption is not correct, since the report doubtless includes all the Steel Corporation's output, the companies not reporting being among the independents. The corporation's output did not decrease materially from October to November, and probably increased somewhat. A computation taking this into account suggests that if the corporation's output was unchanged from October to November the output of the independents decreased by about 28 per cent, whereby the entire output decreased about 15 per cent. As independent production declined continuously the rate at present is much below the November average.

Pig Iron

Little change has occurred in pig iron prices in the past week. Prices on an average are approximately 20 per cent under the top level reached late last August and about 50 per cent above the Industrial Board schedule, which represented the market from the time of the Industrial Board adjustment, March 21, 1919, until October following. Declines thus far have been almost voluntarily on the part of furnaces, not being occasioned by competition for business, since scarcely any business has been offered. The remainder of the decline is likely to be left quite largely for more competitive times. Quotations for the valley market are: Foundry, $37; bessemer, $35; basic, $33.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0.65 - $0.75
Acetone	lb.	$0.13 - $0.13½	.13½ - .14
Acid, acetic, 28 per cent	100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent	100 lbs.	7.25 - 7.50	7.75 - 8.00
Acetic, glacial, 99½ per cent, carboy	100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals	lb.	.14½ - .15	.15½ - .16
Boric, powder	lb.	.15½ - .16½	.17 - .18
Citric	lb.	.. -	.50 - .52
Hydrochloric (nominal)	100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 - .16	.16½ - .18
Lactic, 44 per cent tech	lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		..... -	..... - .....
Nitric, 40 deg	lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.18½ - .19	.19½ - .20
Phosphoric, Ortho, 50 per cent solution	lb.	.19 - .19½	.19½ - .21
Picric	lb.	.28 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	. - ..	..... - .....
Sulphuric, 60 deg., drums	ton	..... -	14.00 - 15.00
Sulphuric, 66 deg, tank cars	ton	18.00 - 19.00	. - .
Sulphuric, 66 deg, drums	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg, carboys	ton	..... -	..... - .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 - 24.00	.. - .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - .....
Tannic, U. S. P.	lb.	..... -	1.30 - 1.35
Tannic (tech)	lb.	.50 - .55	.56 - .60
Tartaric, crystals	lb.	. - .	.43 - .45
Tungstic, per lb. of WO	lb.	..... -	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	..... -	5.50 - 6.00
Alcohol, Methyl (see methanol)		..... -	..... - .....
Alcohol, denatured, 188 proof (nominal)	gal.	..... -	.84 - .86
Alcohol, denatured, 190 proof (nominal)	gal.	..... -	.88 - .90
Alum, ammonia lump	lb.	.04½ - .04½	.05 - .05½
Alum, potash lump	lb.	.05½ - .06	.06½ - .07
Alum, chrome lump	lb.	.13 - .13½	.14 - .14½
Aluminum sulphate, commercial	lb.	.02½ - .03	.03½ - .03½
Aluminum sulphate, iron free	lb.	.03½ - .04	.04½ - .04½
Aqua ammonia, 26 deg, drums (750 lb)	lb.	.07½ - .08	.08½ - .09½
Ammonia, anhydrous, cylinders (100-150 lb)	lb.	.33 - .35	.36 - .38
Ammonium carbonate, powder	lb.	.14 - .14½	.14½ - .15
Ammonium chloride, granular (white salammoniac)	lb.	.12 - .12½	.12½ - .13
Ammonium chloride, granular (gray salammoniac)	lb.	.11 - .12	.12½ - .13
Ammonium nitrate	lb.	.. - .10	.11 - .14
Ammonium sulphate	lb.	.04 - .04½	.04½ - .04½
Amylacetate	gal.	..... -	4.50 - 5.00
Amylacetate tech	gal.	..... -	4.00 - 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	.12 - .12½	.12½ - .13
Arsenic, sulphide, powdered (red arsenic)	lb.	.15 - .15½	.15¾ - .16
Barium chloride	ton	85.00 - 90.00	95.00 - 100.00
Barium dioxide (peroxide)	lb.	.24 - .25	.2[illegible] - .27
Barium nitrate	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		..... -	..... - .....
Blue vitriol (see copper sulphate)		..... -	..... - .....
Borax (see sodium borate)		..... -	..... - .....
Brimstone (see sulphur, roll)		..... -	..... - .....
Bromine	lb.	.50 - .52	.54 - .56
Calcium acetate	100 lbs.	2.00 - 2.25	.. - .....
Calcium carbide	lb.	.04 - .04½	.04½ - .05
Calcium chloride, fused, lump	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder)	lb.	.03 - .03½	.03½ - .04
Calcium peroxide	lb.	..... -	1.50 - 1.70
Calcium phosphate, monobasic	lb.	..... -	.75 - .80
Calcium sulphate, pure	lb.	..... -	.25 - .30
Camphor	lb.	. ..	.95 1.00
Carbon bisulphide	lb.	.08 - .08½	.09 - .09½
Carbon tetrachloride, drums	lb.	.13 - .13½	.14 - .14½
Carbonyl chloride (phosgene)	lb.	.. -	.60 - .75
Caustic potash (see potassium hydroxide)		..... -	.. - .....
Caustic soda (see sodium hydroxide)		..... -	..... - .....
Chlorine, gas, liquid-cylinders (100 lb)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	....	.43 - .50
Cobalt oxide	lb.	..... -	3.90 - 4.00
Copperas (see iron sulphate)		..... -	..... - .....
Copper carbonate, green precipitate	lb.	.22 - .22½	.22½ - .23
Copper cyanide	lb.	..... -	.65 - .70
Copper sulphate, crystals	lb.	.06½ - .06½	.07 - .07½
Cream of tartar (see potassium bitartrate)		..... -	..... - .....
Epsom salt (see magnesium sulphate)		..... -	..... - .....
Ethyl Acetate Com 85%	gal	.. ..	1.05 - 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		..... -	- .....
Formaldehyde, 40 per cent (nominal)	lb.	.19 - .19½	.19½ - .20
Fusel oil, ref	gal.	. -	3.60 - 3.75
Fusel oil, crude (nominal)	gal.	..... -	2.50 - 2.75
Glauber's salt (see sodium sulphate)		..... -	..... - .....
Glycerine, C. P. drums extra	lb.	..... - . .	.21 - .22
Iodine, resublimed	lb.	.... -	3.85 - 4.00
Iron oxide, red	lb.	..... -	.15 - .25
Iron sulphate (copperas)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Lead acetate, normal	lb.	-	.13½ - .16
Lead arsenate (paste)	lb.	.13 .14	.14½ - .15
Lead nitrate, crystals	lb.	..... -	.90 - 1.00
Litharge	lb.	.12 - .12½	.13 - .13½
Lithium carbonate	lb.	..... -	1.50 - .....
Magnesium carbonate, technical	lb.	.10½ - .11	.11½ - .12
Magnesium sulphate, U. S. P.	100 lb.	3.00 - 3.25	- ..
Magnesium sulphate, commercial	100 lb.	..... -	2.50 - 2.75
Methanol, 95%	gal.	.. ..	1.90 - 2.00
Methanol, pure	gal	.. ..	2.30 - 2.35
Nickel salt, double	lb.	..... -	.12 - .12½
Nickel salt, single	lb.	..... -	.13 - .13½
Phosgene (see carbonyl chloride)		..... -	..... - .....
Phosphorus, red	lb.	.50 - .52	.53 - .55
Phosphorus, yellow	lb.	..... -	.35 - .37
Potassium bichromate	lb.	.20 - .21	.21½ - .22½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.		$0.43 – $0.47
Potassium bromide, granular	lb.		.45 – .50
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.13 – .13½	.13¼ – .14
Potassium chlorate, crystals	lb.	.13 – .14	.15 – .18
Potassium hydroxide (caustic potash)	lb.	.16 – .16½	.16½ – .17
Potassium iodide	lb.	......–......	3.00 – 3.20
Potassium nitrate	lb.	.14 – .16	.16½ – .17
Potassium permanganate	lb.	.50 – .55	.56 – .60
Potassium prussiate, red	lb.	.55 – .57	.58 – .60
Potassium prussiate, yellow	lb.	.34 – .35	.35½ – .36
Potassium sulphate (powdered)	ton	$240.00 – 255.00	......–......
Rochelle salts (see sodium potas. tartrate)		......–......	......–......
Salammoniac (see ammonium chloride)		......–......	......–......
Sal soda (see sodium carbonate)		......–......	......–......
Salt cake	ton	......–......	45.00 – 50.00
Silver cyanide (nominal)	oz.	......–......	1.25 –......
Silver nitrate (nominal)	oz.	......–......	.46 – .48
Soda ash, light	100 lb.	1.90 – 2.00	2.10 – 2.30
Soda ash, dense	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium acetate	lb.	.08 – .08½	.08½ – .09
Sodium bicarbonate	100 lb.	2.75 – 2.85	3.00 – 3.25
Sodium bichromate	lb.	.09¾ – .10	.10¼ – .10½
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U. S. P.	lb.	.06½ – .07	.07½ – .08
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.85 – 2.00	2.15 – 2.25
Sodium chlorate	lb.	.10 – .10½	.10½ – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .28
Sodium fluoride	lb.	.17 – .17½	.17 – .18½
Sodium hydroxide (caustic soda)	100 lb.	3.75 – 4.00	4.25 – 4.35
Sodium hyposulphite	lb.	......	.04 – .04½
Sodium molybdate	lb.	2.50 –......	3.25 –......
Sodium nitrate	100 lb.	2.85 –......	3.00 –......
Sodium nitrite	lb.	.07 – .07½	.07½ – .08
Sodium peroxide, powdered	lb.	.35 – .40	.42 – .45
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.		.33 – .35
Sodium prussiate, yellow	lb.	.18 – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.03 – .03¼	.03½ – .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.15 – 2.25
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.07 – .07½	.07½ – .08
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.15 – .15½	.15½ – .16
Sulphur chloride, red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	......–......
Sulphur dioxide, liquid, cylinders	lb.	.09 –......	.10 – .12
Sulphur (sublimed), flour	100 lb.	......–......	3.70 – 4.35
Sulphur, roll (brimstone)	100 lb.	......–......	3.40 – 3.90
Tin bichloride, 50 per cent	lb.	.11 – .12	.12½ – .13
Tin oxide	lb.	......–......	.50 – .51
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.12 – .13	.13½ – .14
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, XX	lb.	.09½ – .09¾	.10 – .10½
Zinc sulphate	lb.	.03½ – .04	.04¼ – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.10 — $1.15
Alpha naphthol, refined	lb.	1.45 — 1.50
Alpha naphthylamine	lb.	.47 — .50
Aniline oil, drums extra	lb.	.24 — .30
Aniline salts	lb.	.30 — .32
Anthracene, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.10 — 1.15
Benzidine sulphate	lb.	1.05 — 1.10
Benzoic acid, U.S.P.	lb.	.75 — .80
Benzoate of soda, U.S.P.	lb.	.75 — .85
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35 — .40
Benzene, 90%, in drums (100 gal.)	gal.	.32 — .33
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.40 — .45
Beta-naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta-naphthol, sublimed (nominal)	lb.	.75 — .80
Beta-naphthol, tech (nominal)	lb.	.40 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 — 1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 — 1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
D chlorbenzene	lb.	.07 — .10
Diethylaniline	lb.	1.45 — 1.50
Dimethylaniline	lb.	.70 — .80
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.27 — .32
Dinitronaphthalene	lb.	.42 — .45
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.75 — .77
H-acid (nominal)	lb.	1.60 — 1.65
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.17 — .18
Monoethylaniline	lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09 — .09½
Naphthalene, flake	lb.	.09 — .09½
Naphthalene, balls	lb.	.10 — .10½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.30 — .32
Para-amidophenol, base	lb.	2.20 — 2.25
Para-amidophenol, HCl	lb.	2.10 — 2.15
Para-dichlorbenzene	lb.	.10 — .15
Paranitroaniline	lb.	1.05 — 1.10
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.20 — 2.35
Para-toluidine	lb.	1.85 — 2.00
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.08 — .10
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	2.75 — 3.00
Resorcinol, pure	lb.	3.75 — 4.00
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.33 — .35
Salicylic acid, U. S. P.	lb.	.37 — .40
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 — .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .22
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.40 — 1.45
Toluidine, mixed	lb.	.45 — .55
Toluene, in tank cars	gal.	.35 — ....
Toluene, in drums	gal.	.38 — .40
Xylidines, drums, 100 gal.	lb.	.45 — .50
Xylene, pure, in drums	gal.	.45 — .50
Xylene, pure, in tank cars	gal.	.40 — .42
Xylene, commercial, in drums, 100 gal.	gal.	.37 — .38
Xylene, commercial, in tank cars	gal.	.30 — .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.26 — $0.27
Beeswax, refined, light	lb.	.28 — .35
Beeswax, white pure	lb.	.35 — .40
Carnauba, No. 1. (nominal)	lb.	.80 — .90
Carnauba, No. 2, North Country	lb.	.37 — .38
Carnauba, No. 3, North Country	lb.	.25 — .26
Japan	lb.	.19 — .20
Montan, crude	lb.	.12 — .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07½ — .08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07½ — .07¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 — .09¼
Paraffine waxes, refined, 125 m.p.	lb.	.09½ — .09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10½ — .11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13½ — .14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.14½ — .15½
Stearic acid, single pressed	lb.	.15½ — .16
Stearic acid, double pressed	lb.	.16 — .16½
Stearic acid, triple pressed	lb.	.16 — .17½

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.75
Pine oil, pure, dest. dist.	gal.	1.65
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.70
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b., New York, for carload lots

Rosin B-D, bbl.	280 lb.	$10.00 –
Rosin E-I	280 lb.	10.00 — ..
Rosin K-N	280 lb.	10.00 — ..
Rosin W. G.-W. W.	280 lb.	10.25 — ..
Wood rosin, bbl.	280 lb.	11.00 —
Spirits of turpentine	gal.	.80 — .
Wood turpentine, steam dist.	gal.	.79 — ..
Wood turpentine, dest. dist.	gal.	.79 — ..
Pine tar pitch, bbl.	200 lb.	..... — 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	— 15.00
Retort tar, bbl.	500 lb.	15.00 — 15.50
Rosin oil, first run	gal.	.70 — ..
Rosin oil, second run	gal.	.73 — ..
Rosin oil, third run	gal.	.90 — ..

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.22 — $0.23
Upriver coarse (nominal)	lb.	.14½ — .15
Upriver caucho ball (nominal)	lb.	.16 — .16½
Plantation—First latex crepe	lb.	.19 — ..
Ribbed smoked sheets	lb.	.18 — ..
Brown crepe, thin, clean	lb.	.16 — ..
Amber crepe No. 1	lb.	.17 — ..

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.13½ — $0.14
Castor oil, AA, in bbls.	lb.	.15 — .15½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11 — .11½
Coconut oil, Ceylon grade, in bbls.	lb.	.13½ — .14
Coconut oil, Cochin grade, in bbls. (nominal)	lb.	.15 — .16
Corn oil, crude, in bbls.	lb.	.09½ — .10
Cottonseed oil, crude (f.o.b. mill)	lb.	.06 — .07
Cottonseed oil, summer yellow	lb.	.09½ — .10
Cottonseed oil, winter yellow	lb.	.11 — .12
Linseed oil, raw, car lots (domestic)	gal.	.80 — ..
Linseed oil, raw, tank cars (domestic)	gal.	.75 — .77
Linseed oil, boiled, car lots (domestic)	gal.	.82

Olive oil, commercial	gal	2.75	3 00
Palm, Lagos	lb.	.08½ —	09
Palm, Niger	lb.	.07½ —	.08½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½ —	.09
Peanut oil, refined, in bbls	lb.	.14½ —	.14½
Rapeseed oil, refined in bbls	gal.	1.15 —	1 20
Rapeseed oil, blown, in bbls	gal.	1.25 —	1 35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09½ —	10
Soya bean oil, tank cars, f.o b., Pacific coast	lb.	.06 —	07

FISH

Light pressed Menhaden	gal.	$0.65 —	$0.70
Yellow bleached Menhaden	gal.	.67 —	.70
White bleached Menhaden	gal.	.72 —	75
Blown Menhaden	gal.	1.05 —	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—$30.00
Barytes, ground, off color, f o.b Kings Creek	net ton	22.00	— 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	— 12.00
Barytes, floated, f.o.b. St. Louis	net ton	26 50	— 28.00
Barytes, crude, first grade, Missouri	net ton	10 00	— ....
Blanc fixe, dry	lb.	.05	— .05½
Blanc fixe, pulp	net ton	60.00	65.00
Caseine	lb	.14	18
Chalk, domestic, extra light	lb.	.05	— .06
Chalk, domestic, light	lb.	.04½	— .05½
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb.	.04½	— .05
China clay, (Kaolin) crude, f.o b. mines, Georgia	net ton	8 00	— 10 00
China clay (Kaolin) washed, f.o b Georgia	net ton	12 00	— 15 00
China clay (Kaolin) powdered, f.o b Georgia	net ton	18 00	— 22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	— 12.00
China clay (Kaolin) ground, f.o b. Virginia points	net ton	15.00	— 40.00
China clay (Kaolin), imported, lump	net ton	25.00	— 35 00
China clay (Kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	— 14.00
Feldspar, crude, f.o b. Maine	net ton	7 50	— 10 00
Feldspar, ground, f o.b. Maine	net ton	21 00	— 23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00	— 21.00
Feldspar, ground, f.o.b. N Y State	net ton	17 00	— 21.00
Feldspar, ground, f o b Baltimore	net ton	27 00	— 30 00
Fuller's Earth, f.o.b New York	net ton	16 00	— 17.00
Fuller's earth, granular, f.o.b Fla	net ton	25 00	— . . .
Fuller's earth, powdered, f o b Fla	net ton	18 00	— . .
Fuller's earth, imported, powdered	net ton	35.00	— 40 00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	....	— .09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07	— .09
Graphite, higher lubricating grades	lb.	.11	— .40
Pumice stone, imported, lump	lb	.04	— .50
Pumice stone, domestic, lump	lb.	.06	— . . .
Pumice stone, ground	lb.	.04	— 07
Quartz (acid tower) fist to head, f o b Baltimore	net ton	......	— 10 00
Quartz (acid tower) 1½@2 in., f o b Baltimore	net ton	......	— 14 00
Quartz (acid tower) rice, f.o b. Baltimore	net ton	......	— 17 00
Quartz, lump, f o b North Carolina	net ton	5.00	— 7 50
Shellac, orange fine	lb.	1.00	— 1.05
Shellac, orange superfine	lb	1.05	— 1 10
Shellac, A. C garnet	lb.	.90	— 95
Shellac, T. N.	lb.	.85	— .95
Soapstone	ton	15.00	— 25 00
Sodium Chloride	long ton	. . .	— 17.50
Talc, paper-making grades, f o b. Vermont	ton	12.00	— 22 00
Talc, roofing grades, f.o b. Vermont	ton	9.50	— 15.00
Talc, rubber grades, f o b. Vermont	ton	12 00	— 18 00
Talc, powdered, Southern, f o b. cars	ton	12 00	— 15 00
Talc, imported	ton	60 00	— 70 00
Talc, California Talcum Powder grade	ton	20 00	— 45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f o.b. Eastern shipping points	net ton	100 110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o.b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f o.b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f o b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f o b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f o b. Mt. Union, Pa.	1,000	55 60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	—$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17	— .18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	16	— 17
Ferro-manganese, 76-80% Mn, domestic	gross ton	140 00	— 145 00
Ferro-manganese, 76-80% Mn, English	gross ton	135 00	140 00
Spiegeleisen, 18-22% Mn	gross ton	60 00	— 65 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2 00	— 2 50
Ferro-silicon, 10-15%	gross ton	60 00	— 65 00
Ferro-silicon, 50%	gross ton	80 00	— 85 00
Ferro-silicon, 75%	gross ton	...	— 160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.65	— .75
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7 00	— ....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	— 7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20% silica, not more than 11% moisture	gross ton	$10.00	— $11 00
Chrome ore, Calif concentrates, 50% min. Cr_2O_3	unit	.60	65
Chrome ore, 50% Cr_2O_3 f.o.b. Atlantic Seaboard	unit	60	65
Coke, foundry, f.o b. ovens	net ton	9 00	— 10 50
Coke, furnace, f.o b ovens	net ton	8 00	— 9 00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24 00	— 26.00
Fluorspar, lump, f o b. Tonuco, New Mexico	net ton	17.00	— .....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50	— 25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	— .01½
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	45	— 50
Manganese ore, chemical (MnO_2)	gross ton	65 00	— 70.00
Molybdenite, 85% MoS_2, per lb of MoS_2, N. Y.	lb.	55	— .60
Monazite, per unit of ThO_2, c i f. Atlantic seaport	unit	35 00	— ....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	— . ..
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	17	— ...
Pyrites, domestic, fines, f o b mines, Ga	unit	.12	— .14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	— . ..
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	4 25	— 4.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.00	— 4.25
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2 75	— 3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	— 3.00
Vanadium pentoxide, 99%	lb.	12.00	— 14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.50	— .....
Zircon, washed, iron free	lb.	.05	— .....

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	15 00
Aluminum, 98 to 99 per cent	22 00@33 00
Antimony, wholesale lots, Chinese and Japanese	5 62½
Nickel, ordinary (ingot)	43 00
Nickel, electrolytic	45 00
Tin, 5 ton lots	36 25
Lead, New York, spot	5 75
Lead, E. St. Louis, spot	6.25
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.75

OTHER METALS

Silver (commercial)	oz.	...61½
Cadmium	lb.	$1.40@1.50
Bismuth (500 lb. lots)	lb.	2.40
Cobalt	lb.	6 00
Magnesium (f o b. Niagara Falls)	lb.	1 75
Platinum	oz.	85.00
Iridium	oz.	350 00 400 00
Palladium	oz	85 00
Mercury	75 lb.	48 00@49 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	22 50
Copper bottoms	34 00
Copper rods	29 00
High brass wire and sheets	22 25
High brass rods	19 00
Low brass wire and sheets	30 50
Low brass rods	19 50
Brazed brass tubing	36 25
Brazed bronze tubing	41 50
Seamless copper tubing	26 00
Seamless high brass tubing	25 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound.

	New York Current	New York One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 00	17 00	10 00	11 50
Copper, heavy and wire	11 50	16 00	9 50	11 00
Copper, light and bottoms	10 00	14 00	9 00	9 50
Lead, heavy	4 00	4 75	4 00	4 50
Lead, tea	3 00	3 75	3 00	3 50
Brass, heavy	7 00	10 50	7 00	10 50
Brass, light	5 00	7 50	5 00	5 50
No. 1 yellow brass turnings	6 50	10 00	5 50	5 50
Zinc	4 50	5 00	3 00	4 50

Structural Material

The following base prices per 100 lb are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Structural shapes	$3 80	$4 15	$3 47	$3 58	$3 37	$3.58	$3.47
Soft steel bars	3 70	4 15	3 37	3 34	3 27	3 48	3.37
Soft steel bar shapes	3 70	4 15	3 37	3 48	3 27	3 48	3.37
Soft steel bands	4 65	5 50	4 07	6 25	...	....	....
Plates, ¼ to 1 in. thick	4 00	4.15	3 67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Colorado

AULT -The Great Valley Sugar Co., Central Savings Bank Bldg., Denver, has awarded the contract for the construction of a sugar factory to the Schwarz Eng. Co., Mack Bldg., Denver. Estimated cost, $1,000,000.

LAFAYETTE The Great Valley Sugar Co., Central Savings Bank Bldg., Denver, has awarded the contract for the construction of a sugar factory to the Schwarz Eng. Co., Mack Bldg., Denver. Estimated cost, $1,000,000.

PLEASANT VALLEY (Noel P. O.) - The Great Valley Sugar Co., Central Savings Bank Bldg, Denver, has awarded the contract for the construction of a sugar factory to the Schwarz Eng. Co, Mack Bldg., Denver.

Idaho

WEISER The city plans an election Jan. 4 to vote on $150,000 bonds to improve water-works, including a filtration plant. Burns & McDonnell, 102 Interstate Bldg., Kansas City, Mo., consulting engineers.

Illinois

CENTRALIA The American Rubber Co, 1526 South Wabash St., will soon award the contract for the construction of a 2 story, 60x100 ft rubber factory. Estimated cost, $100,000 The Consulting Co., 2801 Union Central Bldg, Cincinnati, archt.

SPRINGFIELD The city is having plans prepared for the construction of an iron removal and softening plant to have a 15,000,000-gal. capacity. Burns & McDonnell, 102 Interstate Bldg, Kansas City, Mo., consult. engrs.

Indiana

KENDALLVILLE The Noble Tire & Rubber Co. will receive bids after Jan. 1 for the construction of a 2-story, 50x200-ft. rubber factory Estimated cost, $75,000. A M. Strauss, 207 Bank Bldg., Ft. Wayne, archt

TERRE HAUTE The Union Hospital, 7th and 8th Aves., plans to build a 6-story, 11x200 ft. hospital. Laboratory equipment will be installed in same. Estimated cost, $300,000. Johnson, Miller & Miller, 105 South 7th St, archts.

Iowa

DES MOINES The Salvation Army, S. E, 6th St and Indianola Rd, has had plans prepared for the construction of a 2-story, 51x136 ft. maternity hospital. A chemical laboratory will be installed in same. Estimated cost, $140,000. Sawyer & Watrous, 101 Hippee Bldg, archts.

POCAHONTAS The Bd. Educ will receive bids for the construction of a 2-story, 56x110-ft high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. W. E. Hulse & Co., 309 Securities Bldg., Des Moines, archt.

TRIPOLI The Bd Educ. will receive bids about Feb 15 for the construction of a 3 story, 61x100 ft grade and high school. A chemical laboratory will be installed in same. Estimated cost, $200,000. Keffer & Jones, 204 Masonic Temple, Des Moines, Iowa, archts.

WILLIAMS The Currie Eng. Co, Webster City, has awarded the contract for the construction of a sewage disposal plant, to W. E. Welden, Iowa Falls Estimated cost, $14,369.

Kansas

BAXTER SPRINGS -The General Amer. Oil Co, 604 New First Natl. Bank Bldg., Tulsa, Okla., will build a 1-story oil refinery in the southeastern section of the town. Estimated cost, $100,000.

Minnesota

WAYZATA The Bd. Educ. has awarded the contract for the construction of a 1-story, 200x200-ft. grade and high school, to the Madsen Constr. Co, 818 Builders Exch. Bldg., Minneapolis. A chemical laboratory will be installed in same. Estimated cost, $131,915.

New Jersey

CAMDEN- J. B. Van Sciver Co., Market St. Ferry, has awarded the contract for the construction of a 1-story, 30x70-ft. kiln building, to P. Haibach, 26th and Thompson Sts, Philadelphia, Pa.

NEW BRUNSWICK- The State of New Jersey is having plans prepared for the construction of a 2-story, 50x80-ft. ceramic building. Estimated cost, $100,000. F. H. Bent, 112 West State St., Trenton, archt.

RIDGEFIELD The Continental Paper Box Co, 122 Washington St., Brooklyn, N. Y., will soon award the contract for the construction of a 2-story, 100x500 ft. factory on Grand and Hall Sts. Estimated cost, $250,000. W. B. Wells, Inc., 1181 Myrtle Ave., Brooklyn Ave., Brooklyn, N. Y., archt. and engr.

North Dakota

UNDERWOOD The Bd. Educ. will soon receive bids for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. W. D. Gillespie, 61½ Bway, Fargo, archt.

Ohio

CLEVELAND The Crossley Rubber Co., 2170 East 18th St., has awarded the contract for the construction of a 1-story, 30x40-ft. factory, to G. E. Peterson, 15921 Euclid Ave. Estimated cost, $10,000.

CLEVELAND -The Premier Refining Co, 1187 West 11th St., plans to alter the 2 story factory on Howard Ave. Estimated cost, $35,000. Service Constr. Co., 6110 Euclid Ave., archt.

COLUMBUS — Ohio State University plans to construct an experimental laboratory building. Estimated cost, $50,000. J. N. Bradford, archt.

Texas

DALLAS -The Bd. Educ., Municipal Bldg., has awarded the contract for the construction of a 2-story high school on Haskell and McKinny Sts, to the Amer. Constr. Co., 111 Gulf Bldg., Houston. A chemical laboratory and equipment will be installed in same. Estimated cost, $765,000.

West Virginia

CHARLESTON -The city plans to build an electric chlorine plant and install meters in same.

Wisconsin

JANESVILLE The Bd. Educ. is having plans prepared for the superstructure of a 3 story, 180x200-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $500,000. VanRyn & DeGellike, Caswell Blk., Milwaukee, archts.

NEENAH The Neenah Paper Co. has awarded the contract for the construction of a 1-story, 60x130-ft. water filter plant, to C. R. Meyer & Sons Co., 50 State St., Oshkosh. Filters will be installed in same.

TWO RIVERS The Bd. Educ. will receive bids about Jan. 1 for the construction of a 3-story, 96x110-ft. high school. A chemical laboratory will be installed in same Estimated cost, $100,000. J. D. Chubb, 109 North Dearborn St, Chicago, Ill, archt.

British Columbia

PRINCE GEORGE --The Eastern Syndicate will receive bids in January for the construction of a pulp and paper plant, etc. Estimated cost, $6,000,000.

VANCOUVER—The Coast Range Steel Co, 119 Metropolitan Bldg., recently incorporated with $15,000,000 capital stock, plans to build a large iron and steel works near here.

Ontario

WALLACEBURG — The Wallaceburg Glass Co., Ltd., plans to expend $50,000 on its plant. Equipment will be installed in same.

WELLAND—The Cross Mfg. Co., Sydney, N. S., plans to build a fertilizer plant here. Estimated cost, $250,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN PHYSICAL SOCIETY will hold its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25 Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

W. S. QUIGLEY, president Quigley Furnace Specialties Co, New York City, has just returned from Europe after an extensive trip made in connection with large installations of the Quigley Powdered Coal System in Italy and Belgium.

THE MISSOURI PORTLAND CEMENT CO. has established offices at the Union and Planters Bank Bldg., Memphis, Tenn. The company is installing a large sand and gravel producing plant in that city to operate in conjunction with the present plant in South Memphis.

THE ALEMITE LUBRICATOR CO. of Chicago, Ill., has established district offices at 47 Monroe Ave., Memphis, Tenn. George Hyatt is local manager of the new office.

THE GENERAL MANUFACTURING CO., with a capital of $150,000, has been established at 390 South Front St., Memphis, Tenn., and will manufacture insecticides and perfumes.

THE MEMPHIS SILICA CO. has acquired a 20-acre silica deposit at Riverton Junction, Ala., and is now arranging for trackage to serve the mines. The executive sales headquarters of the company will be located in Memphis and the product will be distributed for use in manufacture of paint, glass, pottery, cement, cleansers, etc., N. E. Goddard is president, W. J. Whitford vice-president, and J. B. Druschel secretary-treasurer of the new company.

THE NORTHERN REFRACTORIES CO. has been organized with main offices at Ridgeway, Pa, Ives L. Harvey, president, M. T. Shanley, secretary. It is opening up deposits of high-grade clay on its property at Hutchins, Pa., and will put on the market a high-grade flint and ground clay.

THE AMERICAN DRESSLER TUNNEL KILNS, INC., has moved its executive, engineering and thermal offices to 1740 East Twelfth St., Cleveland, O.

ENGLE TILE & FUEL CO. of Newton, Ia., will install a direct heat-radiating drier. This plant specializes on drain tile.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Industrial Editors
J. S. NEGRU
Managing Editor

Volume 23 New York, December 22, 1920 Number 25

Chemical Engineers Visit the South

NEW ORLEANS and Louisiana played host to the American Institute of Chemical Engineers Dec. 6 to 9 and carried off their part delightfully, sustaining their reputation for unbounded hospitality and courtesy to the stranger within their gates. There are but four men in Louisiana who boast membership in the Institute, and while it was to their efforts primarily that the success of the meeting was due, they were loyally supported by city and state authorities, local chambers of commerce in the different towns visited, and railroad authorities who co-operated in making the Institute's path comfortable. On the whole it is doubtful if the Institute has had a more agreeable and successful winter meeting. Louisiana's three S's, salt, sulphur and sugar, were objects of more than ordinary interest. Methods of producing the first two are unique in the recovery of those minerals from beneath the earth's surface, while in the case of the second we have an example of the daring ingenuity and vision of a chemical engineer who succeeded in exploiting the deposit after two failures had been made.

The Institute does well to plan its semi-annual meetings in such a way that acquaintance and sociability are promoted simultaneously with the dissemination of technical knowledge and a study of natural resources and chemical industries. A week or ten days of travel, more than any other feature of a technical meeting, is conducive to the making of acquaintances and friends. It relieves the monotony of sessions for the reading and discussion of technical papers and affords the best opportunity for education through observation and contact. From all these points of view the recent meeting in Louisiana was a marked success.

Enter the Physicist Into Industrial Research

A PROMINENT chemical company has recently appointed a physicist as a member of its research organization. Numerous other large industrial concerns are recognizing this variety of scientist with increasing frequency of late. The reason for this industrial appreciation of workers in our related science is not hard to determine. There is in the present tendency not only encouragement for physicists but also a note of warning for chemists.

A well-planned collegiate course of chemical instruction includes physical chemistry and numerous of its important variations, such as thermal chemistry, electrochemistry, photochemistry, etc. However, very often the student completing even the well-balanced curriculum has passed over much too lightly the fundamentals of physics. Frequently it is quite true, as jokingly remarked, that "the chemist is a man who makes bad physical measurements on pure substances; whereas the physicist makes wonderful physical measurements of the properties of impure materials." This situation was an early contributing reason for the development of a border field known as physical chemistry. However, even a thorough cultivation of this field is not enough, for fundamental physics must be studied and used by every well-trained chemist.

There will continue to be an increasing number of physicists employed by industry and all chemists can rejoice in this recognition of related science, but for many years to come a vast majority of our research organizations will probably not afford this "high-church form of scientist." It behooves the chemist, therefore, in building his research organization to make sure that some at least of his investigators are capable of caring for the purely physical problems with which any group of investigators is inevitably confronted. This, like many other factors, is simply one of the important things to take into account in planning a research organization. And incidentally, one may add, research organizations will succeed only when well planned; they are not much good if allowed to become a *Topsy*, who "just growed."

Obstacles to Dye Legislation

DESPITE the serious situation facing the domestic dye industry and the fact that an overwhelming majority in each house of Congress is ready to vote for the dye bill in substantially its present form, it is becoming increasingly apparent that a small minority has an excellent chance of preventing the passage of the measure at this session of Congress. Representatives of the dye industry now in Washington declare that failure to obtain this legislation will drive to the wall all but the very largest concerns engaged in the manufacture of dyes.

Senator MOSES of New Hampshire is regarded as the chief obstacle in the path of this legislation. He is credited with reflecting the views of certain manufacturers of textiles, but it is known that fully 50 per cent of the textile manufacturers favor the passage of legislation which will insure the continuity of the domestic dye industry. Nevertheless Senator MOSES is understood to be ready to direct a filibuster against the measure.

The chief claim of the opposition is that the bill plays into the hands of two large corporations engaged in the manufacture of dyes. Apparently no note is being taken of the signed statements submitted by sixty-four small manufacturers, stating that the bill is more in the interest of the small than of the large manufacturer.

At the short session of Congress the amount of legislation which can be handled, in addition to the appropriation bills, is limited. The appropriation bills have right of way. With a large number of other bills of

great importance before Congress there is much opposition to the consideration of any measure which is likely to develop a filibuster, thus consuming a great deal of the precious time not occupied by the appropriation bills.

The program is to pass a peace resolution as one of the first acts in the extra session. This will automatically abolish the War Trade Section of the State Department and will remove the control which that organization has been exercising over imports of dyes. The War Trade Section has been limiting imports to dyes not made in this country or to those not made in sufficient quantity. Germany anticipates the lapsing of the license system prior to the enactment of an embargo measure and already is prepared to take full advantage of the situation by moving in a short interval large stores of dyes into this country. Friends of the dye industry and advocates of industrial independence for this country should use all legitimate means to secure legal legislation which will enable us to hold the advantages already gained.

Significance of Price Declines

IT IS a very important fact that Bradstreet's index number stood at 13.6263 on the first day of this month. The index number is a weighted average of commodity prices at wholesale. It is regarded by business men as properly planned and correctly carried out, so that it is really indicative of what it purports to represent.

To make the number 13.6263 more interesting it may be mentioned that the number at the beginning of last February was 20.8690, while the average in the ten years 1904 to 1913 was 8.59637. The number of Feb. 1 marked the high point. It was 142.8 per cent above the ten-year pre-war average, while the number on the first of this month was only 58.5 per cent above. From Feb. 1 to Dec. 1 there was a decline of 34.7 per cent.

This subject of prices is of universal interest. Everyone has to spend money for commodities and is thus directly interested, while many have to purchase services and there is some relation between prices of services and prices of commodities. Those who sell goods are necessarily interested in the general average of prices.

Of the general public the number of men who will endeavor to explain away Bradstreet's index number of Dec. 1 is exceeded only by the number who will pay no attention to it, yet it is an important fact and an illuminating one when properly studied. To explain it away some men will drop into the latest vernacular and say, "But it don't mean anything," because the average man doesn't buy "hides and leather" or "textiles" or "naval stores," which have shown particularly great declines in the past ten months. The real point is that the index number is of wholesale prices and the declines have not all worked out in retail prices. That means simply that they will. Other men will say that some of the low prices of Dec. 1 are due to the existence of unwieldy stocks, that goods are being sold at "a loss" or at "less than cost of duplication," as if the cost of duplication could be known when production costs are declining.

At one time we had the "ascending spiral" and now we have the descending spiral. One decline will bring on another. Declines in prices at wholesale have not fully worked out in declines at retail, whereas the latter should be the greater, as unusual profits had been added. With reduced cost of living, wages can be reduced and manufacturing costs will decline.

There has been much talk and little study of "pre-war prices." Plot them, or even look at them, using Bradstreet's as a criterion. There is no pre-war "level" at all, but a sinuous line trending upward from 1896 as a low point in all the time since 1892. There were fluctuations before the war, why not after the war? It was as foolish to assert that prices were going to stay at a certain level as to pretend that they ever had stayed at any other level. There was, in fact, a fairly steady rise from 1896 to 1913. There were short "off" periods, of which 1908-9 and 1911 were good samples. While the ten-year average 1904 to 1913 inclusive was 8.59637, the highest yearly average was for 1913, 9.2115. Naturally we are thinking of 1921. That is eight years ahead of 1913, and going eight years back of 1913 we find 1905, a normal year in its time, with an average of 8.0988. Carrying the progression forward, by adding to 1913 the difference between 1905 and 1913 we have 9.2115. To get to that level would come nearer getting to "normal" than getting back to any of the numbers actually recorded before the war, but to get to 9.2115 from the present 13.6263 would be going down only 32 per cent. After all, then, there is not much to quarrel about.

Locking the Barn Too Late

THE horse was stolen recently, and although perhaps in general circles there was not as much commotion as if Man o' War had been led away by thieves, yet in the ceramic industry there has been almost equal disturbance. We refer to the case of the resignation of A. V. BLEININGER from his position as ceramic engineer of the staff of the Bureau of Standards to go into commercial work. This resignation had barely been announced when the most vigorous protests from many sources reached the bureau. It is evident that the ceramic industry as a whole had thoroughly appreciated the value to it of the service which had been rendered by Dr. BLEININGER'S organization, and it is also evident that the industry is now much disturbed that he will no longer be available to serve it thus.

Running all through these protests to the bureau is the thought that Dr. BLEININGER could not have been expected to stay under the conditions of inadequate salary both for himself and for his staff. For a long time it has been well known that his work was most disheartening because of the frequent resignations of his more valuable assistants, usually just as they were getting thoroughly acquainted with the work and becoming increasingly valuable to the bureau in its investigations. And yet nothing, or virtually nothing, had been done about it until after conditions got so bad that Dr. BLEININGER found it necessary to resign.

There is a little consolation in the fact that Dr. BLEININGER has left nominally for a single year and that the bureau hopes to have him resume his work in direction of the ceramic investigations at the end of this period. However confident the industry may feel that it will be possible for him to take up the work again at that time, it cannot look with equanimity upon a whole year of delay in this important field.

This is only one of the many cases where valuable scientific investigators much needed in their present official position by the industries are in danger of extreme discouragement leading to separation from the

service. Other industries which find Government activity as valuable and as diplomatically handled as that which has been directed by Dr. BLEININGER may find it wise to investigate the situation in Washington and see if they too are not in danger of losing that service upon which they perhaps now depend more than they realize. An insistence upon retention of work of this sort upon a high plane with properly compensated chiefs and assistants not only will insure continuance of the work but also will safeguard against the dangers of petty administration and unsympathetic or actually antagonistic governmental attitude toward industrial technology. It would be well if more industries bought a new lock to secure their barn door.

Absurd Chemical Consolidation Ideas

RECENTLY one of the members of Congress made what was to him an amazing discovery that thirty-five different Government bureaus or commissions were doing chemical work or employed chemists. As a result this worthy legislator would revise our Government organization post haste, consolidate all chemical activities in one bureau, and thereby, to his mind, eliminate duplication, increase efficiency and reduce greatly the necessary Government expenditures for this scientific service.

The worthy legislator was probably conservative in stating that at least thirty-five different Government organizations do chemical work. In fact, in making this estimate he probably overlooked a number of them. But he certainly overlooked another factor in the matter much more pertinent than those which have occurred to him. Chemistry is in many instances the servant of industry, and in the Government department it is correspondingly the servant. The Geological Survey employs chemists; so, also, does the Bureau of Mines, the Bureau of Standards and the Bureau of Chemistry. However, no one who knows anything of the work of these four typical institutions would expect the Survey chemists, who are experts in mineral analysis, to care successfully for the food and drug problems of the Bureau of Chemistry, or the paint investigations at the Bureau of Standards, or the gasoline studies of the Bureau of Mines. The chemist has become better known industrially and in the halls of our legislatures during recent years than almost any other kind of scientist, but the education of the public and our Congressmen is still far from complete. No opportunity can be lost to make it clear that the term "chemist" is a generic word including many classes and varieties of workers. All of them have a common interest and use somewhat similar methods. But each in his sphere is a specialist, invaluable there, perhaps, but probably of relatively less value in any other field.

Chemists themselves are sometimes prone to forget these facts. They seem willing to rush into any variety of chemistry whether they are experienced or capable therein or not. It is not strange, therefore, that our legislators are disposed to take such stand as that recently exhibited. If the leaders of the profession have influence, however, there is no reason to believe that serious legislation such as that which has been suggested will materialize. We certainly hope it will not, for one might as well say that all typewriting machines must be maintained and used in a single building as to think that all chemists in the Government service could work to advantage through a single bureau.

Chemists And Cooks

A COUPLE of members of the Chemists' Club were walking along 41st St., New York, and as they approached the entrance of the club, whither they were bound for their lunch, an automobile drew up to the back door of the hotel across the way. The chauffeur stepped down and politely provided an exit for his passenger. "Let's wait a minute," said the older chemist to his colleague. "That is probably the chef of the hotel, arriving for his day's work." Sure enough it was. A well-dressed man with a foreign air touched an electric button, an elevator appeared beyond a door, and the chief cook entered it and disappeared into the depths. It was as it should be. Cooking is a great art, and the hotel is successful. A large measure of its success depends upon its chef, who is, very properly, a man of circumstance. He is entitled to the luxuries and ease which often accompany achievement.

On the other hand, the two chemists walked, which was also good for them, for the exercise was conducive to their health. But in a moment of confidence they admitted to each other as they proceeded to the club dining-room for their 95-cent lunches that neither possessed an automobile. That, too, may also be as it should, because likely as not neither of them needs one. One of them also observed that as things are going now a far more important desideratum than an automobile for a chemist is a job, although the two who were engaged in the observation and comment were not lacking in this respect.

Why should not cooking be a profession anyway? The consulting chemist is always ready to work over a face powder or a toilet soap, and he likes the opportunity, whereas if he is asked to cook a dinner the chances are that he will decline with the semblance of scorn. Now a leading reason for his refusal and scorn is likely to be that he can't do it; that he doesn't know how. He lacks what the bewhiskered foreigner in the luxurious automobile has in abundance, and that is The Art.

Our food chemists measure calories and allocate proteins, hydrocarbons and fats, and provide for the economies of householding, but why shouldn't they provide for the joy of living as well? If a poet writes a ballad that finds its way into popularity and everybody sings it he counts it to his credit. Dishes of appetizing food, on the other hand, seldom bear the names of their creators; they are more frequently named for eminent French statesmen, or for celebrated gourmets. We should like to see the names of our great chemists more frequently rolled off the public tongue. Advertising men charge millions of dollars and grow rich by inducing the public to become familiar with names of purveyors and of the goods they sell. This sort of thing has its value. And it would be good for chemistry. Think of a menu containing such items as Oysters, Ghent, à la Baekeland; Potage Vitamines à la Mendel; Scrod à la Theodore W. Richards; Prairie Hen à la W. A. Noyes; Salade Mathématique, Langmuir, prepared with Huile Baskerville and Vinaigre Whitaker; Gâteaux à sucres divers, Hudson.

All of these gentlemen have the mind and the ability to do these things; as for Dr. BAEKELAND, we speak from experience when we say that in the galley of a boat he can produce dishes of supreme merit and that if his preparations were on the market the hotels would bid all sorts of prices for them.

Readers' Views and Comments

Joaquim Bishop, Worker in Platinum

To the Editor of Chemical & Metallurgical Engineering

SIR: I have noticed that Dr. Smith has very little to say, in his books upon the early history of chemistry in America, about the work of Joaquim Bishop, who was assistant to Robert Hare. Bishop became very familiar with Hare's oxyhydrogen blowpipe and used it in working platinum. In 1873, when I was in the private chemical laboratory of Dr. Thomas M. Drown at 1223 Girard St., Philadelphia, Bishop, then by no means a young man, dressed in the straw hat and cowhide boots of a farmer, with a market basket on his arm containing his week's product of platinum crucibles, came to the city from Sugartown to dispose of his product to Bullock & Crenshaw, whose store was located at Sixth and Arch. He frequently came to our laboratory, in response to a request from Dr. Drown, to get instructions about the manufacture of apparatus of platinum. At that time pieces made of platinum were soldered together with gold. Shortly afterward he reported that he could weld them; gold could be dispensed with. He made some rather intricate pieces for us, without any boasting about his skill, which was very great. He was very plain in manner and speech, rather tall, with a pleasant smile. About 1882 I went up to Catasauqua to see H. J. Seaman, then chemist for the Crane Iron Co., and found him putting a patch on a perforated platinum crucible. His anvil was a railroad spike, welded to fit the inside of the crucible and driven into a wooden block. The crucible he was using had been repaired repeatedly in this way.

EDWARD HART.

Lafayette College,
Easton, Pa.

Steel Rails From Sink-Head and Ordinary Rail Ingots

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest the series of papers by Dr. George K. Burgess, "Steel Rails From Sink-Head and Ordinary Rail Ingots," appearing in the November issues of CHEMICAL & METALLURGICAL ENGINEERING. Accompanying editorials were also of exceeding interest, especially that appearing in the issue of Nov. 17, "Why Not Turn the Mold Over?"

There is no question that good rails, or any steel product, is more than a sulphur print, and that Service is the final analysis by which quality must be judged.

The comparative method of conducting the Hadfield and Maryland ingot tests I feel is, however, open to just criticisms in that: First, a similar chemical analysis of steel was not employed. Second, that the more homogeneous and consequently denser Hadfield ingots were rolled in the same number of passes (thirteen) employed in blooming the more open and less dense Maryland ingots. It has been the experience in very many plants which have adopted the turned over, or big-end-up, mold method of producing ingots that the denser steel cannot be reduced in cross-section as rapidly as the more open, less dense ingot, without danger of producing cracks or internal ruptures in the more dense material. Third, that the Hadfield ingots were charged in the soaking or reheating pit cold, which enhances the liability to surface defects and deep cracks most materially. The relatively large number of "second" rails from the sink-head ingots is unquestionably attributable to this practice of cold charging and heavy blooming passes of the Hadfield ingots.

The exhaustive tests of the Bureau of Standards, as described by Dr. Burgess, have clearly proved beyond peradventure that no physical defects and chemical segregation less than 12 per cent can be assured to the producer and buyer of steel product for at least 85 per cent of the weight of the ingot, whereas in the ordinary type of ingot production, even after cropping 26 per cent from the top of the ingot, defects are apt to occur in the middle and bottom portions of the ingot and in the finished product produced therefrom. I wish to reiterate that faulty heating and blooming of rails and other products can spoil or reduce the quality and homogeneous structure of initially perfectly sound homogeneous steel ingots, and that those who undertake to remedy the present defects in rails and other steel products must look further than the obtaining of an initially sound ingot, although that is the primary requisite. Care in reheating and in employing a suitable number of blooming passes has been found absolutely essential in order that the producer of sound ingots may profit thereby in his finished product.

Gathmann Engineering Co.,
Baltimore, Md.

EMIL GATHMANN.

Electric Furnace Refractories

To the Editor of Chemical & Metallurgical Engineering

SIR:—A reply to the letter written by Robert D. Pike, criticizing certain statements made by the writer in the article entitled "Electric Furnace Refractories," and published in your issue of Dec. 15, may be in order.

Particular exception was taken to the statement in that article that amorphous magnesite was entirely unsuited for the manufacture of refractories. The writer still maintains that the statement is correct and will be borne out by anybody and everybody who has had a wide experience in the manufacture and sale of magnesite refractories made from the raw material from Washington, California, Austria, Greece and Venezuela. It will be noted that the statement was not made that refractories *could not* be made from the amorphous type, but that it was *unsuitable*.

After the Austrian magnesite was cut off by the war this country was driven to the use of the amorphous magnesite of California. No one but the manufacturers themselves will ever realize the amount of effort, time and money that was put forth in an effort to make a product satisfactory to the steel and copper industry from this material. Four years of research and experimental work, combined with the erection of special plants and the installation of special equipment, did not solve the problem and convinced both producers and consumers alike that a satisfactory product could not be made. Furthermore, as soon as refractories made from the crystalline ore became available the consumers refused to purchase those made from amorphous ore.

Mr. Pike is quite right in his statement that the formation of periclase or beta magnesite has nothing to

do with the type of magnesite used. However, the formation of periclase was the stumbling block to the successful use of the amorphous type. Periclase is more readily formed with the crystalline type and the formation begins at lower temperatures. Brick and shapes made from the crystalline can be thoroughly converted to the periclase stage in the kiln before they start to squat or soften out of shape, reaching a point of complete crystallization in perfect condition. When the amorphous is used, however, the formation of periclase does not take place until the critical point is reached, and any attempt to reach a point of complete conversion resulted in losses that the manufacturer could not stand on quantity production. The firing of the product was, therefore, stopped before the critical point was reached and while the magnesite was still in the amorphous stage and an unsatisfactory product resulted.

Mr. Pike is not correct in his statement that the Northwest Co. was the first in the United States to build and operate a plant which produced a true dead-burned magnesite. In 1915 the American Refractories Co. started the first dead-burning plant in this country at Harper, Ohio. Later the Lehigh Portland Cement Co. converted a portland cement plant at Coplay, Pa., and operated it as a dead-burning plant. Following this the Harbison-Walker Refractories Co. constructed and operated a dead-burning plant at Chester, Pa. All of these plants produced true dead-burned magnesite from California amorphous magnesite and all were constructed and operated before the Northwest plant at Chewelah, Wash., was built. It might be added that these plants produced material of the highest possible grade from the material used and were operated by men recognized as being the foremost in the industry.

The real reason for the production of only calcined magnesite instead of dead-burned in California was that there was not and is not any single deposit in California large enough to warrant the establishment of a dead-burning plant, and so long as it was necessary to ship the material from several points, the refractories manufacturers preferred to convert existing rotary kiln plants in the East to dead-burning plants or to add rotary kiln equipment to their brick plants. The magnesite was calcined in California before shipment East in order to save freight, as it loses practically half its weight through the driving off of the CO_2 gas. California magnesite was not "dead-burned," therefore, simply because the users preferred it otherwise and there was never a time when the magnesite manufacturers, or for that matter the ultimate consumers, were confused over the terms "calcined" and "dead-burned."

It is useless to enter into any argument over the relative merits of Austrian and American magnesite. It is quite sufficient to say that in spite of the fact that a considerable tonnage of Austrian has been coming into this country regularly for the past two years, the supply has never equaled the demand and the cargoes have always been sold before reaching this country.

Pittsburgh, Pa. A. F. GREAVES-WALKER.

A Substitute for Cork

It is reported that a Czechoslovakian chemical works at Brünn has treated turf by a special patented process whereby was furnished a material for insulation and building purposes that is said to be, in most respects, not inferior, and in some superior, to cork. The product is reported to be light, firm and soundproof, to possess great insulating properties, and to be damp-proof.

Kauri-Gum Industry in New Zealand

The kauri-gum industry, which has been an important factor in and around Auckland for the past half century, is taking on new impetus since the closing of the war, reports Consul General Winslow, of Auckland. In the past most of the work was done by hand and by individuals, something like gold was mined years ago in new fields, with the result that the top had only been skimmed over and the better pockets dug out. These methods have secured about $100,000,000 of kauri gum to date, and it is claimed that there is still left in the kauri field gum and byproducts worth at least two or three times what has been taken out.

Government Encouragement for Industry

Until recently the development of the kauri-gum fields has been left entirely to private enterprise, but about three years ago the New Zealand Government established a department for the supervision and encouragement of the industry, with the result that more extensive operations are being undertaken by companies as well as by individuals. It is now proposed to develop the industry along more systematic and scientific lines than those heretofore employed.

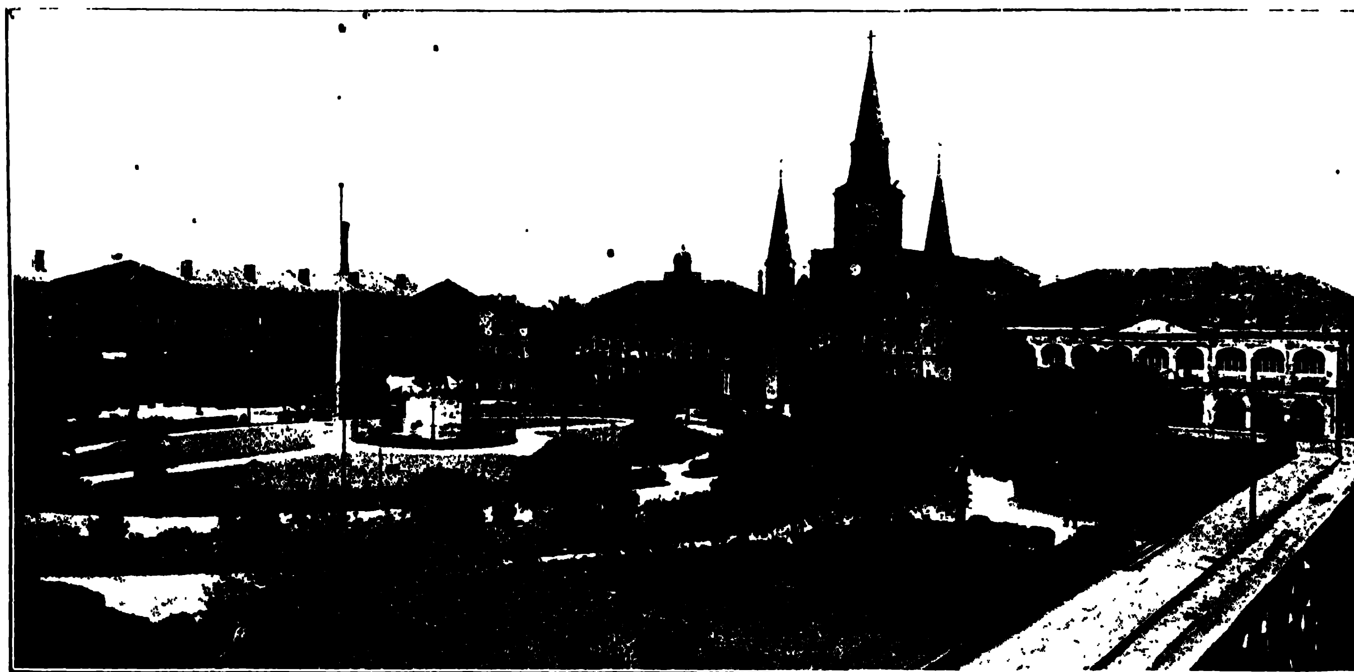
From 12,000 to 15,000 tons of kauri gum will, it is expected, be produced per annum, instead of 8,000 or 9,000 tons, as was the case previous to the war, to say nothing of the byproducts, which are estimated to be worth as much as or more than the gum itself. One company plans an output of 8,000 to 9,000 tons of gum per annum, and there are besides many private individuals at work in different sections of the field, and other interests are contemplating putting in new up-to-date plants.

Sluice Mining—Extent of Fields

The latest undertaking is to mechanically gather the gum from the peat, or pukau, which is really the damaged kauri gum, in the low or swampy land found in the territory around Auckland. This is to be worked by what is known as the sluice process, similar to sluicing for gold. The peat is placed on a screen and water is forced through it. The screen gathers the chip gum and allows the waste or tailings to drop beneath. This chipped gum is divided into about 15 per cent first quality, 15 per cent second quality and 70 per cent low grade. The tailings are converted into kauri-gum oil in a manner similar to extracting oil from shale. It is estimated that 40 to 50 gal. of kauri-gum oil can be taken from a cubic yard of pukau. This oil is a very valuable commercial oil, containing a large percentage of motor spirit and turpentine.

It is stated that one company in Auckland has control of kauri-gum rights covering 47,000 acres, estimated to contain 13,000,000 cu.yd. of pukau. In addition, the New Zealand Government still holds kauri-gum reservations that are estimated to contain an even larger quantity of pukau, to say nothing of many private interests holding small sections of kauri swamps. This will give some idea of the real size of the industry that means so much to the paint and varnish interests of the United States, as well as to the linoleum and rubber manufacturers.

The New Zealand Government is allowing persons to stake out tracts or claims of three acres on the government reservations, for which the individual operators must pay 10 per cent of the value of the gum taken from these swamps.



HISTORIC JACKSON SQUARE. OLD SPANISH CABILDO AT RIGHT

The New Orleans Meeting of the American Institute of Chemical Engineers

Report of the 13th Winter Meeting, Reviewing Salient Features of Papers Presented, With Notes on Excursions to the Union Sulphur Plant at Sulphur, the Salt Mines at New Iberia and the Luray Cavern

THE thirteenth winter meeting of the American Institute of Chemical Engineers took place at New Orleans, Dec. 5 to 9. The paper program was held in the ancient Cabildo. This is a dignified two-story structure of adobe and shell lime, which has stood since 1795 as a monument of Spanish dominion over the Louisiana territory. Not far distant Audubon Park marks the place where, during this same memorable year, Etienne de Boré made the first plantation sugar. Eventually this was to become the primary product of the district and exerted no small influence in bringing about the Louisiana purchase eight years thence by the United States. President David Wesson in the opening address told what the Institute has been, is and should be by starting off with one of his appropriate stories.

PRESIDENTIAL ADDRESS

"In the good old days of long ago, when every man of standing in this part of the country had his special body servant, two colored boys were heard discussing their respective masters. The first was bragging about the great wealth his master, who was a rich planter, had accumulated. He ended by saying 'Your boss is always traveling. Don't you know a rolling stone gathers no moss?' the answer came back quick as a flash, 'It sure doesn't get any moss, but it gets lots of polish just the same, and that it what your boss needs.'

"This remark applies in some respects to the Institute. When we take an excursion like the present one, the railroads remove considerable of our moss, but the inspiration and broadening effect caused by close association with many master minds of our profession engaged in the various fields of industry more than compensate for the time and lucre spent in attending this meeting.

"One of the first objects of the Institute was to bring men together who had made good in their profession, so all might be benefited by mutual interchange of views.

"Another object was the elevation of the profession to a position in the community commensurate with the services of its members.

"Up to a year ago the Institute passed through a slow but steady growth. The high code of ethics and the standing of its members gave it a respected place, but there were not enough of us to do properly the work for which we seemed to be especially fitted.

"Some of our far-seeing members suggested that the Institute would carry more weight in important national affairs if the membership contained all those who were eligible. A modest campaign was started with the result that our total membership today numbers 454 as against 365 of a year ago, an increase of 24 per cent.

"During the past year we have joined the Federated American Engineering Societies, whose object is to secure the co-operation of the prominent engineering societies of the country to utilize their possibilities for constructive work in great public service questions, in

matters of transportation, conservation of natural resources and similar affairs.

"We have given hearty support to the proposed reorganization of the Department of Interior into a Department of Public Works.

"The Institute is backing the compilation of the Compendium of Critical Chemical and Physical Constants, which when completed will furnish a valuable storehouse of information and become a needed tool chest for members of the profession.

"The Institute is also acting to some extent in an advisory capacity to the Government engineers having in charge the survey for the new Boston-Washington superpower project.

"These facts are mentioned to show that at the present time the Institute is not merely a joy ride association, but its activities are of national importance.

"There is no longer any question of the value of the work of the chemical engineers to the welfare of the country. There is, however, the great question as to how it can be made of greater value. We have all seen what organized labor has done through the sheer strength of numbers and organization. Is it asking too



AUDUBON PARK





CLOISTER ALLEY

much to have all those who are fitted by education, achievement and high character brought into one strong organization by becoming members of our Institute? With the professional leaders of our chemical industries all working together toward one common end, an enormous influence for good can be exerted upon the material, economic, educational, legislative and industrial affairs of the country. The days have gone by when the Institute was regarded by some as a sort of excursion club for a select few. The day has come when the Institute must take the lead in shaping the thought of the chemical industries of the country, and to do this, it should count among its members all the qualified leaders of those industries. During the past year we have made a fine start. Let us, therefore, keep up the good work of securing desirable members so we may better accomplish the work which lies before us."

THE A.I.C.E. AND THE F.A.E.S.

Prof. James R. Withrow gave a report on the Washington meeting of the Federated American Engineering Societies, which need not be abstracted here, as a full report has been presented in our issue of Dec. 1. His views on the chemical engineer among engineers are reproduced as being of salient interest.

"The American Institute of Chemical Engineers is an organized effort to represent the solidarity of the profession of chemical engineering. The chemical engineer occupied a peculiar position in the engineering profession. His branch is new compared to the others such as civil, mechanical, and even electrical engineering, as far as emphasis is concerned, though as a producer or a manager of chemical production he is older than some of these, though not in an organized way. The chemical producer of the nineteenth century was unorganized. His only approach to solidarity came through chemical societies. These were naturally academic and looked down upon the chemical engineer as an empiricist who was neither an engineer nor a chemist. The mechanical engineer felt that he could do all the engineering necessary in chemical manufacturing. On the other hand few chemists connected with manufacturing could resist the temptation to call themselves chemical engineers, though their work was entirely analytical control or industrial research, and though they did not have to deliver the production or put up or operate the equipment. The chemical engineer can do and often does the strictly chemical things too, but on the other hand not all that do this important control and investigational work are engineers.

"The American Institute of Chemical Engineers has played an important part in clearing the atmosphere about what constitutes a chemical engineer. To the speaker's mind all is not as clear as it might be even with the Institute, for he is compelled every few months to vote against good chemical friends, who are strictly research or control (analytical) chemists and not engineers at all, to his way of thinking, and who stand approved by even our eligibility committee, careful and fair as we must concede it to be.

"However, with this good work done or in progress, it is our part to go steadily forward in assuming the responsibilities of an engineering organization. It was quite natural, perhaps, that during the war the larger group of chemical men, the American Chemical Society, were mistaken by the other engineering societies as their chemical complement. The American Chemical Society should have been taken into all that it was taken into, but the great bulk of its members are not interested in chemical engineering. This Institute should not have been omitted, however. Repeatedly I have had to protest in this matter. Now it would be the Naval Consulting Board, again it would be the National Research Council, again the Joint Conference Committee. Others have interested themselves in this also, to my knowledge. Sometimes I have notified the Institute of my protests and sometimes I have not.

"It is our duty to stress less the chemical and more the engineering. The words of our name make this clearly necessary. Chemical engineering is *engineering*. It is the engineering of chemical productions—not the chemistry of chemical production. That is industrial chemistry—and is *chemistry*, and by no means engineering, though chemical engineering is its handmaiden.

"It is our duty also to weave our web closer and closer to the other branches of the engineering profession. It is here that our future lies. We have at once the most difficult, the most enthralling and the most undeveloped field of the whole profession of engineering.

"Since it is our duty to align ourselves more and more with the engineering profession, our question is, Where shall we begin so as to be of greatest assistance to the engineering profession as a whole, and make the other engineering profession branches respect the dignity of our field? My purpose is to emphasize that we have taken our rightful place as an Institute of Chemical Engineers by joining hands in the public service for America's good, with the other engineering associations in the Federated American Engineering Societies."

Associate Membership Discussed

Frank E. Dodge introduced a resolution creating associate membership, which is believed to be more desirable than the present junior grade. No action was taken, and after considerable discussion the motion was tabled to allow time for general opinion to crystallize. Many manufacturing plant mechanical engineers having allied chemical interests and accomplishments are to be included in this class if it is worked out on the tentative basis discussed at the meeting.

Longworth Dye Bill Indorsed

Recognizing the conflicting opinions in Congress toward protecting the dye industry, the Longworth bill was briefly indorsed and the following resolution wired to Washington:

> Whereas the American Institute of Chemical Engineers, at the annual meeting at New Orleans, now in session, recognizing the importance of the coal-tar industry to the country at large and the great danger threatening it in case adequate protection is not afforded it by our Government before peace with Germany is declared; therefore be it
>
> *Resolved*, That we reiterate the position taken at our annual meeting in Savannah in December, 1919, and urge immediate favorable action on the so-called Longworth bill.

Section 9 of Nolan Bill Condemned

The rider in the Nolan bill, Section 9 of H.R. 11,984, which may be found in our issue of Oct. 27, was condemned as being improper legislation. It was thought that the rider would lead to interference by the Government bureaus with business enterprise with which they were originally intended to co-operate in supplying service of benefit to all.

Welfare Plans of the du Pont Company

Charles L. Reese gave an interesting account of the present plans of the du Pont company in protecting the savings of employees with stock investments in the company as well as the presentation of awards of stock for extra compensation whenever merited. During the war some of the employees received an annual bonus as high as from $30,000 to $50,000. Invention, bravery, valuable suggestions were all compensated for in adequate manner. Regularity and continuous employment are not overlooked in the stock awards. The complete details will be published in an early issue.

Conservation of Heat Losses

E. R. Weidlein described the development work done for the Magnesia Association at the Mellon Institute. Calculation charts were given with which the most economical installations are found. When it is considered that the energy losses of 100 ft. 6-in. uncovered pipe at 100 lb. pressure are about equivalent to 300 tons of coal per year on an average, the importance of 85 per cent magnesia needs no further comment. In discussion Henry Howard recommended combination with felt for low-temperature insulation when condensed moisture would remove the insulating air cells in the usual magnesia insulation. Roofing paper should be applied as protection against water and should not be allowed to become hot, else the flux oils saturate and ruin the insulation.

Recent Advances in the Sulphur Industry

In the absence of Dr. Raymond F. Bacon, the paper on sulphur was read by Dr. Weidlein. Two new sulphur domes have been operating recently in Texas, with the result that the supplies of sulphur have been adequate to supply every demand at prices actually competitive with pyrites. Dr. Bacon believes that sulphur should be used as an engineering material, as it has many desirable properties not obtainable readily elsewhere. It can be filled with sand to lower the volume cost. Acidproof conduits have been produced at an extremely low cost from sulphur.

The Sulphuric Acid Fume Problem

This was a preliminary paper by Drs. James R. Withrow and F. C. Vilbrandt on their investigation on acid fumes. The literature and legislation were reviewed and the various analytical methods of testing contaminated air critically examined. The permanganate method was found unreliable due to the fact that intermediate reduction products of colloidal manganese oxides were produced. Standard SO_2 mixes were also found unsatisfactory, due to this vapor not forming stable mixtures under all mechanical conditions. For instance, passage through an abrupt angle caused considerable variation in the composition of the air-vapor mixture.

Cost Accounting

Successful plant operation depends on proper interpretation and analysis of costs. A. G. Peterkin presented the manager's point of view. He wants less routine reports and masses of burdensome statistics on costs, with the result that the accounting department will be free enough from routine labor to work up any data upon request at any time. The basic fundamentals on cost keeping were presented, the details of which will be published in a subsequent issue.

Sugar and Molasses

Lezin A. Becnel presented some interesting charts on cane products showing the relationship between molasses and sugar production. He was very much in favor of less sugar extraction and the consequent production of higher quality sirup byproducts. The price of the latter will be more than sufficient to compensate for the sugar remnant, when compared with the present grades of lesser epicurean virtues.

Resources of Louisiana

A rich soil abundantly irrigated by the waters of the alluvial Mississippi is Louisiana's greatest asset. N. L. Alexander, chief of the State Conservation Commission, gave an illustrated lecture describing the forest and game reserves of the state. About 200,000,000 ft. of lumber is cut annually by the 460 sawmills within the state. Reforestation is rapidly becoming necessary and

anticipating this the state has established a 30,000-acre reservation. Pulpwood of good kraft quality has been produced in fifteen years. The Goodyear Co. is planning to plant an extensive reserve to supply its pulp mills in the near future. Tax reductions are being offered to induce forest planting and lower the investment required. Boys' clubs appear to be especially promising in this direction. The game reserves far outstrip the combined zoos of the world. Ducks, geese and all waterfowl from the entire North American continent appear to appreciate the natural advantages of the state during the winter season.

Sulphur, salt, gas and petroleum have been found in quantity. The two former will be described later. Considerable alarm is felt over the rapid growth in the state of the carbon black industry, which will rapidly exhaust the gas fields and yield very small return to the welfare of the state compared to household consumption. The present law requires all new installations to obtain a state permit, which will be granted in fields located in places remote from towns and cities.

Water Purification, Sewage and Drainage

George G. Earle, the engineer who has freed the Crescent City of the difficulties incident to the negative elevation of the city, described the pumping system used to empty the seepage, sewage and rain waters over the levees into the river. Special pumps were designed based on the screw effect which will pass almost any obstruction from an overcoat to a demijohn.

Handling Concrete Mixes

On large construction work the mixer is usually located as centrally as possible and to facilitate the handling of the mix, a very wet mix is used. Maximilian Toch drew attention to the danger of defective construction due to this and advocated that the engineering profession undertake to improve the present practice. He was not prepared to offer suggestions, but hoped to be able to do so in the immediate future.

Activated Sludge

Edward Bartow gave an interesting lecture on the treatment of sewage by aëration in the presence of activated sludge as developed in England. The greatest problem requiring solution appears to be an economical method of drying the sludge. This contains 90-odd per cent of water, which is removed with difficulty on the scale required. Experiments are now under way that may lead to results at Milwaukee. Where a large area of open country is available and the climate is dry, solar evaporation offers about the most satisfactory way around the drying difficulty.

Salvaging Sag Paste

Sag paste is the zinc oxide ointment used during the war as a skin protector against poison gas. C. B. Morey described the method used by the Larkin Co. in salvaging the fatty constituents and the tin in the container tubes. Several million tubes were worked up into merchantable products, the operations for which were of interest due to the way the problems encountered were solved.

Data on Horizontal Tube Evaporation

Results on evaporation data are hard to get, due to the multitude of variable factors. Prof. W. L. Badger presented his fourth report in which he worked on distilled water in a horizontal tube evaporator. The paper will be published in full in an early issue.

Visit to Union Sulphur Plant

The Institute Special train arrived at Lake Charles Wednesday morning. The local Chamber of Commerce showed great appreciation of the talents of chemical engineers, undoubtedly being influenced by the accomplishments in their locality of the late Herman Frasch, and not only were prepared to welcome the visitors but banqueted and carried them in their automobiles out to Sulphur, about twelve miles distant.

The area of the sulphur works is about sixty-five acres, studded with derricks similar to an oil field. The great boiler house and multitude of compressed air, hot water and sulphur pipe lines are the distinctive features. The old dome looks more like a lake, due to subsidence of the soil where the millions of tons of sulphur have been removed. Plank roads set on piles interweave through the works. A slight mist of water vapor floats over the ground, but the 750 ft. of earth almost completely hides the presence of the superheated water below.

The blackish-brown molten sulphur is air lifted from the lower levels of the bed into 3,000-gal. open pans, from which it is pumped by centrifugals to the board-framed stock pile.

Salt Mine at New Iberia

Chemically pure salt is usually obtained only by the aid of chemical technology, but only the arts of the miner are required at the salt domes called Averys, Weeks, etc., islands because of their elevation above the surrounding flood lands. The beds are of Quaternary age. The crystal structure is such that practically all the mother liquor inclusions have drained off to some unknown locality, which when found will probably give the long-looked-for source for potash and magnesium salts.

The ladies of New Iberia were the hosts. The party was driven out to the rice mill, where the grain was hulled, the bran removed and a polish applied by means of a paste of glucose and soapstone. At the present time a large pulp mill is being erected to utilize the cane bagasse and rice straw of the district.

Refreshments were served at the hotel, after which Toastmaster Williamson called up the speakers. Dr. Olsen in his talk did his best to repay the hosts with a liberal supply of expert advice on salt. He told them that while they were receiving about $4 per ton for the raw salt at the mine, they were paying about $140 to the North for the manufactured goods made from this ton of salt. The orchestra finally resorted to dance music and the party ended at a late hour with the refrains of "Home, Sweet Home."

New York Party Stops Over in Virginia

The special car Custer was dropped off at Roanoke so that the party could see the city. The blast-furnace plant of the Virginia Iron, Coal & Coke Co. was visited. The Dwight Lloyd process of desulphurizing pyrite ash proved to be the most interesting feature. From 3 to 4 per cent sulphur is present in the ash as it is received from the sulphuric acid works. This is mixed with powdered coal and ignited on a 60-ft. chain belt grate. Excess air is drawn through the mass, which has been leveled to a uniform thickness of 6 in. Practically all the sulphur is oxidized and the quenched iron and coke

clinker is mixed with local brown and Lake Superior ore to give the analysis required for the blast-furnace charge.

The Luray Cavern, with its unique calcite crystals wrought into amphitheatres, towers of Babel, Castles on the Rhine, Saracen's tent, fish market, scarfs, drapery



LURAY CAVERN

and hundreds of artistic forms, was a fitting sequel to the meeting. The underground chemical plants operated by nature at Sulphur and New Iberia could be much more appreciated after the visit to this subterranean museum of fine art.

Attendance

A. A. Backhaus, Walter L. Badger, William M. Barr, G. E. Barton, Lezin A. Becnel,† Percival C. Brooks, W. E. Burkhard, Harry O. Chute, Charles E. Coates,* Albert Dinwiddie, Frank E. Dodge, W. C. Ermon, A. E. Gibbs, Freeman I. Gibson, John Henning, Robert W. Hilton, Henry Howard, Daniel D. Jackson, Courtenay de Kalb,* Harry W. Kellogg,* Arthur C. Langmuir,* M. P. Landis, Louis J. Matos, John C. Minor, Hugh K. Moore,* C. B. Morey, J. W. O'Brien, John C. Olsen,* Howard C. Parmelee, Albert G. Peterkin, George A. Prochazka,† Charles L. Reese,* A. E. Rice, Wallace Savage, Ralph S. Sherwin, Albert W. Smith,* Kent Smith, W. R. Swint,* Maximilian Toch, Edward R. Weidlein, David Wesson,* Charles S. Williamson,* James R. Withrow, Frederick C. Zeisberg.*

French Factory for the Manufacture of Vaseline

Preparations have been made for the erection of a vaseline factory along the Nievre River at Ile-d'Elle, Department of Vendee, where the existence of a clay rich in alumina has been discovered, reports Consul Moorhead, of Nantes, France. New methods employed will produce vaseline at lower than ordinary prices.

*Accompanied by wife.
†Accompanied by wife and daughte

Need for Work on Aluminum by Bureau of Mines Pointed Out by Dr. Moore

The Bureau of Mines has requested an appropriation of $29,920 for work on aluminum. In explaining the need for this work, Dr. R. B. Moore, the bureau's chief chemist, has prepared the following statement:

During the last two or three years the Bureau of Mines has had two men working in aluminum, mainly in connection with aluminum losses in remelting, etc. The small sum available has not made it possible to take up larger phases of the work—namely, the cheap manufacture of aluminum oxide, either in a primary operation or in connection with byproducts, and improvements in the manufacture of aluminum metal itself. Such a line of work will involve a special appropriation which is not now available and will require at least a minimum of $30,000 to carry out in an efficient manner in so far as the Government is concerned.

Aluminum is one of the most important metals of the present day and its use in the industries and for domestic purposes has only just begun.

In the process of aluminum manufacture, oxide is first produced, the source of the oxide being almost entirely bauxite. By electrolytic methods the oxide is then converted into the metal. Therefore there are two distinct steps involving improvements and efficiency—namely, the production of the oxide and afterward the production of the metal.

At the present time the cheap production of potash from silicate rocks, such as potash, feldspar, leucite, etc., involves aluminum oxide as a byproduct. The possibility of making aluminum oxide from certain types of clays and other aluminum minerals besides bauxite is of extreme importance for the cheap production of aluminum metal. The possibilities of even producing metallic aluminum directly from the aluminum minerals without the intermediate production of the oxide and the after use of electrolytic methods have by no means been entirely exhausted. On the other hand, undoubted improvements could be made in the present electrolytic methods, especially in the way of getting a standardized product.

The use of aluminum has tremendous possibilities in the industries and for domestic purposes. Its alloys with magnesium are receiving at the present time much attention, as such alloys are often even lighter than aluminum.

Duralumin, which is an alloy of aluminum, copper, manganese, etc., is an extremely light alloy but has the strength of mild steel. It has been used by the Germans with great success for a large number of purposes, especially for the framework of dirigibles, for airplanes, etc. The uses of aluminum and its alloys in connection with automobile parts, for domestic purposes, etc., are well known. If the price could be brought down to considerably less than the price at the present time, its uses would be greatly extended.

American Shoes in Switzerland

American shoes are sold in Berne and, in fact, in practically all the larger cities of Switzerland. Imports since the war show an encouraging increase. In that country there are about twenty shoe factories with an output of about 80,000 pairs daily. One factory alone is said to produce 50 per cent of the total output. Because of the development of the industry there is also a comparatively good market for shoe uppers, reports Consul Haynes. The possibility of success would be more probable if stocks were kept in Switzerland, such a system being generally preferred to the presentation of samples. The value of leather imports is about $4,000,000 annually, the import duty varying, according to quantity and quality of leather, from 77c. to $4.63 per 100 kilos (220 lb.) gross weight. The duty per 100 kilos is as follows: Sole leather, 16 fr.; box calf, brown, glazed, 24; box calf, black 18; vamp leather, brown or glazed, 10; other upper leathers, 4; other leathers not specified in the tariff, 4 fr.

Ammonia and Benzene Column Stills

Description of Operating Methods of Ammonia and Benzene Column Stills—Action of Steam in Heating and Conveying Vapors—Causes of Trouble and Precautions—Process Control—Recommendations on Liquor Metering

By A. THAU*

FOR the distillation of ammonia and benzene in connection with the recovery of byproducts from coke ovens, continuous column stills are almost universally employed. The original "Savalle" column, which was the first continuous alcohol still, was adopted at first as a progressive departure from intermittent boiler-type stills. Gradually improvements were introduced to adapt the columns to the particular purposes for which they are applied in coke-oven work, and in recent years they have reached high efficiency, while at the same time their bulk in proportion to their capacity has been considerably decreased.

Designers of these stills were formerly rather reluctant in constructing single units for very large capacities. Experience had shown that if particular care was not taken when heating up the stills, the bottoms or flanges of the sections would crack. This danger increased with the diameter of the still. This accounts for the fact that in old ammonia and benzene plants a large number of small units were used, while on modern works few large ones are used and in most cases only one unit.

The control of a badly performing distilling column has always been considered a difficult task, but if the process taking place inside the still is perfectly understood, it is not difficult to allocate and remedy irregularities.

The Savalle column, the principle of which has been retained completely in subsequent design as shown in the figure, consists of a number of circular or rectangular sections, flanged together. While the liquid to be distilled is being introduced into the top section of the column, steam enters countercurrent at the lowest section near the bottom of the still. The steam is distributed through a number of round holes or rectangular slots *a*, the edges of which project about 2 in. above the bottom plates. These steam passages are covered a short distance above the projecting edges by hood-shaped baffles *b*, which project downward close to the bottom or tray *c*. They are provided with small teeth so as to distribute the steam evenly in a fine spray through the liquid which collects on tray *c* of each section.

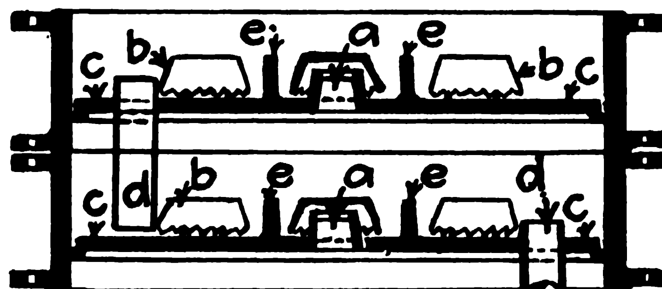
Tubular or rectangular overflows *d* are provided for each section. Their upper edge does not project quite as high as those of the steam passages *a*. They go down into the next lower section so that their end is sealed in the liquid collected on the bottom. Baffle strips *e* are arranged on each bottom *c* between the baffles *b* in order to compel the liquid to flow over each tray and all around the baffles *b*.

By these arrangements the steam is guided upward and the liquid downward through the column in separate passages. If liquid travels through the steam passages or steam through the overflows, the operation of the still is impaired, though perhaps it is not immediately noticeable. However, before dealing with such occurrences it will be necessary to follow closely the processes performed in each section.

*Superintendent of coke works and chemical plants of the Oxelösund's Iron Works, Oxelösund, Sweden.

Twofold Action of Steam

The steam expands and fills the section completely, thereby directly heating the lower layer of the liquid and indirectly the liquid in the section above. The transmission of the heat through a cast-iron plate of about ½ in. in thickness is much slower than by direct contact. Vapors of products with a lower boiling point are volatilized and mix with the steam. In the bottom section, where the liquid should contain only traces of products, this admixture is naturally relatively small, but it increases from section to section upward, while an amount of steam, proportional to the amount of vapors taken up, condenses. This action



is of minor importance compared with the effect resulting from the steam being forced in fine streams from under the baffle edges through the liquid with which it is thus brought into very intimate contact. The transmission of heat from the steam to the liquid is thereby greatly increased and the admixture of light vapors becomes much greater. It is clear that these actions are parallel in each section of the still, one supplementing the other. In the same degree as the steam traveling upward becomes enriched by vapors, the liquid running down becomes spent.

A different way of describing the direct action in a column still can be applied by assuming that the steam, in passing through the indirectly heated liquid, takes up vapors with a lower boiling point in exchange for water vapor which is condensed and dilutes the liquid. Whether this or the other explanation appeals the more is immaterial, as the actions are due to both. The column still can, of course, be used as a washer and some of the first gas washers ever built were constructed on the very same principle. The gas takes the place of the steam and the washing liquid is fed the same way as for distilling. The only differ-

ence from distilling rests with the fact that a chemical or mechanical absorbing effect is obtained without the aid of heat. Ammonia, benzene, cyanogen and naphthalene washers of this type are still used. Though they were formerly built of very large diameters with large gas passages and baffle openings, they are now rarely applied as washers owing to the great amount of back pressure they cause, which also impairs their efficiency.

In the construction of the column still two different tendencies are prominent. Many constructors disregard the indirect action of the steam and provide as many passages, baffles and overflows as can be crowded into the column. Others try to make full use of the indirect heating by the steam and arrange only one steam passage, baffle and overflow to each section so that large layers of liquid are collected in each, offering a large surface to the steam above and underneath. In the former types provision is made to enforce a rapid circulation of the liquid. In the latter designs the liquid is to remain in each as long as possible and flow slowly in proportion to its feed—in an ordinary zigzag way down the still sections. These latter stills, extensively used in England and less in number on the European Continent, form the minority in use. Thus far the action of a fractionating still is the same, whether used for the distillation of ammonia or benzene. It will now be necessary to treat both kinds separately.

Ammonia Stills

The ammoniacal liquor as it comes from the coke-oven plants contains free and fixed ammonia, the latter as dissolved salts. The stills consist, according to the work they have to perform, of three parts—viz., one to drive the free ammonia, one to liberate the ammonia by substitution of a stronger base in the salts and one to treat the liquor holding the liberated ammonia in solution. These three parts are usually united in two columns and at times in one. The fixed ammonia amounts to about one-third, but the part of the equipment in which it is distilled is generally of the same size owing to the bulk of water handled.

The upper part of the column into which the ammonia liquor is fed must be large enough to give the capacity needed to drive off all those compounds which are liberated by the application of heat, mainly ammonia, carbon dioxide and hydrogen sulphide. The liquid leaving this part of the still should contain only traces of free ammonia and no carbon dioxide. The sulphur compounds can be disregarded. Carbon dioxide, which is always present in crude ammonia liquor, is too often neglected and the detrimental part it plays in the operation has escaped proper attention. Though easily volatilized between 90 and 100 deg. C., it condenses, thus going into solution again with the ammonia liquor in the still. Pressure in the still has an impeding influence upon the liberation of CO_2 by heat. The presence of carbon dioxide in the liquor can be ascertained by adding a solution of calcium chloride to a sample which in the presence of CO_2 gives a calcium carbonate precipitate.

While the principles of a column still have been sufficiently described in general, there remains to be mentioned the so-called dephlegmating, a cooling action, which continually takes place on the inner walls of the sections above the liquid levels. As the steam introduced at the bottom is the only source of heat, it follows that the bottom is the hottest part of the still and by the loss of heat through radiation as well as by the introduction of the liquor at the top, the temperature gradually decreases. This dephlegmating action is important in stills built for direct action, inasmuch as a large portion of the steam is condensed. The vapors are more saturated with ammonia the higher the column is relative to the heat added by the steam. In those stills in which the indirect distilling actions are more pronounced than the direct ones, the vapors are altogether richer in ammonia. In order to retain the indirect heat as much as possible, it is often desirable to counteract dephlegmation, by which the efficiency in this case is impaired. Such stills are covered with a magnesia-asbestos cover.

Use of Milk of Lime

To liberate the fixed ammonia, the liquor leaving the top portion of the still enters a mixing chamber in which a strong base alkali, usually milk of lime, is introduced. The lime does not react with the free ammonia, but it replaces the ammonia in its salts and liberates it. If the liquor contains carbon dioxide, it enters into combination with the lime, forming carbonate of lime, which sets stone hard in the still and makes frequent cleaning of the still necessary. For this reason it is advisable to have the liquor free of CO_2. The most certain way to avoid the formation of a stone precipitate is to decarbonate the liquor before it enters the still. One way is to provide a preheater of any effective type, as a heat exchanger warms the incoming liquor by the outflowing waste liquor to a temperature over 90 deg. C. If from lack of efficiency this is not attained, a steam coil must be added. A pipe from the top of the heater is connected direct to the ammonia gas main of the still through which the liberated CO_2 is permitted to escape without entering the still. This pipe must be erected higher than the liquor feed pipe of the still and a feed valve for the liquor arranged on the heater inlet, otherwise ammonia liquor from the heater would be introduced into the ammonia steam pipe.

The milk of lime fed into the still should be kept at a constant strength, generally 10 to 15 deg. Bé. (15 to 23 deg. Twaddell, 1.07 to 1.1 specific gravity). It must be free from large pieces which are not easily suspended in water. It always pays to take care in the preparation of the milk of lime. The lime should be slaked and the solid parts which do not pass a fine grid removed. It is then stored in a receptacle where the water can drain off gradually to thicken. After that it is washed through a very fine sieve into the stirring tank, from which it is pumped to the still. An ammonia distilling column can with the above precautions be kept going for years without being dismantled. If the efficiency decreases, the hand hole lids of those portions of the still in which limed ammonia liquor is treated are removed and the internal parts cleaned by flushing with water at fairly high pressure by means of a hose and nozzle. A well-designed ammonia still, baffle hoods, overflow passages must be proportioned in size so that these removable parts can be taken out through the hand holes for cleaning, inspecting or replacing.

The lime-mixing chamber of the still must be provided with a drain cock of sufficient diameter to drain any lime sediments formed between shifts. A funnel-

shaped mixing chamber bottom with drain cock in the middle has been found most suitable for keeping the lime chamber permanently clean. To compensate for the lowering in temperature by the introduction of the milk of lime, a small steam pipe is brought into the lime-mixing chamber immediately above the bottom and the required amount of steam to supply the heat needed is allowed to enter. The steam pipe is arranged inside the lime chamber as a perforated coil to obtain sufficient agitation to prevent the lime from settling out. The end of the lime feed pipe is advantageously connected to the pipe through which the ammonia liquor enters the mixing chamber from the section above it, preventing the dip pipe from getting obstructed and at the same time insuring thorough mixing of liquor and lime.

The part of the still for treating the limed liquor overflowing from the lime chamber does not call for special remarks. It is advantageous to have this column standing alone at the side of the other, although more floor space is taken up. If it becomes necessary to dismantle a still, the lime still usually needs the cleaning and repairs and for this reason it is better to have it as a separate column.

The waste liquor outlet should be provided with a float valve so that the steam is automatically prevented from escaping through the waste-liquor pipe. The same result can be attained if the waste liquor is passed through a heat exchanger countercurrent to the incoming ammonia liquor. The waste liquor outlet of this apparatus must then be arranged at a height to keep the bottom section of the still sealed.

Operating Precautions

As the pressure inside a still is very low, only very delicate gages can be used. If the still is shut down without closing the cock of the gage, it will be ruined by the vacuum created in the still after the condensing of the steam. It is much better to provide the steam-inlet pipe of the still with two valves a short distance apart. A high-pressure steam gage is connected between the valves. The lower valve is set according to the steam requirements of the still and the upper one is opened to show a certain pressure on the gage which, of course, is much higher than the actual pressure inside the still. With the upper valve the man in charge has to compensate for variations in the steam pressure by keeping the pointer of the gage constantly at the mark. The bottom section of the column and the lime-mixing chambers are provided with water gages, and from their readings the operation of the still can be judged to a certain extent.

If a new or empty column still is started up, the steam must be applied slowly to warm up all parts gradually to prevent an uneven expansion of trays, mantle and flanges, which are apt to crack easily if suddenly affected by great changes of temperature. The steam condenses and the water fills the trays and seals the overflows. It should take at least four hours to warm up a cold still of average size. As soon as a thermometer immersed in the ammonia steam main shows about 100 deg. C., the liquor-feed cock is opened and the lime pump started. Liquor feed and steam supply are gradually increased as long as the waste liquor does carry recoverable ammonia. The ultimate analysis should not show above 0.005 per cent NH_3. The liquor in the water gage of the lime chamber should remain steady and at its proper level. The quantity of steam admitted to the lime chamber must be just enough to compensate for the cooling by the introduction of the milk of lime to keep the liquor boiling gently. Too little steam in the lime chamber makes itself conspicuous by a rattling noise with which the steam enters the liquid. A surplus of steam causes the contents to boil over. It is indicated on the water gage of the lime chamber and may cause the whole still to boil over all of a sudden.

Causes of Trouble

Bad operation of a still makes itself felt in three ways: 1. The ammonia vapor is too weak, containing too much water. 2. The still boils over. 3. The waste liquor is too rich in ammonia with normal liquor feed.

An excess of steam compared with the liquor feed must first of all be looked for, especially when the ammonia liquor is as weak as 0.6 per cent NH_3. If steam supply and feed are adjusted in proper proportion, there is a possibility of a tray having become leaky so that baffles and overflows of one section have become unsealed. No water is obtained from such a tray when opening the hand holes. It also happens that with a faulty still the baffle edges do not reach far enough down. In such a case the still should be increased in height by adding sections. An improvement can be made by placing a dephlegmator over the top section and pass the ammonia through the dephlegmator pipes round which cooling water circulates. The writer had a singular experience in this connection when called to a plant to restart an ammonia still which would not operate properly, although it had been cleaned thoroughly and had even been dismantled completely for thorough inspection. After the first failure the still was opened and it was found upon removing the hand hole lids from the top section that the condensed water vapors did not run straight down outside the column, but congregated along the edges of the flanges before they fell down. This indicated that the foundation of the column had given way on one side. Although the malalignment was so slight that it could not be noticed with the eye, it had caused the overflows on one side of the sections to become unsealed and the steam traveled upward without passing through the liquor.

If the ammonia vapor is too weak, the still is either overfed and must be restarted with less pressure (otherwise an overflow results) or else the waste liquor outlet is sure to be obstructed. The latter obstruction can be detected by the water gage of the bottom section being filled completely. If the water gage on the lime chamber shows an abnormally high level, it indicates that the overflow pipe from the lime chamber to the lime still is obstructed. If both water gages should remain normal, the dip pipe by which the liquor enters the lime chamber from the section above is obstructed. This can quickly be ascertained by draining the lime chamber a little, reducing the level in the gage. If, on opening the liquor-feed pipe to the still, the liquor stands at its old level, the dip pipe is open and the obstruction must be found higher up.

An obstruction in the upper sections of the column can almost always be traced to the first overflow of the top section and is due to tar having been mixed with the liquor. The light oils of the tar distill over with the ammonia and their residue collects as a

soft pitch under the overflow, gradually obstructing it. This can also be avoided by preheating the liquor to its boiling point. If the tar comes in great quantities, it will be carried further down and meet so high a temperature in the lower sections that it will flow right through the still, if it is not carried away in lime deposits.

If, in a properly adjusted still, the waste liquor contains too high a percentage of ammonia, this is due to the still becoming dirty. Lime sediment deposits around the baffles so that the steam is not divided into fine streams when passing through the liquor, but finds its way through large openings. The remedy is obvious.

When liquor heat exchangers are employed, a leak in the ammonia lime, which is under greater pressure than the waste liquor, allows ammonia to pass into the waste liquor. An easy way to discover this is to throw a small quantity of fluorescine, about 10 g. per ton of liquor, into the high level ammonia liquor tank and stir it up so that the liquor gets an even fluorescent green color. If the preheater leaks, the color will be found very quickly in the effluent waste liquor, as the coloring power of this aniline dye is so intense that it can be traced with the eye in minute quantities.

Benzene Stills

What has been said about the ammonia stills also applies to a certain extent to benzene stills, which in principle and in design of the single sections correspond exactly with the ammonia stills.

Benzene stills are built in single columns and consist of sections of equal design right through. Dephlegmating action in the still itself is not desired. As the oil enters the top of the still at a temperature at which the vapor pressure of the benzene is high, such columns must be well covered to reduce radiation as much as possible. There must be as many steam passages and baffles on each tray as can be arranged and dead spaces must be avoided.

To obtain the best heat economy, the incoming rich oil first passes through a tubular heat exchanger in which it absorbs the heat of the benzene vapors leaving the still. It then circulates through a second heat exchanger, absorbing the heat of the effluent oil. Then it passes through a preheater with steam coils or specially shaped heating elements offering large heating surfaces, from which it is charged into the still. By these means a low steam consumption in the still is obtained.

A benzene still rarely gets out of order or obstructed. The oil does not deposit solids while in the still. If the liquid boils over, it is due to overloading, a sudden increase of steam pressure or water in the oil. For proper operation of a benzene still, it is important that the effluent oil leaving the still should contain only traces of benzene. It should leave the still at a temperature not below 150 deg. C. to be sure that it is not contaminated with water, which decreases its absorbing properties and increases the steam consumption in the still.

Most of the benzene column stills work only with direct steam, which should be superheated to prevent too rapid condensation, allowing the condensed water to mix with the oil. Some builders provide a few of the sections with steam coils, thus reducing the amount of direct steam and decreasing the chances of getting watered spent oil.

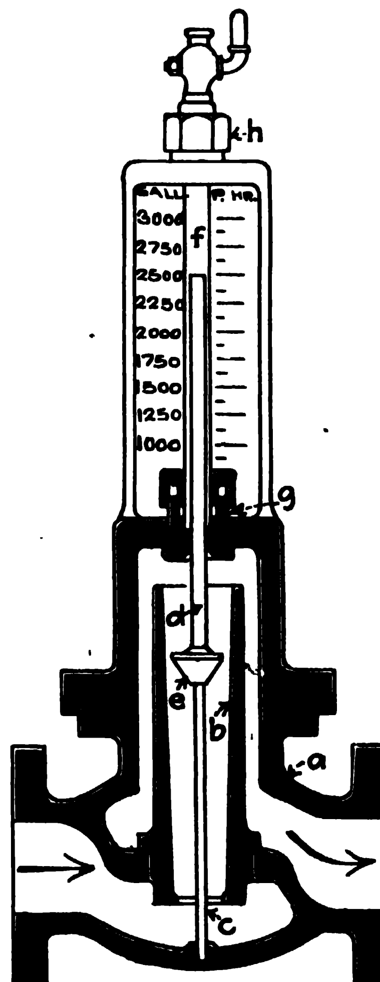
The benzene still designed by Dr. Gasser has tubular sections which are horizontally placed one above the other in a scaffold of joists and are connected by pipes. The oil has to make a round trip horizontally through each section, and flows over a steam coil all the way downward through all the sections. Just enough direct steam is let into the bottom section to accelerate the distilling action. With such a still it is very easy to keep the oil free from condensed water. The steam consumption is considerably lower than with the ordinary column still. The sections, being arranged in single units above one another, are easily accessible. Also it is possible without difficulty to redistill the crude benzene continuously and recover the heavier products, toluene, xylene, solvent naphtha, etc., as separate fractions at the same time.

Control of Column Stills

Control of the column stills is had by adjusting the steam consumption, the amount of liquor or oil passing through, the steam pressure, temperature and composition of the effluents.

The waste of steam with continuous ammonia stills can be considerable before being observed. In large plants or where steam is generated directly by fuel, a steam meter should be connected into the steam lines leading to the stills. There are a number of reliable steam meters on the market which are too well known to call for a description in this connection.

Ammonia liquors should be passed through a meter of the piston type, as wheel and propeller meters are not as reliable, are too sensitive to changes of temperature and too easily get out of order or become obstructed by tar and naphthalene deposits. The flow meter shown in section in the figure is a simple, cheap and reliable device which is not generally known and is equally adaptable to ammonia liquor, oil or benzene. It consists of a valve-shaped body *a* with a tubular seat *b* which is slightly tapered inside. In the center of the tube *b* a spindle *c* is rigidly fastened and screwed into the bottom of the valve body. Over it a tube *d* slides vertically, to which is fastened on its lower end a valve cone *e*. The tube *d* projects on top into a gage glass *f* fastened by a lower gland *g* and an upper one *h*, the latter being provided with a vent cock on top. Behind the gage glass an enameled scale is arranged, graduated in liters or



gallons per hour. The feed cock is arranged on the outlet end of the meter. The liquor, oil or benzene passing through the meter lifts the cone *e* in proportion to the amount of liquid passing through, and the top of the tube *d* indicates on the scale how much feed is applied.

The advantage of the instrument rests with the fact that the movement of the indicating tube *d* is not impaired by a gland or similar guide, but moves freely in the glass tube, which is under the same pressure as the inside of the meter. The instrument is also built in another type in which the scale is arranged underneath the valve body and the indicating spindle protrudes thereby through the bottom downward. The meter must be arranged with a bypass so that the still need not be stopped should the gage glass break. As brass is quickly destroyed by the corroding effects of ammonia upon copper, these meters are made entirely of iron for use on byproduct plants.

Steam pressures are read on ordinary steam gages with large dials; recording gages are rarely used on stills. Temperatures are of the greatest importance. To make sure that the temperatures are actually read and observed by the men in charge, the use of mercury steel tube thermometers which have dials exactly like steam gages are recommended. Excepting the rigid types, they offer the further advantage that they can also be supplied with flexible connection between indicator and mercury stem. The mercury stem is immersed in any remote corner or up on top of a still or main, while the indicator, which is connected to the stem by means of a flexible capillary wire, can be fixed in a convenient spot where it can be continually seen. This makes it possible to arrange all the thermometers belonging to a benzene or oil still in one row so that the operation of the still and the attached apparatus can be observed at a glance. Where it requires special attention to keep the spent oil at the required temperature the outlet thermometer of the still should be arranged for indicating and recording at the same time.

Production of Oil From English Shales

An interesting report upon the shale deposits underlying the county of Norfolk, England, has recently been issued, reports Consul General Skinner, of London. The shale is said to be found at shallow depths and can be delivered at the principal works at a cost of 5s. ($1.21) per ton. The yield of a good quality of crude oil by means of treatment in specially designed retorts is reported to be satisfactory, and the nearness of the deposits to the surface makes possible the removal of the overlay and the excavation of the shale by means of mechanical diggers.

Two commercial seams of shale have already been opened up and are at the present time available for production, though a number of other shale seams have been disclosed beneath these in boring operations to test the full depths of the shale deposits.

The upper seam is a hard, well-laminated body of shale 8 ft. thick, having two small bands of "blacs," or less hard and laminated shale, intercalated with its other members, respectively, 6 in. and 5 in. thick. The whole seam, including these bands, can be classed as rich commercial oil shale. Variations in physical properties and chemical composition naturally occur in a seam of this thickness, and these differences have been carefully noted and analyzed.

The lower seam is 8 ft. thick. Its roof is 37 ft. from the surface and its base rests on a band of pyrites at 45 ft. which forms a good hard floor. This is a good mineable seam, being composed of a black shale 4 ft. thick, and a lower 4-ft. seam of hard, dark-green shale.

Oil Content

The oil content is present in a dual form namely, in a state of free oil absorbed from some source of liquid oil beneath or in juxtaposition to the beds affected, and, secondly, in the form of a heterogeneous material of unknown origin, indigenous to and probably deposited along with the other elements of the shale at the time of its inception.

The yield per dry ton of shale treated is stated to average 33 gal. of oil content, from which may be recovered 7 gal. of gasoline, 9½ gal. of kerosene, 9 gal. of lubricating oil, with a bituminous residue of 50 lb., equivalent to 5 gal.

Method of Treatment

The report referred to also contains the following particulars in connection with the retorting methods employed for the extraction of the oil:

Shale must be distilled at a comparatively low temperature in order to obtain and preserve both the liquid oil and solid products, the resulting incondensible gases being used for heating the retort. In the case of a rich shale, the lower the working temperature the greater is the quantity of light spirit and the less gas.

In the early days of the Scottish shale-oil industry the original retorts were of the horizontal type, like those employed in gas making, but these were rapidly discarded and the vertical type universally adopted. In these vertical retorts the shale is fed into the retort from the top and exposed to a gradual increase of temperature, by which means the light, medium and heavy oils are released in rotation. Access of air must be avoided in order to prevent burning the oil, with consequent production of gases. In practice, it is found that steam protects and helps to carry away rapidly the oil as it is formed, and at the same time it increases the yields of all grades of oil as well as of ammonium salts. In the development of the Norfolk shales toward commercial production it has been essential to devise special methods of retorting. The suitability of these methods is dependent upon factors inherent in the shale itself, and, consequently, foreign to the specific needs common to the shales of other and older fields.

It was the appreciation of these necessary departures from ordinarily accepted retorting practices that ultimately led to the design, construction and operation of a special retort which not only gives a yield of oil above that obtained in the ordinary laboratory retorts, but, on fractionation, the crude oil from this retort separates into spirit, kerosene and lubricating oil equal in quality and percentage quantities to those obtained from the crude oil of the laboratory tests. Further, the scrubbing of the gas (which was not attempted with the laboratory retorts) has yielded a further substantial percentage of light spirit.

With regard to the question of the yield of ammonia from the shales, various tests have been made of core samples of the upper seam, and the average yield of sulphate of ammonia over the whole thickness of the seam was 22.6 lb. per dry ton of shale. The nitrogen content, running as high as 0.75 to 0.95 per cent, has formed other organic substances, such as pyridine.

The German Vegetable-Fiber Industry

THE attention of textile men in Europe and elsewhere is being attracted to the remarkable results being attained in Germany in the manufacture of yarn from grasses, plants, leaves, etc., reports H. W. Adams, representative of the Department of Commerce in Germany. This new German industry is centered in the plant of the Deutsche Faserstoff-Gesellschaft (German Fiber Material Co.) located in Fuerstenberg, in Mecklenburg, Germany.

This plant was established in 1912. During the first year in which it was in operation it confined its activities to the manufacture and sale of the fibers. In 1913 spinning machinery was set up, and since then the spinning of yarn from these fibers has been carried on on an ever-increasing scale. During the eight years of its existence the products of this concern have covered a wide range of vegetable fibers, including China grass, Australian seaweed, jute, old jute rags and shoddy worsted yarn. Besides the above-mentioned fibers a number of others were worked up during the war by the same firm and extensively used in the various lines of the German textile industry. Some of these fibers were abandoned after the war, owing to the fact that the supply thereof to be found in Germany was not sufficient to warrant their permanent use. Among these fibers are to be mentioned nettle, hops, willow bark, pine needles, cornstalks, ginster and asparagus. It has been found that the fiber taken out of pine needles and cornstalks can be readily used in the paper mills, it being possible to produce a very strong and tough paper therefrom.

Prior to the outbreak of the war the Deutsche Faserstoff-Gesellschaft was able to secure sufficient supplies of China grass, Australian seaweed and jute, and it focused its efforts on these fibers. During the war the importations of this raw material were cut off and have not as yet been resumed. Since the close of the war this concern has confined itself mainly to the manufacture of yarn from old jute rags.

Wide Field in Use of Solidonia in Woolen Industry

The vegetable fiber derived from China grass is known as solidonia. It is similar to ramie, which is known and used in the United States. The Deutsche Faserstoff-Gesellschaft by means of a special process produces a long, fine, soft and curly fiber. The curliness of the solidonia fiber presents a special feature. This fiber looks very much like wool and mixes readily with that product, thus opening a wide field for its use in the woolen industry.

This solidonia fiber was introduced into the United States shortly before the outbreak of the war and was taken up by various textile industries, especially by concerns manufacturing woolen goods and underwear. German textile experts assert that solidonia is of special importance for use in the manufacture of underwear, as it serves to prevent the garments from shrinking.

In Germany solidonia gained a wide field of use on account of the shortage of wool during the war. As a substitute for linen, solidonia has been used in Germany for the manufacture of table linen of beauty and strength. It has also been used for machine belting. German hosiery and underwear mills have produced from it socks and stockings which are difficult to tear, unshrinkable underwear and sporting jackets of fine quality and strength.

The German woolen mills have manufactured an army cloth which, composed of 75 per cent wool and 25 per cent solidonia, it is asserted, surpasses in tensile strength any pure-wool cloth. Similar results are claimed with respect to paper-makers' felts, which, with a percentage of solidonia mixture, show a considerable increase in strength. Furthermore, women's and men's clothing composed of half solidonia and half wool or shoddy, especially in piece-dyed goods, have found a welcome on the market. In textile circles in Germany it is declared that there is an unlimited field for the use of this fiber. Prior to the war the price of solidonia in Germany was two-thirds the cost of good staple wool. No actual comparison can be given at the present time, as none of this raw material is coming into Germany. In 1914 solidonia in the carded stage found a ready market at 30c. a lb., delivered in New York or Boston.

Splendid Results Obtained in Use of Posidonia Fiber

Another fiber from which the Deutsche Faserstoff-Gesellschaft has obtained splendid results is the fiber known as posidonia. This is also a vegetable fiber. It is derived from seaweed which is dredged in Australia and cleansed and washed in sweet water. Brought to Germany, the fiber is subjected by this concern to a chemical treatment for the purpose of softening it and making it resilient, the original fiber being stiff, harsh and brittle. The staple of this fiber is declared to be equal to a medium staple wool, and it is spun on the worsted and woolen system. This fiber is characterized by an elasticity and springiness, and the cloth which is made out of pure posidonia appears to show scarcely any creases. German cloth mills have mixed posidonia with wool or shoddy, and cloth of good strength and appearance has been obtained. German textile men believe that this fiber, by reason of its springiness, will have a wide field of use in the carpet industry. This fiber sold at half the price of shoddy before the war. Since the war none of this raw material has been imported into Germany.

Unusual Results Obtained With Jute

The principal way in which jute has been employed in the United States is in the form of cheap lining and burlap. The Deutsche Faserstoff-Gesellschaft has accomplished some unusual results with jute. By a special process of chemical treatment a long, fine and beautiful fiber is being produced therefrom, a fiber which can readily be spun on the worsted system, pure or mixed with wool.

This same concern has secured fine results from old jute rags, which are being cleansed and made into shoddy, which also can be spun on the worsted or woolen system.

The inventor of all the processes has been the managing director of this company's plant since its establishment in 1912.

This plant began work with a total of fifteen employees. Its personnel now numbers over 250. The buildings have been enlarged and new ones erected, and plans are on foot to make still greater additions. The output of this plant is 10,000 lb. of treated fiber per day of eight hours. The worsted mill is now continually working, being operated in three eight-hour shifts.

Defects Arising in Steel During Fabrication

Microscopic Appearances Caused by Surface Defects, Cold Working, Overheating, and Burning—Nuclei of Fatigue Fractures Are Associated With Phosphorus Bands—Photographs of Changes in Structure During Annealing of Steel Castings Are Also Given

By AUSTIN B. WILSON

GENERALLY speaking, by "defects in steel" it is understood that those defects which can be avoided by the employment of the proper practice are meant. The effects of almost all defects can be more or less mitigated in some way and in many cases entirely eliminated. There are, however, some defects which cannot truly be regarded as such, since, although their presence is not desirable, they do not under favorable conditions exert a marked influence upon the behavior of the metal. "Defect" in reality should be used to designate only those substances or conditions in the metal which make for failure in service.

It is possible to divide the defects which cause early failure into two great classes—defects due to errors in chemical composition and defects due to the treatment of the steel during the process of manufacture. Of these two great classes the latter is undoubtedly the one of greater importance inasmuch as it is the one more frequently met with.

The errors of the first class are due as a rule either to errors in the original charge or from reactions which occur during melting and refining.

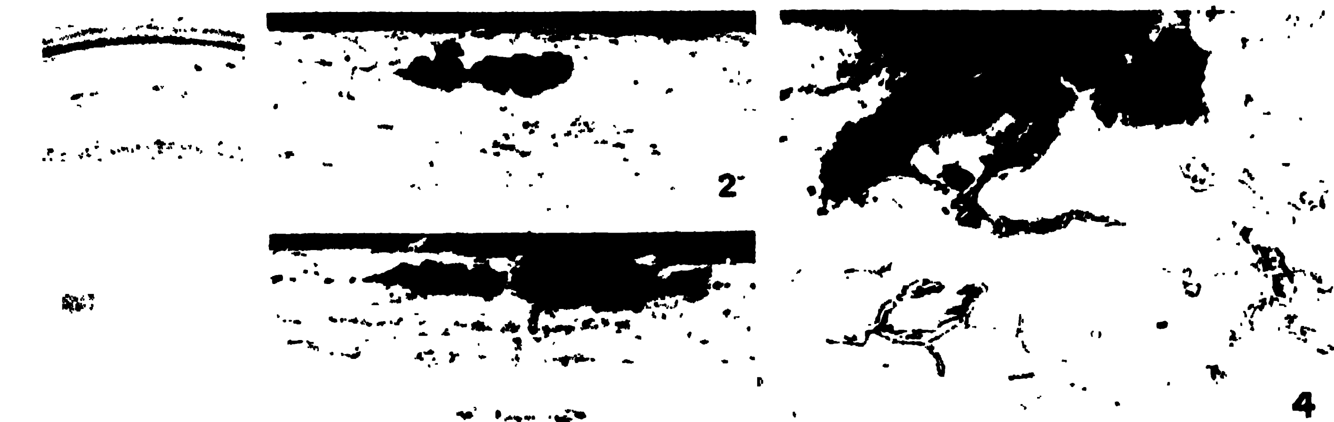
Unsuitable mechanical properties are the direct result of larger errors in chemical composition, but this phase may here be entirely disregarded, as this is not in reality a defect in the material, but rather an error in the choice of metal to be used for the particular purpose. Such a case would be the selection of medium carbon forging steel for use as a watch spring.

Localized Corrosion

Larger chemical errors may also produce an undesirable tendency toward corrosion. As it is highly improbable that a cheap and practical method of producing an incorrodible iron or steel will ever be found this phase may also be quickly passed over. On the question of corrosion there are two schools about equally divided. One claims that corrosion is purely electrolytic and takes place only by means of small galvanic cells formed by impurities. The other asserts corrosion is due to direct oxidation of the iron by the oxygen of the water. The former attempts to prevent corrosion by use of very pure iron. The latter, while admitting that pure iron commences to rust less quickly than does steel, claims that once the corrosion has started it takes place with equal rapidity.

Whatever the mechanism and theory of the process of corrosion may be, it is certain that some impurities heighten the tendency in this direction. Figs. 1 to 4 illustrate this very well in the case of tinplate which contained pinholes in the tin coating. Fig. 1 is the top of a can upon which a number of pinholes can plainly be seen. After photographing, this can-top was cut up and microsections were taken through and near to some of the pinholes shown. Fig. 2 shows a particle of silicate slag near the surface of the steel base which has not started to corrode, although it can readily be seen that the tin coating is perforated. Fig. 3 is another spot very close to the former where corrosion of the steel has just set in. Fig. 4 is from another specimen showing corrosion in the last stages.

The reader may well ask for further explanation of the above phenomena before proceeding. To begin with, the pinholes in the tin coating are due to the evolution of gas caused by raising the temperature of the steel in the tinning process. This gas, it has been con-



FIGS. 1 TO 4. PINHOLES IN TINNED PLATE DUE TO SLAG INCLUSIONS

Fig. 1. Top of can, showing pinholes. Fig. 2. Slag near surface, no corrosion. × 325. Fig. 3. Slag near surface, corrosion starting. × 325. Fig. 4. Corrosion in last stages. × 325 Figs. 2, 3 and 4 are etched with HNO_3.

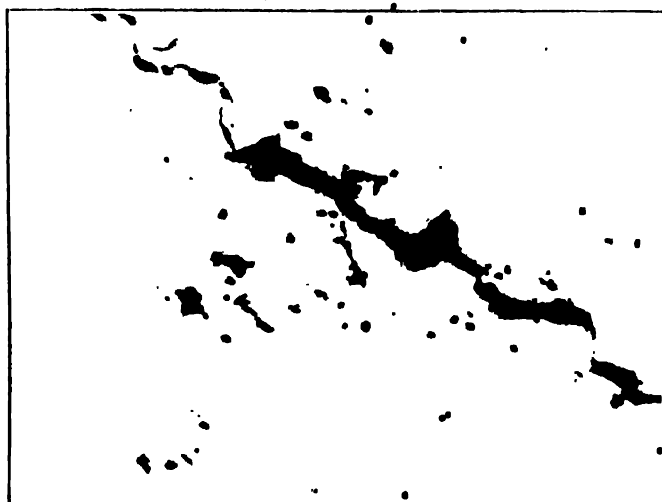


FIG. UNOXIDIZED CRACK IN HEAD OF RAIL. UNETCHED. × 200.

clusively proved, was absorbed during the pickling just prior to the tinning, and the presence of slag is known to favor this absorption. The iron of the base being electro-positive to the tin, as soon as opportunity offers a galvanic action is set up at and through the perforations in the tinplate, the iron going into solution in preference to the tin and the steel rapidly corroding away. This corrosion can be diminished by the making of cleaner steel—i.e., steel freer from slag and oxide inclusions.

Errors in composition of less magnitude are a greater menace in steel than those just described. In case there results metal of unsuitable mechanical properties the error is soon discovered, but in cases of smaller chemical errors it frequently occurs that the defect is not found until it has caused irreparable damage. These smaller errors may lead to the formation of brittle impurities which are suspended or mechanically entrapped in the steel or to the formation of brittle intercrystalline envelopes which destroy the cohesion of the metal. Not all impurities, however, are mechanically held. Some, such as phosphorus, enter into solid solution with the free ferrite which is present and thus affect its ductility to a great extent.

In connection with the smaller errors mentioned above it might be well to refer in particular to the alloy or "special" steels. In heat treating this class of steel a slight error in composition may give rise to vastly different mechanical properties than was expected from the particular thermal treatment employed.

Practically the only possibilities of defects in chemical composition which are of sufficient importance to be given consideration are those which arise from the incomplete removal of phosphorus, sulphur and other undesirable elements. It is too well known to require more than a passing reference here that abnormal amounts of phosphorus and sulphur are the cause of "cold-shortness" and "red-shortness" respectively.

Defects Due to Improper Heating

In considering the defects which are caused during fabrication it is well to begin with those which may originate during the casting of the metal or even prior thereto. Cracks, segregation and non-metallic inclusions originating in poor practice in teeming, or to events happening during solidification of the metal, have already been briefly noted by the author in an article appearing in Chemical & Metallurgical Engineering, vol. 23, page 1,161, Dec. 15, 1920.

Defects originating in the hot-working will now be considered. Under this heading fall all operations such as forging, rolling, pressing, hot stamping, etc.—in fact, all operations in which the steel is worked at temperatures exceeding or very close to its critical point. These defects are entirely under the control of the steelmaker and can usually be traced to either carelessness or ignorance.

It sometimes occurs that through some inadvertence, possibly the breaking of a pyrometer thermocouple, possibly non-uniformity in the heating of the furnace, one piece or perhaps a certain portion of a piece is heated to a temperature much higher than the rest. This causes the metal at that spot to become weak and brittle and, should the piece be subjected to mechanical working, might cause the formation of internal cracks or fissures which would be revealed only upon failure. In Fig. 5 is shown an internal crack found in the head of a rail. This crack, unlike a crack exposed to the oxidizing influence of the air, was found to be free from oxide and probably originated as just explained.

Cold-Working

Finishing at too low a temperature or "cold-working" induces "strain-hardening," which, although sometimes permissible, often leads to very serious results. Where this strain-hardening is used merely to stiffen small articles not to endure any great stress it serves its purpose well. It frequently happens, however, that cold-worked materials, for instance bolts or rivets strain-hardened in forcing into place, are called upon to sustain important loads and at the same time are subjected to alternating stresses. Experience has proved that strain-hardened metal is particularly unreliable in such cases. It is wise to avoid the use of cold-worked metal where important loads must be borne.

Frequently cold-working occurs through ignorance or carelessness in engineering construction, for instance cases such as forcibly "setting" pieces which do not fit properly or correcting small irregularities in shape by hammering. In tank building bolts and rivets are often hammered until quite cold, although it is an established fact that a rivet with a distorted structure corrodes much more rapidly under certain conditions than does a well-annealed rivet.

In a few cases, notably that of cold-drawn wire, strain-hardened metal is quite reliable as far as strength is concerned, but even the increase of elastic limit so caused does not accomplish much in preventing failure from fatigue. Fig. 6 shows the badly distorted microstructure of a severely cold-drawn wire which gave poor service as an automobile wheel spoke. Fig. 7 shows a finer, more uniform and much less distorted structure in a wire of exactly the same composition. This structure was obtained by "patenting," a form of heat treatment which gives to wires a fine, sorbitic structure. This wire gave good service, and although of slightly lower elastic limit far surpasses the former in resistance to fatigue.

Too severe cold-working also causes defects other than those mentioned above. These are defects which are discovered during fabrication and which merely result in scrapping. The author has in his possession a wire which has been overdrawn so severely that numerous checks have occurred throughout its length.

Cold-working of steel results in leaving the struc-





Fig. 6. Badly distorted structure of cold-drawn wire spoke. Etched with picric acid. × 100.

Fig. 7. Sorbitic structure of "patented" wire spoke. Etched with picric acid. × 100.

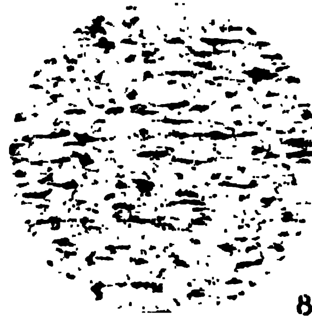




Fig. 8. Distorted structure of lo carb cold-drawn Etched with nitric acid. × 50.

Fig. 9. Distorted structure at bearing surface of rail, als oxide streak (gray) in seam. Etched with picric acid. × 50.

ture of the metal in a distorted and strained condition. It is generally accepted, however, that cold-working does not permanently damage the metal as long as the tensile strength continues to increase. Fig. 6 as well as Fig. 8, a low-carbon wire, illustrates typical cold-drawn and therefore severely distorted wire. Although it is less frequently a cause of defects than its opposite, too drastic working is likewise dangerous in cases where the additional hardness and strength imparted by the cold-working is relied upon.

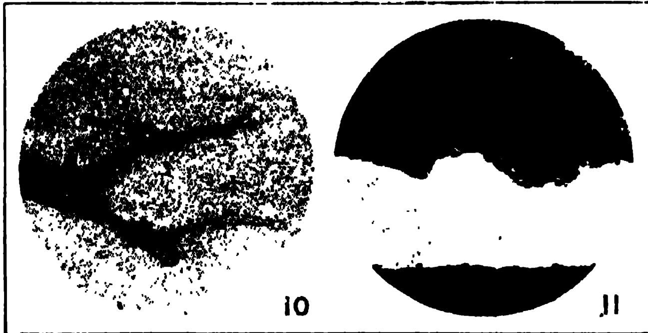




Fig. 10. Lap in nickel steel forging. Etched with picric acid. × 50.

Fig. 11. Scale rolled into surface of sheet. Unetched. × 100.

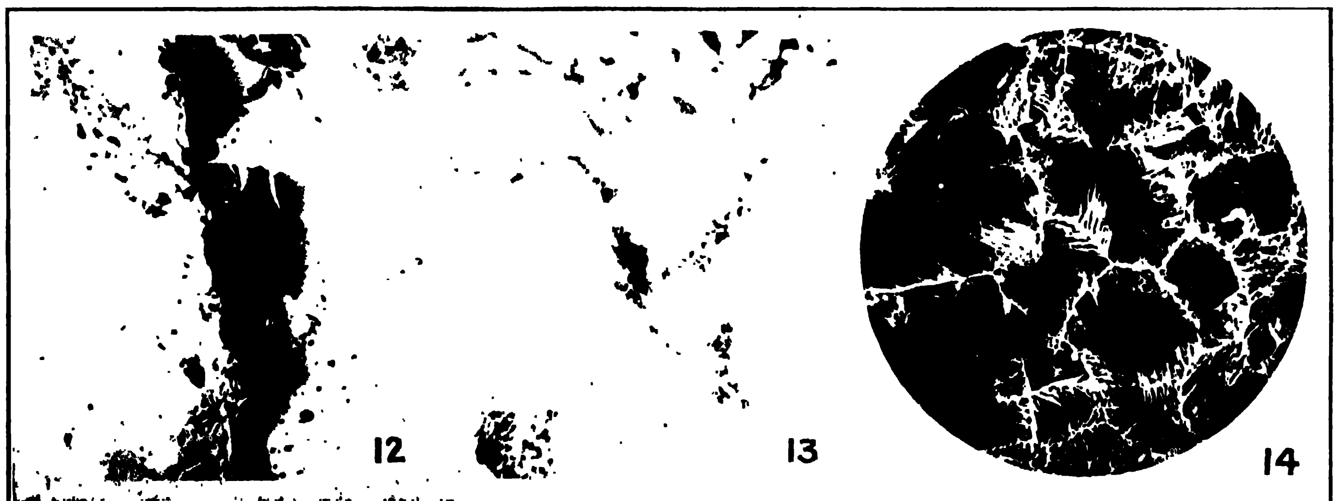
An example of a very superficial cold-working is shown in Fig. 9, a photomicrograph taken just under the bearing surface of a rail—i.e., at a point which has been subjected to the severe cold-working of heavy trains at a high speed. If worked unequally different portions may recrystallize at different rates on annealing, thus causing cracks. This, however, is not so likely to occur in steel as in certain non-ferrous alloys.

An excessively rapid deformation of the metal even when at a sufficiently high temperature may likewise result in cracks or checks. No examples of these are necessary, as they are illustrated by photomicrographs illustrating other defects, their appearance depending upon their exposure or non-exposure to oxidizing influences.

Defects During Hot-Working

For forging an ingot should be at least twice as great in cross-section as the finished shape. It sometimes happens, however, that through a desire to effect economy in the forging operation a smaller ingot is used. This results in a very superficial working of the metal. After forging the structure will be very non-uniform, the metal near the surface being fine grained, that near the center being coarse and brittle.

In addition to the foregoing there are several more or less minor defects which are formed during hot-working. Among these are the laps, seams, etc., due to the partial welding of portions of the metal which have become overlapped during the rolling or forging. Fig. 10 is an instance of this. Another defect in this class is the rough, uneven finish caused by scale, etc., on the surface being rolled into the metal (Fig. 11). The former defect should be weeded out by careful inspec-





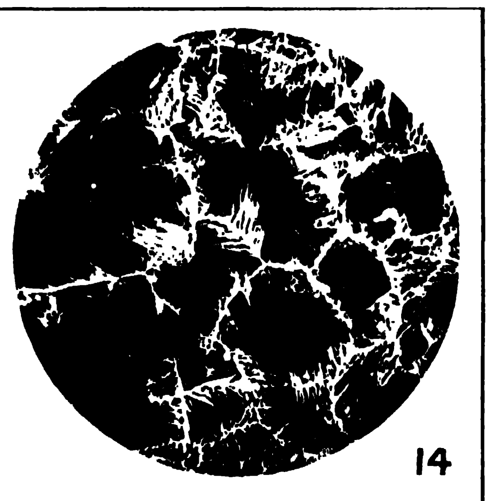


Fig. 12. Oxide around grains in burned steel. Unetched. × 100.

Fig. 13. Oxide around grains in burned steel, also dark pearlite grains. Etched with picric acid. × 100.

Fig. 14. Overheated steel. Etched with picric acid. × 50.

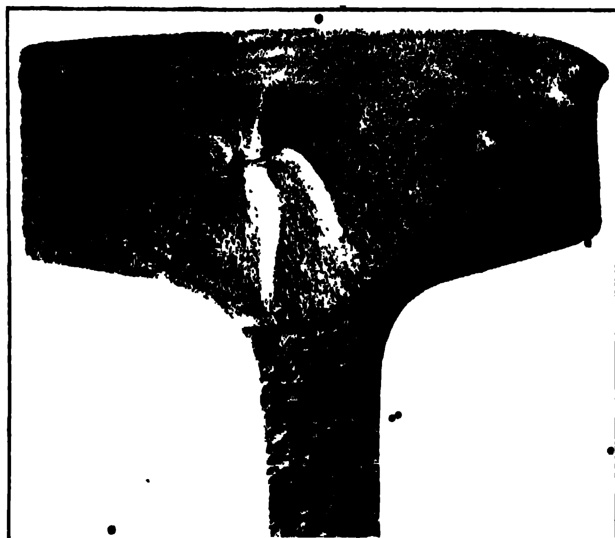


FIG. 15. CROSS-SECTION OF RAIL SHOWING TRANSVERSE FISSURE IN HEAD WHICH CAUSED FAILURE

tion before the material is allowed to leave the plant. The latter may be prevented only by carefully blowing the scale from the surface of the metal before it enters the rolls.

Although often confounded and spoken of as one and the same, there is a great difference not only in the structure but also in the properties of "burnt" and "overheated" steel. Steel that has been "burnt" has been heated above the point of incipient fusion and cannot be restored short of remelting. It is both "cold-short" and "red-short." Its cohesion has been destroyed, the grains being surrounded by oxidized films, as in Figs. 12 and 13, which effectually prevent welding. "Overheated" steel has a coarse fracture and structure (Fig. 14) and, like "burnt" steel, is extremely brittle. Unlike "burnt" steel it can, however, easily be restored by suitable heat treatment. "Overheated" steel results from long annealing at a temperature below that of incipient fusion.

Reheating for a prolonged time even at a moderate temperature has a detrimental effect upon steel to be used for certain purposes. Treatment of this kind, say a long tempering just below the critical point of a steel containing pearlite, causes the pearlite to break up and the Fe_3C to form small globules in a ferrite matrix and eventually to coalesce into much larger particles. Thus we have large cementite islands surrounded by ferrite. This structure is the softest, weakest and most ductile which can be assumed by any steel containing pearlite, and is well known as granular pearlite or spheroidised cementite. The tendency toward this structure is heightened by the presence of any free cementite.

The results of heating in an injurious atmosphere are too well known to need more than passing mention.

Hardening Troubles

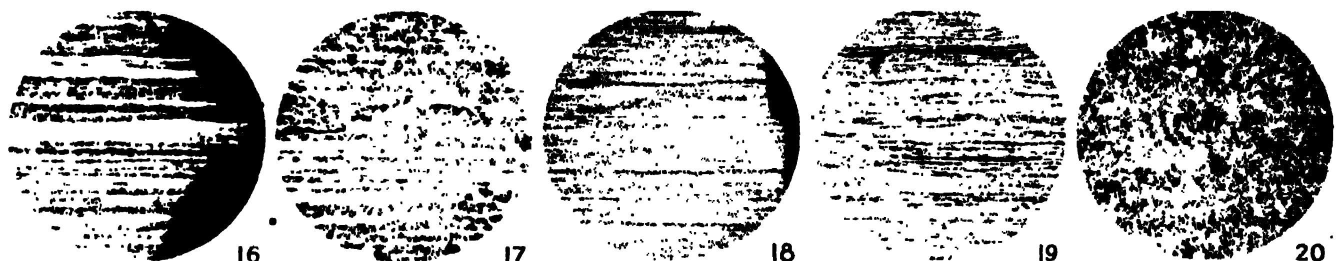
In quenching defects may be caused by any of several conditions. If carried out from too high a temperature a coarse martensitic structure is formed which is exceedingly brittle. If from too low a temperature nothing is accomplished. The quenching effect must be nearly equal throughout the entire piece or severe internal stresses may be set up, often sufficiently great to cause immediate cracking. The quenching medium plays an important part, some quenching mediums giving much more drastic effects than others.

Defects arising from improper tempering may likewise be summed up in a few words. Tempering at too high a temperature undoes all the work of the quenching. Tempering at too low a temperature leaves the steel more brittle than is desired and does not remove enough of the effects of quenching. Tempering unevenly throughout results in severe internal strains, as in quenching non-uniformly.

Fatigue Failures

Before closing, the author would like to call attention to a class of failure which is due usually to some inherent defect in the steel. These are the "fatigue" failures. This class of failure is met with in rails and is known as a failure from a "transverse fissure." Fig. 15 is a photograph of the top portion of a 100-lb. open-hearth rail which failed from this cause. The fissure can plainly be seen in the head of the rail. It shows the detailed fracture typical of "fatigue" fractures. Near the center of the smooth area can be seen the nucleus at which the fracture started. Once started it gradually progressed under the alternating stresses produced by passing trains until the surface was reached and the head completely broken.

It is, however, not with the progression of the fracture, but rather with its origin, that the writer would deal. A recent paper before the American Institute of Mining and Metallurgical Engineers presented convincing data that the origin of the transverse fissure—the nucleus—invariably occurred in brittle high-phosphorus areas in the rail. It also showed that rails in which the phosphorus was uniformly distributed rarely failed in this manner. A few photomicrographs illustrating the above are included herewith. They are all etched with Stead's cupric chloride reagent, which



FIGS. 16 TO 20.
Fig. 16. Streaked structure at nucleus of transverse fissure. Etched with Stead's cupric chloride reagent. × 10.
Fig. 17. Crack in rail head following high-phosphorus (light) streaks. Etched with cupric chloride. × 10.
Fig. 18. Streaked structure in nickel steel wrist-pin shown in Fig. 14 (page 1,211). Etched with cupric chloride. 10.
Fig. 19. Streaked structure in cross-section of tin-plate. Etched with cupric chloride. × 200.
Fig. 20. Uniform, unstreaked structure in rail rolled from a reheated bloom. Etched with cupric chloride. × 10.



FIGS. 21 TO 24. STRUCTURES REPRESENTING STAGES IN THE ANNEALING OF CAST STEEL

Fig. 21. Typical Widmanstättian or cast structure showing bad annealing.* Etched with picric acid × 75.

Fig. 22. Poor annealing. Etched with picric acid. × 75.

Fig. 23. Fair annealing, only trace of cast structure remaining. Etched with picric acid. ×

Fig. 24. Good annealing. Etched with picric acid.

darkens the purer metal and leaves white the portions higher in dissolved impurities such as phosphorus.

Fig. 16 is a longitudinal section through the nucleus of a transverse fissure. The pointed projection is formed by a portion of the nucleus. This specimen has a distinct banded structure, showing a poor distribution of phosphorus, and it will be noted that the broadest white band—i.e., the most pronounced phosphorus segregation—occurs exactly at the nucleus. Fig. 17 was taken near the nucleus of another fissure. It shows the same banded structure and a longitudinal crack following closely the white high-phosphorus bands. Fig. 18 typifies the same structure found at the nucleus of a fatigue fracture which occurred in an airplane wrist-pin. Fig. 19 shows this same type of structure as found in poor tinplate.

As stated above, proper heat treatment will remove almost all danger from this source. The steel should be heated to a temperature well above Ac_3 and held there for a long time to allow the proper diffusion of phosphorus to take place, after which the now coarse grain of the steel must be refined. In rail making it is merely necessary to reheat the bloom before rolling. The grain will be refined during subsequent rolling operations. Fig. 20 illustrates the structure of a rail so treated. Note the uniform phosphorus distribution and the absence of streaked structure.

At this point it would be well to mention a popular fallacy of which one frequently hears; namely, failure through "crystallization" caused by alternating stresses. This is not possible. A fatigue failure is the direct result of the gradual breaking down of the crystal grains.

Annealed Steel Castings

In a recent test of steel castings in which the author participated about forty heats of metal were made. Representative test pieces were taken throughout and specimens were subsequently cut from these for microscopic examination. After etching with picric acid they were classified as to annealing. Figs. 21 to 24 represent respectively bad, poor, fair and good annealing. Fig. 21 shows the well-known cast or Widmanstättian structure typical of all steel before heat-treatment. This structure is weak and brittle, especially under shock, and its elimination is the primary object in the annealing of steel castings. Under static or tensile tests these four classes of structure differ silghtly in physical properties, but under shock great differences are readily made manifest. Analyses of these heats were approximately: carbon, 0.25; manganese, 0.69; sulphur, 0.026; phosphorus, 0.019; silicon, 0.045. The results of the tensile tests averaged: yield point, 76,550; elongation, 29 per cent; reduction of area, 46.2 per cent. Under a Frémont drop test with a piece of given cross-section the bad, poor, fair and good annealing gave, respectively, resistance to impact of 2, 12, 15, 16.5 kilogram-meters, which agrees perfectly with what the microstructures would indicate. Fig. 21 shows a very pronounced Widmanstättian structure. Fig. 22 shows this less pronounced. Fig. 23 shows traces of the cast structure. In Fig. 24 it is altogether absent. The need for careful and thorough annealing is here clearly shown, especially in case the material is subject to shock or vibration. The test-bars used in the above were all attached to freight car castings and the differences in structure were readily traceable to variations in the annealing practice.

In concluding the author would say that he has hardly scratched the surface of his subject, but that the explanations and descriptions given are only those which are generally accepted by metallurgists. This paper and the preceding[1] may, therefore, be of value to those who, although more or less interested in the subject, have not either the time or facilities for its study.

Niagara Falls, N. Y.

Newcastle Steel Works Expands

An expenditure of about £3,500,000 has been decided upon by the directors of the Broken Hill Proprietary Co. (Ltd.) of Australia for extensive additions to the present plant at the Newcastle Steel Works, where already 5,000 men are employed. The demands of the commonwealth for adequate supplies of iron and steel for newly established industries as well as increased orders from abroad brought about this decision. Two representatives of this company have been sent to the United States for the purpose of gleaning information relative to the cost of the required additional machinery, according to advices from Consul General Sammons, of Melbourne. All additions are planned to be completed in two years. Another blast furnace, making four in all, is to be erected, together with the added number of coke ovens required. A byproduct plant will be used in connection with the coke ovens. Other additions include a duplex steel plant, a continuous mill for the rolling of steel bars and billets, a duplication of the present rod mill, and a sulphuric-acid plant for the supply of acid in connection with the production of sulphate of ammonia and for galvanizing.

[1] CHEM. & MET. ENG. Vol. 23, No. 24, Dec. 15, 1920, p. 1161

World's 1920-21 Sugar-Crop Estimates

THE world's sugar-crop estimate for 1920-21 is over 1,700,000 tons greater than the production of 1919-20. While definite advices have been received from many sources, some of the reports are only partial and are subject to adjustment, and it must be understood that in a great many instances there are still two or three months of growing weather that can materially affect the present outlook, says the *Weekly Statistical Trade Journal*. Under such conditions these crop estimates must be looked on as more of an indication than an estimate, but nevertheless they are quite valuable in determining what the prospects of supplies are for the next sugar year.

CANE CROPS -EUROPEAN BEET CROP

As regards Cuba, while the usual inquiries have been sent to the factories, reports are coming in very slowly, due perhaps to the unsettled financial situation there. The centrals hesitate in giving any indication of their probable output until conditions improve. The Cuban weather during the growing season has been favorable in the western half of the island; the eastern half has been lacking somewhat in rainfall. Santa Clara Province was affected by a light rainfall. Increased planting has been reported in a number of sections. Ten or twelve new factories that are either complete or under construction may add something over last year's production. For the present the Cuban crop indication can be placed at 4,000,000 tons.

Santo Domingo and the British West Indies have all been affected by a more or less serious drought during the growing season and in some cases crops are reduced. The weather in Porto Rico has been irregular, but no material change is expected in the production. Formosa and Japan will show increased outputs. Dry weather prevailed in Natal and the Fiji Islands.

Preliminary figures issued several months ago, based on sowings, are not likely to be attained in the European beet crop. Many contributing circumstances have been the cause; partly irregular growing weather, lack of coal, transport materials, labor, etc. The figure for Germany, based on a yield per hectare much below a normal acreage, indicated on the area planted a crop of 1,300,000 tons, but even the low yield per hectare used by us will not be reached, and it is hardly likely that a crop in excess of 1,150,000 tons will be made in that country. Similar conditions obtain in Czechoslovakia; latest official advices from there state the crop would reach only 650,000 tons raw value. France is showing quite an improvement over the preceding crop and will probably have a production of 100,000 tons more than its last one. Spain also shows a material increase.

AMERICAN AND CANADIAN BEET CROPS

Regarding conditions in the United States, the output of the beet crop in Ohio is estimated at 45,000 tons, Michigan at 145,000, Colorado 250,000, Nebraska 75,000, Utah 140,000, Idaho 50,000, and California 151,000. In this last state the compaign is so nearly over that the figure given will be very close to the actual out-turn.

The above estimate is freely confirmed by the United States Government, which estimates the crop of beet roots as of Nov. 1 as 8,812,000 tons. Using an average yield of the past three years (including last year's poor out-turn), gives a crop indication of 900,000 tons. This year's yield will exceed the three years' average materially, according to present prospects.

According to advices, prospects in Canada are very good, and with the material increase in sowings the indications are that a crop of at least 35,000 tons will be made.

The total indicated world production for 1920-21 of both cane and beet sugar is 17,085,500 tons, against the last campaign of 15,310,824 tons, an increase of 1,774,676 tons. The largest world's production on record was the 1913-14 campaign, when the production totaled 18,667,399 tons.

PRELIMINARY 1920-21 FIGURES

Preliminary estimates (in long tons) for the 1920-21 crop in the various sugar-producing countries of the world and the final estimates for the two previous crops follow:

Countries	1918-19 Tons	1919-20 Tons	1920-21 Tons
United States:			
Louisiana	250,802	108,035	175,000
Porto Rico	362,618	433,825	435,000
Hawaiian Islands	538,913	505,500	525,000
West Indies Virgin Islands	9,000	12,400	5,000
Cuba	3,971,776	3,730,077	4,000,000
British West Indies			
Trinidad	47,850	58,416	60,000
Barbados	75,271	50,000	50,000
Jamaica	43,000	46,875	45,000
Antigua	12,841	45,540	13,500
St. Kitts	10,901	10,036	8,000
Other British West Indies	7,580	5,651	10,000
French West Indies			
Martinique	10,027	22,000	20,000
Guadeloupe	26,604	31,000	25,000
Santo Domingo	158,309	175,736	189,000
Haiti	3,300	5,000	5,000
Mexico	70,000	92,000	100,000
Central America.			
Guatemala	13,441	15,000	15,000
Other Central America	14,240	20,000	20,000
South America			
Demerara	107,560	96,000	100,000
Surinam	8,000	12,000	12,000
Venezuela (exports)	16,970	18,000	20,000
Ecuador	7,000	7,000	8,000
Peru	300,000	350,000	350,000
Argentina	130,266	292,110	225,000
Brazil	183,079	177,155	300,000
Total in America	6,379,348	6,289,356	6,715,500
British India (consumed locally)	2,370,000	3,049,157	3,000,000
Java	1,749,408	1,335,763	1,515,000
Formosa and Japan	415,678	283,482	350,000
Philippine Islands (exports)	195,289	203,000	200,000
Total in Asia	4,730,375	4,871,402	5,065,000
	1918-19 Tons	1919-20 Tons	1920-21 Tons
Australia	209,853	175,000	175,000
Fiji Islands	80,000	60,000	60,000
Total in Australia and Polynesia	289,853	235,000	235,000
Egypt (consumed locally)	75,899	90,000	80,000
Mauritius	252,770	235,490	240,000
Reunion	50,000	40,000	40,000
Natal	185,000	150,000	160,000
Mozambique	20,615	35,000	40,000
Total in Africa	584,284	550,490	560,000
Europe:			
Spain	6,618	6,048	5,000
Total cane-sugar crops	11,990,478	11,952,296	12,580,500
Germany	1,324,579	750,000	1,150,000
Czechoslovakia	700,000 {	535,000	650,000
Hungary and Austria		50,000	50,000
France	110,096	154,444	250,000
Belgium	74,183	146,918	225,000
Netherlands	173,436	238,692	300,000
Russia (Ukraine, Poland, etc.)	336,616	225,000	175,000
Sweden	127,467	145,000	175,000
Denmark	144,600	160,000	165,000
Italy	106,682	182,843	175,000
Spain	139,409	81,650	175,000
Switzerland	10,800	8,550	10,000
Bulgaria	2,441	10,974	10,000
Rumania	....	....	10,000
Total in Europe	3,250,309	2,689,071	3,520,000
United States.	674,892	652,957	950,000
Canada	22,300	16,500	35,000
Total beet-sugar crops	3,947,501	3,358,528	4,505,000
Grand total, cane and beet sugar	15,937,979	15,310,824	17,085,50

Refractories for Electric Furnace*

A description of the Properties of Refractory Brick and of the Raw Materials Employed in Their Manufacture, With a Review of the Many Factors Involved in the Efficient Use of Refractories in General

By R. M. Howe†

BEFORE discussing the subject from a theoretical or practical standpoint the writer wishes to present certain data to be used as a foundation. These data have been gathered from both private and public sources, and acknowledgement is hereby made of the splendid co-operation of individuals interested in this field.

Physical and Chemical Data
Raw Materials

There are nine raw materials which are most commonly used in or which are being most seriously considered for use in the manufacture of electric-furnace linings. They are fireclay, silica (or ganister), magnesite, dolomite, chrome, bauxite (and diaspor), zirconite, carborundum and alundum. The last two are mentioned by their trade names, as considerable data are given as applying to these products. Strictly speaking, they are not raw materials, but can be classed as such most advantageously and used to represent this general type of material.

The ranges of analyses given in the accompanying table are believed to be typical of the materials used for refractory purposes.

A discussion of the influences of different impurities must be omitted, as this would be the subject of a paper in itself.

ANALYSES OF REFRACTORY RAW MATERIALS

	Fireclay	Ganister	Magnesite (1)	Dolomite	Chromite (2)	Diaspor and Bauxite (3)	Zirconite (4)	Carborundum (5)
Ignit	3 16	Up to 5	48–52	42–48	...	15 31	2 72	.....
Silica......	40 70	96 99	Up to 5	Up to 4	3 10	4 10	7 74	....
Alumina....	45 15	Up to 2	Up to 1	Up to 4	14 2	52 72	0 66	Up to 2
Iron oxide..	Up to 5	Up to 2	Up to 5	Up to 4	14 19	2 6	3 10	Up to 1
Lime.......	Up to 0.7	Up to 0.3	Up to 3	27-34	Trace	Trace	....	Up to 0 3
Magnesia...	Up to 0.7	Up to 0.3	40 47	16 20	11-17	Trace	....	
Alkalis.....	Up to 2	Up to 0 6	...	...	...	Trace	...	..
Zirconia....	....	....		..	...	...	84 1	....
Chromic oxide.....	....	..	...	...	36–46	.....	..	.....
Carbon	.	..	..	....	....	.	....	27 30
Silicon.. ..	...	.	.....	.....	....	...	....	65 70
Titania	Up to 2	Trace	.....	.....	....	1–5	1 21	....

(1) McDowell & Howe, *J. Am. Ceram. Soc.* vol. 3, pp. 199, 201 (1920).
(2) Met. & Chem. Eng., vol. 8, p. 107 (1910). *Sprechsaal*, vol. 26, p. 1,075 (1893). Private communications.
(3) Met. & Chem. Eng., vol. 8, p. 107 (1910). R. Wohlin, *Sprechsaal*, vol. 46, p. 767 (1913). Private communications.
(4) H. C. Meyer, Met. & Chem. Eng., vol. 13, p. 263 (1915).
(5) Catalog, Carborundum Co. of America.

The refractory bricks or shapes made therefrom have similar analyses. In many cases the difference in composition between the raw material and the finished product is simply due to the removal of carbon dioxide, water or organic matter, but in a few cases it is the result of the addition of a binder, as for example the lime in silica brick.

Properties of Refractory Brick

Fusion Point.—The fusion points of a number of refractory brick were published by Kanolt[1] in 1912, and as they agree closely with those secured by the writer, Kanolt's results are given herewith. That of zirconia brick has been determined by several investigators, but the results of Arnold[2] and Ruff[3] show the best agreement, being 2,600 deg. C. and 2,563 ± 10 deg. C. respectively. Fused bauxite, or alundum, fuses at 2,050 deg. C.[4] Silicon carbide, or carborundum, does not fuse but decomposes at about 2,240 ± 5 deg. C.

FUSION POINTS OF REFRACTORY BRICK

	Deg. C
Fireclay..	1615 to 1715[1]
Silica..	1700 to 1705[1]
Magnesia ...	2165[1]
Chrome....	2050[1]
Bauxite.........	1565 to 1785[1]
Zirconia...............	2563[3] to 2600[2]
Carborundum, decomposes at	2240[5]
Alundum...............	2050[4]

When the fusion point of refractory material is determined, the results actually show the temperature at which a small piece of the material softens under its own weight. When the influence of pressure, as well as that of high temperatures, is taken into consideration far different results obtain.[6] Fireclay brick begin to compress slowly at about 1,350 deg. C. when a pressure of 50 lb. per sq.in. is applied. Zirconia brick "squatted" at 1,420 deg. C. and 1,600 deg. C. under pressures of 75 and 25 lb. per sq.in. respectively. Magnesia, chrome and silica brick usually show slight signs of softening under pressure and then suddenly shear. Load tests on bauxite brick showed compressions of from 1.96 to 6.35 per cent[7] under a pressure of 25 lb. per sq.in. at 1,350 deg. C. after one and one-half hours.

BEHAVIOR OF REFRACTORY BRICK WHEN HEATED UNDER PRESSURE OF 50 LB. PER SQUARE INCH

Kinds of Brick	Investigator	
Fireclay .	Bleininger and Brown	Softens at about 1,550 deg C
Silica	Brown, Le Chatelier.. ..	Rigid at 1,500 deg C, but probably shears at about 1,600-1,650 deg C
Magnesia .. .	Brown, Mellor and Emory	Shears at 1,410-1,555 deg C
Chrome. .	Brown, Mellor and Emory	Shears at 1,400-1,450 deg. C
Zirconia ..	Estimated from Mellor and Emory........ ..	"Squats" at about 1,510 deg C
Bauxite.......	W. F. Rochow... . .	Softens at about 1,350 deg C
Carborundum.	B. C. Landbarger..	No signs of failure at 1,650 deg C the furnace limit

[1]C. W. Kanolt, U. S. Bureau of Standards, Tech. Paper 10 (1912).
[2]H. Arnold, *Chem. Ztg.*, vol. 42, p. 413 (1918).
[3]Ruff and Lauschke, *Sprechsaal*, vol. 36, p. 70 (1916).
[4]Catalog Norton Co.
[5]Tucker and Lampen, *J. Am. Chem. Soc.*, vol. 28-I, p. 953 (1906).
[6]Mellor and Emory, *Gas J.*, vol. 142, p. 478 (1918). J. H. Brown, *Trans.* Am. Ceram. Soc., vol. 14, p. 391 (1912). Le Chatelier and Bogitch, *Trans.* Am. Inst. Mining Eng., vol. 60, p. 134 (1919). Bleininger and Brown, Tech. Paper 7, U. S. Bureau of Standards (1913).
[7]Private communication, W. F. Rochow.

*Paper read before the Columbus meeting of the Electric Furnace Association, Oct. 7, 1920.
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Carborundum brick do not fail at 1,650 deg. C.[8] under a pressure of 50 lb. per sq.in. The accompanying table indicates what may be expected of different kinds of refractory brick when heated under a pressure of 50 lb. per sq.in.

Specific Gravity of Refractory Brick

The following data, gathered from different sources, illustrate rather clearly how the weight of an installation depends upon the type of bricks used.

Material	Specific Gravity
Fireclay.	2 65 2 75
Silica.	2 29 2 44
Magnesia	3 44 3 60
Chrome.	3 90 4 00
Carborundu	3 12 3 20
Bauxite[10]	3 15 3 25
Alundum[11]	3 90 4 00
Zirconia[12]	5 0

The higher values for zirconia, bauxite, chrome, magnesia and fireclay brick generally indicate harder burning, while the specific gravity of silica brick decreases with the intensity of the burn.

Electrical Resistivity of Refractory Brick

It is natural that interest in the electrical resistivity of refractories has increased with the more general application of the electric furnace, yet very little information on the subject is available. Stansfield, MacLeod, and McMahon[13] have compared the resistivity at high temperatures of silica, Austrian magnesia and chrome brick made in America, and firebrick from Caledonia. Certain data regarding the resistivity of electric furnace products are given in trade catalogs, but otherwise there is very little information available.

ELECTRICAL RESISTIVITY IN OHMS PER C C

Temp Deg. C	Magnesia Brick[14]	Chrome Brick[14]	Silica Brick[14]	Fire-brick[14]	Carborundum[15]	Alundum[16]
528			...			130
600				21,000	14 6	....
700				17,000	10 9	16 (730 deg. C.)
800	..	2,800		13,000	7 8	... .
900		760		9,000	5 4	5 3 (892 deg. C.)
1,000		420		6,600	3 7	1.8 (1,020 deg. C.)
1,100		430		4,400	2 1	....
1,200		450		2,300	1 3	... .
1,300	6,200	410	9,700	1,300	0 96	. . ..
1,400	420	320	2,400*	690	0 65	.. ..
1,500	55		710	280		. ...
1,550	30		22	60	. .	. ....
1,565	25		18			

* Megohms

Specific Heats of Refractory Bricks

Aside from the data given by Heyn[17] for silica and magnesia brick, and that given by Mellor[18] for fireclay brick, little is known regarding this constant. Other investigators[19] have simply reported determination over a narrow and low temperature range and have apparently disregarded the fact that specific heat increases with the temperature.

SPECIFIC HEATS OF REFRACTORY MATERIALS

Material	At 100 Deg. C.	At 1,000 Deg. C.
Firebrick[18]	.... 0 199	0 253
Silica[17]..	.... 0 219	0 298
Magnesia[17].	... 0 231	0 324
Alundum[18]..	.... 0 198	. .
Carborundum	... 0.186 (31,985 deg)	...

Thermal Conductivity of Refractory Brick

The thermal conductivity of refractory brick has been determined several times, and in a number of instances remarkable checks have been secured. In nearly every investigation, however, there has been one marked deviation which has been due to the material used. For example, Wologdine[20] used a silica brick sample which was not typical of American manufacture and noted a conductivity lower than that of fireclay. In other cases concordant results have been secured except with magnesia brick, a fact which leads one to believe that the samples were not typical of the product used in commercial furnaces for withstanding the action of metal, slag and high temperatures. When these apparent discrepancies are eliminated, the results show rather close agreement, as may be seen in the accompanying table of selected data.

THERMAL CONDUCTIVITY OF REFRACTORY BRICK AT 1,000 DEG. C. IN COLONIES PER CENTIMETER CUBE PER SECOND PER DEG. C.

Observer	Fireclay	Silica	Magnesia	Chrome	Carborundum
Dudley...... .	0 0034	0.0042	.....	.....	......
Wologdine.	0 0042	.....	0.0071	0.0057	0.0231
Dougill, Hodsman and Cobb.	0 0040	0 0046	0 0085	... .	..
Goerens and Gillis.	.....	......	0 0080	.....	..
Average.......	0 0039	0 0044	0.0079	0.0057	0.0231

Zirconia[11] brick are said to have a very low thermal conductivity. That of silica brick has been observed to increase greatly at 1,050 to 1,100 deg. C.[21]

Resistance to Temperature Changes

Refractory brick and shapes made from fireclay and electric-furnace products are only slightly affected by sudden changes in temperature. Silica, magnesia and chrome brick must be heated very slowly, especially at low temperatures, if spalling is avoided. When once heated, however, any of these bricks will withstand considerable variation in temperature if the change is not too sudden. The more important data regarding the thermal properties of the various refractories have been grouped into tabular form for convenience of reference and comparison. In many instances specific data are lacking, so the writer has taken the liberty of supplying relative data or comparative notes to aid in the formulation of conclusions. The specific data represent the average results obtained.

Material	Fusion Point Deg C.	Point of Failure Under 50 Lb. per Sq.In. Load, Deg. C.	Thermal Conductivity at 1,000 Deg. C.	Specific Heat at 100 Deg. C	Resistance to Spalling
Fireclay......	1,700	1,350-1,400	0 0039	0.199	Good‡
Silica......	1,700	1,600*	0 0044	0 219	Poor‡
Magnesia	2,165	1,480	0 0079	0 231	Poor‡
Chrome . .	2,050	1,425	0 0057	.	Poor‡
Bauxite... . .	1,785	1,350 or more	Same as Fireclay	.	Good‡
Zirconia.....	2,575	1,510†	Low†	..	.....
Carborundum	2,240	Above 1,650	0 0231	0 198	Good‡
Alundum.........	2, 50	....	High‡	0 186	Good‡

* Estimated from known data.
| Average of results with 25 lb and 75 lb. per sq.in.
† Private communications.

[8]Private communication, A. C. Lindbarger.
[9]Trade catalog.
[10]Private communication, J. L. Crawford.
[11]F. A. G. FitzGerald, Met. & Chem. Eng., vol. 10, p. 129 (1912).
[12]H. C. Meyer, Met. & Chem. Eng., vol. 12, p. 791 (1914).
[13]Stansfield, MacLeod and McMahon, *Trans.* Am. Electrochem. Soc., vol. 22, p. 89 (1912).
[14]Stansfield, MacLeod and McMahon, *op. cit.*
[15]Catalog, the Carborundum Co.
[16]Catalog, Norton Co.
[17]E. Heyn, Mitteilungen aus dem Koniglichen Materialprufungsamt, vol. 32, p. 180 (1914).
[18]Wilson, Holdcroft & Mellor, *Trans.* Ceram. Soc. (Eng.), vol. 12, p. 279 (1912-13).
[19]Trade catalogs of the manufacturers.

[20]Boyd Dudley, Jr., *Trans.* Am. Electrochem. Soc., vol. 27, p. 336 (1915). S. Wologdine, *Electrochem. Met. Ind.*, vol. 7, p. 383 (1909). Dougill, Hodsman and Cobb, *J. Soc. Chem., Ind.*, vol. 34, p. 465 (1915). Goerens and Gillis, *Ferrum*, vol. 12, p. 1 (1915).
[21]C. H. Meyer, *op. cit.*
[22]E. Heyn, Mitteilungen aus dem Koniglichen Materialprufungsamt, vol. 32, p. 181 (1914).

There is little doubt that the use of fireclay brick for metallurgical purposes is advisable wherever they give satisfaction. They are inexpensive, easy to install, and require less care in handling than any other refractory material. However, it is realized that there are serious limitations to the application of fireclay brick in the electric-furnace industry because of the extremely high temperatures involved. Consequently, it is necessary to secure the most refractory firebrick available for use in the hotter zones, and even then the furnace temperature should not exceed 1,650 deg. C. for any length of time. Since this temperature is very close to the fusion points of the more refractory fireclays, satisfactory service is secured by applying certain precautions which tend to increase the life of any refractory.

Precautions Aiming to Increase the Life of Refractories

Insulation of any kind should be carefully avoided when fireclay brick are used at their limiting temperatures, for when the heat which is naturally carried away accumulates on the inner hotter surface failure invariably results. Care must be exercised in preventing the accumulation of plant dust on the furnace roof, for it acts as an insulator and sometimes causes failure. It is also advisable to make the ratio between the heating surface and the radiating surface as small as possible in order to secure additional service from the lining. Undoubtedly the use of water cooling plates would be advantageous, as has been demonstrated in the hotter zones of a blast furnace. A refractory block should never be heated from more than one surface, especially when under pressure; the results of this condition are shown by the load tests.

These rules apply to any kind of refractory material.

Use of Silica Brick

When fireclay brick do not give satisfactory service in roofs silica brick are usually installed. They have fusion points which are practically the same as those of the more refractory fireclay brick, but possess other characteristics which favor longer service. They must, however, be heated very slowly, especially at the lower temperatures, because of their tendency to spall. When this precaution is taken and a temperature of over 1,000 deg. C. is maintained, a silica brick roof should give extended service.

When the roof is heated rapidly strains develop, but are often unnoticed because the expansion of the brickwork holds the brick and pieces in place. Upon cooling, however, the brickwork contracts and reduces the pressure on the different parts of the roof, thus allowing the loosened portions to fall into the hearth. It is believed that if the pressure could be maintained during a cooling period spalling would be less pronounced. Upon heating up again it would be necessary to release gradually the pressure to allow for the expansion of the brick, in order to prevent their being crushed.

It has been the writer's experience that the smaller silica shapes spall less readily than the heavier blocks, due probably to the great expansion strains developed in the latter during the heating periods. This fact would favor the use of small standard sizes rather than the larger special shapes.

There are two characteristics possessed by silica brick which are evidently associated with their satisfactory service in roofs. They have a relatively high thermal conductivity, which helps cool the brickwork, and they are rigid under a pressure of 50 lb. per sq.in. at temperatures within 100 deg. C. of their fusion points. It is believed that these two facts, coupled with the high viscosity of silica, explain why brick of this type can be used at temperatures very close to their actual melting points. Care should therefore be exercised in furnace design and construction to develop the thermal conductivity of the walls to the maximum. Brick made from various sized angular fragments and burned so as to convert a large proportion of the quartzite to tridymite and cristobolite (indicated by a specific gravity of 2.29 to 2.38) usually have the greater strength at high temperatures.

The use of fused silica brick has not been overlooked, and it is doubtful if they would spall. Their cost, however, would hardly be justified, as more refractory electric-furnace products could be prepared at a slightly greater expense.

Use of Magnesite Brick

Magnesia brick are favored with a high fusion point, thermal conductivity and resistance to the corrosive action of slag and metal. Because of this fact the brick and grains are used extensively in the hearths and bottoms of basic furnaces. They have less desirable characteristics of being subject to spalling and to the chemical action of certain substances. Extreme care must therefore be exercised in the selection, treatment, installation and use of this material.

The magnesite after being burned should contain from 4.0 to 8.5 per cent of ferric oxide, as this impurity facilitates "sintering." When this amount of iron oxide is present and the specific gravity is from 3.44 to 3.60, the product is sure to be well burned, resistant to slaking and will undergo little or no contraction after being installed. Either the grains or the brick made therefrom may be stored indefinitely if protected from water. These characteristics will be affected by the lime content, which, as is generally conceded, should be low. Investigations reported elsewhere have led to the following conclusion regarding the influence of this oxide.

"The magnesite that was lower in lime showed less tendency to slake and higher refractoriness, as well as greater resistance to attack by firebrick and silica brick, and to the action of the corrosive mixture." [23]

Dense hard burned magnesia brick have a thermal conductivity higher than that of silica brick and permit only slight slag penetration.

They should be laid dry in order to prevent any possible action with water and should never be exposed to the action of steam,[24] which causes them to disintegrate.

They are attacked by carbon at 1,700 deg. C.[25] according to the following reversible equation:



$$MgO + C \rightleftharpoons Mg + CO$$

As this action proceeds, a gray or black deposit consisting of an intimate mixture of magnesia and carbon is deposited in the cooler zones. Both silicon and phosphorus also attack magnesite when they are present in the melt, that high in lime being most easily affected.

When the grains are used in the hearth they should be sintered into place in ½- to 1-in. layers over a foundation of magnesia brick, using a small amount of

[23] McDowell and Howe, Am. Inst. Min. Eng. *Bull.* 146, p. 309 (1919). The corrosive mixture contained phosphorus, silica and ferric oxide.

[24] R. H. Youngman, *J. Am. Chem. Soc.*, vol. 3, p. 217 (1920).

[25] O. P. Watts, *Trans.* Am. Electrochem. Soc., vol. 11, p. 279 (1907). Goodwin and Mailey, *Ibid.*, vol. 9, p. 89 (1906). R. E. Slade, *J. Chem. Soc.*, vol. 93, p. 327 (1908). P. Libeau, *Compt. rend.*, vol. 144, p. 799 (1907).

slag as a binder. This practice should result in the formation of the densest structure, one which would be less easily scoured or loosened in patches.

Dolomite is rarely, if ever, used in the manufacture of brick at the present time because of the difficulty encountered in preventing the lime from slaking. Several years ago such brick were made at different European steel plants, but as it was necessary to use them immediately in order to prevent their disintegration they were gradually replaced by magnesia brick.

The use of dolomite in patching and, in a few cases, for building entire bottoms has continued to the present day, probably because of its low initial cost as compared with that of magnesite. Dolomites highest in magnesia and containing about 4 per cent of iron oxide and alumina apparently have the most desirable characteristics; when over 4 per cent is present, especially when accompanied by more than 3 or 4 per cent of silica, the product is less refractory.[26]

The writer has compared burned dolomites with "treated" dolomites and dead-burned magnesites and drawn the following conclusions:

The magnesites are more resistant to slaking than the dolomites or dolomite preparations, also to the action of the corrosive mixture and that of fireclay and silica. One of the treated dolomites has a slaking tendency so low as to group it with the magnesites; in its resistance to corrosion it compares more closely with the untreated calcined dolomite high in impurities.

The materials highest in impurities and lowest in lime were most resistant to slaking.[27]

Use of Chrome, Zirconia, Bauxite and Other Special Brick

Chrome brick have certain desirable characteristics, but are rarely used in electric furnaces. They are favored by a high thermal conductivity, fusion point and resistance to slagging action. On the other hand, they are difficult to bond, the chromic oxide may be reduced to chromium, and this may contaminate the metal being melted.

The use of a layer of chrome brick or of chrome ore has proved to be a very satisfactory method of separating silica and magnesia brick in order to prevent their interaction at high temperatures. It is possible that chrome, because of its insolubility, might be utilized at the slag line either by itself or in conjunction with magnesite. The successful use of chrome might greatly increase the resistance of the lining to the action of the slag, which dissolves the magnesite or dolomite so rapidly.

As far as the writer is aware few zirconia brick, if any, are being used in electric furnaces, although several investigators believe that their use will solve many problems. These opinions are based upon the high fusion point of the pure material, the low conductivity of the brick, and their marked resistance to the solvent action of certain fluxes.

There are numerous commercial disadvantages, however, which must be overcome before the full refractory value of zirconite is developed. The mineral is often badly contaminated with iron oxide and as a result its fusion point is seriously lowered. It also undergoes considerable shrinkage at high temperatures and must therefore be given a severe heat treatment before installation, in order to prevent shrinkage in service. It is evident that the raw material used in the brick tested by Mellor[28] was not properly selected or else it had not been sufficiently burned. Otherwise brick fusing at about 2,474 deg. C. would not have "squatted" at 1,420 deg. C. under a pressure of 75 lb. per sq.in.

Bearing in mind that the influence of impurities and of the incomplete removal of shrinkage will be accelerated by the low thermal conductivity of the brick, it is evident that three things must be accomplished before the full value of zirconite as an electric furnace refractory is realized:

1. Raw material of the necessary purity must be available, either by proper sorting or purification.
2. It must be bonded into a mechanically strong brick.
3. This brick should undergo little shrinkage after being installed.

Very little is published regarding the use of zirconia in binding up furnace bottoms. When its high fusion point and insolubility is considered, this possibility is not remote.

Bauxite brick have characteristics very much the same as those made from zirconite, a fact which is not surprising because of the similarity in behavior of the dominating oxides found in each. In order to secure the full value of bauxite as an electric-furnace refractory it is therefore necessary to subject the brick to an intense heat treatment in order to completely remove the shrinkage. Bauxite brick do not possess the advantage of having a high thermal conductivity.

Carborundum and alundum offer good possibilities for service in roofs, as they have all of the assets of silica brick, with the additional advantage to a low tendency to spall. Their fusion points are high, as is the thermal conductivity. Their tendency to shrink is naturally low, and they can support a heavy load at high temperatures. The writer is unable to state to what extent they are affected by furnace gases or slag. In a few cases oxidation of the silicon carbide to silica, resulting in the weakening of the brick structure, has been reported. It is probable that the practice of insulating bricks of this type could be practiced with greater safety than with other types, because of their higher fusion points and low shrinkage.

Conclusions

In conclusion, the writer wishes to emphasize certain factors concerning the service secured from refractory brick. They should be protected from rain while being stored in order to prevent the weakening of their structure. They should be laid up with a material similar to the brick themselves, or one which will not corrode or flux them, using as small a joint as possible. The furnace should be constructed so that heat will be conducted away from the hotter portions. The ratio of heating to cooling area should be made as low as possible. Refractory brick or shapes should be heated from one side only in order to keep the heating surface low and in order to avoid the effect of pressure at high temperatures. Insulation lowers the margin of safety and should therefore be avoided, even to the extent of allowing dust to accumulate on the roof. When the furnace is being heated this should be done gradually, especially where magnesite and silica brick are involved. When the furnace is being cooled it should be remembered that cold blasts produce or accelerate spalling.

[26] M. Zyromski, *Am. Mfr.*, vol. 39, p. 9 (1886).
[27] McDowell and Howe, *op. cit.*

[28] Mellor and Emory, *op. cit.*

Adsorption by Silica Gel*—II

Adsorption Efficiencies on Ethyl Ether, Acetone, Benzene, Water and Petroleum Ether Vapors—Experimental Results—Dehydration of Air at Various Saturations—Solvent Recovery†

BY E. B. MILLER

CONSIDERABLE losses of valuable solvents such as ether, acetone, alcohol, benzene, etc., occur in a variety of industrial processes. In the recovery of such solvents silica gel will probably find some of its most important applications. The general principles already discussed apply in this field and we can predict approximately the adsorptive power of the gel for the vapor of a particular solvent before determining it experimentally. These general principles have already been illustrated in some detail by experimental data on sulphur dioxide, and it will not be necessary to go into the same detail hereafter.

For the recovery of solvents after they have been adsorbed by the gel the most satisfactory method,

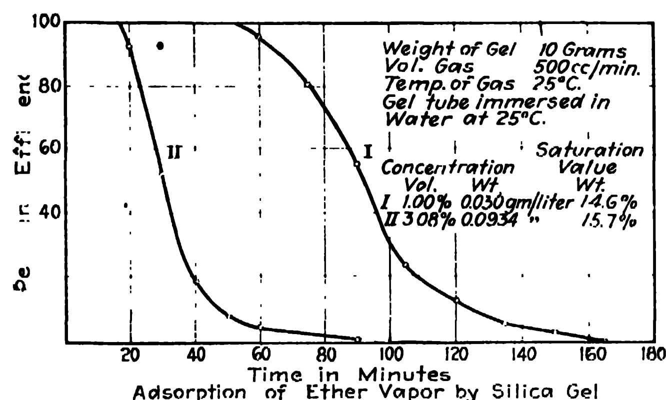


FIG. 6. ADSORPTION EFFICIENCY ON ETHER VAPOR

applicable in nearly all cases, consists in heating the gel to the proper temperature and sending steam directly through it. For the volatile solvents here considered 105 deg. C. is sufficient to bring about rapid distillation from the gel. This method is particularly adapted to the recovery of substances which, like ether, benzene, etc., are but slightly soluble in water and do not react chemically with it.

Steam displacement was used in the laboratory experiments described below. In carrying out an experiment the tube containing 100 g. of gel with its adsorbed material is connected on one side with a source of steam and on the other with a condenser and receiver, the latter being so constructed that its contents may be drawn off and weighed. When all connections are made the gel is heated to about 105 deg. C. by immersion in an oil bath. During heating some of the adsorbed material generally distills out. When the desired temperature is reached steam is admitted to the gel and the mixed vapors are condensed and collected in the receiver.

In reference to the percentage recoveries of the various solvents as shown in the following pages it should be pointed out that, working on such a small scale, the experimental errors are relatively large. No very special effort was made to eliminate losses in handling and weighing the distillates.

ETHYL ETHER

Fig. 6 gives the results of two typical experiments on the adsorption of ether vapor at 25 deg. C.

The desired mixture of ether vapor and air is obtained by saturating a metered volume of air by bubbling it successively through several bottles of pure ether kept at a constant temperature. The resulting mixture may, if desired, be diluted by further admixture with air. The weight of ether carried by the air is determined by absorbing it completely from a known volume in a weighed portion of silica gel and noting the increase in weight. From the weight of ether in a known volume the volume per cent is calculated on the assumption that the gas laws hold for ether vapor, which is of course only approximately correct.

An examination of the curves show that, using a 1.00

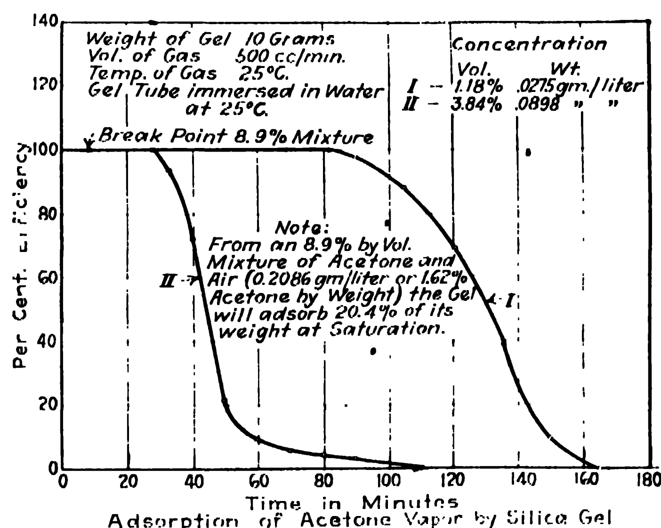


FIG. 7. ADSORPTION EFFICIENCY ON ACETONE VAPOR

per cent mixture of ether vapor and air, the gel adsorbs at 25 deg. C. an amount of ether corresponding to 14.4 per cent of its own weight; and, using a 3.08 per

Experiment 1. 100 g. of gel containing 29 g of adsorbed ether.
Temperature of condenser, 20 deg. C.
Temperature of receiver, 0 deg. C.
Receiver vented to air.

	Distillate		
	Et		Water
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	10 209	35 2	None
15 minutes of steaming	14 376	49 5	0 755
20 minutes of steaming	None	None	
Recovery	24 585		

*Paper presented before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Part I see CHEM. & MET. ENG., vol. 23, No. 24, Dec. 15, 1920, p. 1,155.

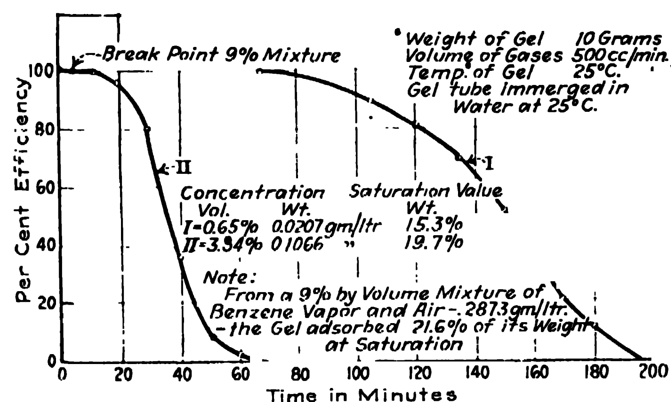


FIG. 8. ADSORPTION EFFICIENCY OF BENZENE VAPOR

cent mixture, it takes up 15.5 per cent of its own weight. In each case it adsorbed nearly 8 per cent of its own weight at 100 per cent efficiency.

Two experiments were carried out under slightly different conditions.

At the end of experiment 1 no ether was left in the gel. The 15 per cent loss was due to evaporation through the vent in the receiver and to experimental

Experiment 2. 100 g. of gel containing 30 5 g of adsorbed ether Temperature of condenser, 0 deg C. Temperature of receiver, 0 deg C. Receiver vented through a tube containing silica gel.	Distillate		
	Ether		Water
	Grams.	Per Cent of Total	Grams
During heating to 107 deg C	9 769	32	. .
10 minutes of steaming.	17 821	58 4	17 545
20 minutes of steaming	None	None	. . .
Recovery. . . .	27 590	90 4	. . .

losses in handling and weighing. We carried out the next experiment using colder water in the condenser in order to minimize the loss by evaporation through the vent in the receiver.

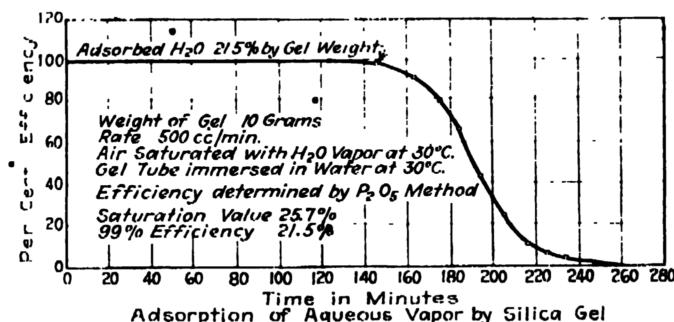


FIG. 9. ADSORPTION EFFICIENCY ON WATER VAPOR

The vent in experiment 2 adsorbed 0.095 g. of ether.

ACETONE

Fig. 7 shows the results of several experiments on the adsorption of acetone vapor at 25 deg. C. from mixtures with air ranging in concentration between 1.18 and 8.9 per cent acetone vapor by volume.

The mixtures with air and analyses of same were made in a manner similar to that already described for ether. The data given on the curve sheet are self-explanatory.

We give here the results of three experiments in the recovery of adsorbed acetone.

Experiment 1. A tube containing 100 g. of gel with 33.8 g. of adsorbed acetone was connected with a source of steam, a condenser and a receiver as already described. During the heating some acetone was distilled out and condensed in the receiver, but the amount was not determined separately. When the temperature reached 105 deg. C. steam preheated to 112 deg. C. was passed through the gel for a period of eighty minutes; 94.44 c.c. of condensate was obtained which had a density of 0.94094. This corresponds to 33.77 g. of acetone, or 100 per cent recovery.

Experiment 2. One hundred grams of gel containing 33.3 g. of adsorbed acetone. Temperature of condenser 20 deg. C. Temperature of receiver 0 deg. C. Receiver vented to air.

During heating to 107 deg. C. 8.0485 g. of acetone distilled over. Steam was then passed for twenty minutes, giving a distillate of 16.9726 g., having a density of 0.81529 at 25 deg. C. This corresponds to 15.36 g. of acetone and 1.6126 g. of water.

Further steaming for thirty minutes gave a distillate of 26.69 g., having a density of 0.9770 at 25 deg. C. This corresponds to 3.87 g. acetone and 22.82 g. water.

Acetone recovered was 27.28 g., or 82 per cent of the total.

Experiment 3. One hundred grams of gel containing

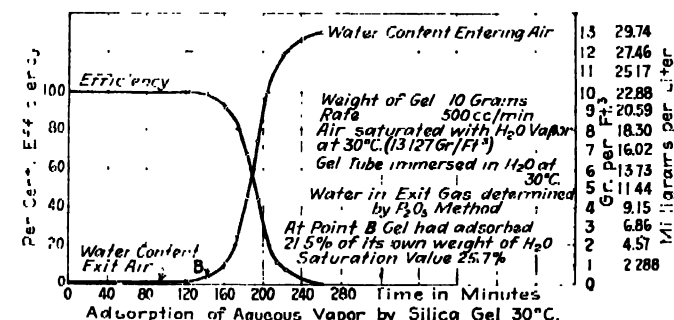


FIG. 9A. DRYING POWER OF SILICA GEL $P/Po = 1$

33 g. of adsorbed acetone. Temperature of condenser, 0 deg. C. Temperature of receiver, 0 deg. C.

Acetone to the amount of 6.062 g. distilled over during heating to 107 deg. C. Steaming for ten minutes gave a distillate of 34.47 g., having a density of 0.8654 at 25 deg. C. This corresponds to 24.8184 g. of acetone and 9.6516 g. of water. Further steaming gave no liquid acetone.

Acetone recovered, 30.8827 g., or 93.5 per cent of the total. During distillation the receiver was vented through a column of gel. Only a negligible increase in weight occurred.

BENZENE (BENZOL)

Fig. 8 gives the results of some adsorption experi-

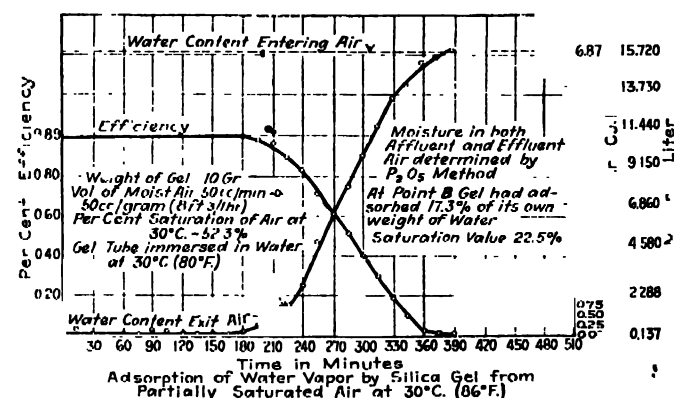


FIG. 9B. DRYING POWER OF SILICA GEL $P/Po = 0.53$

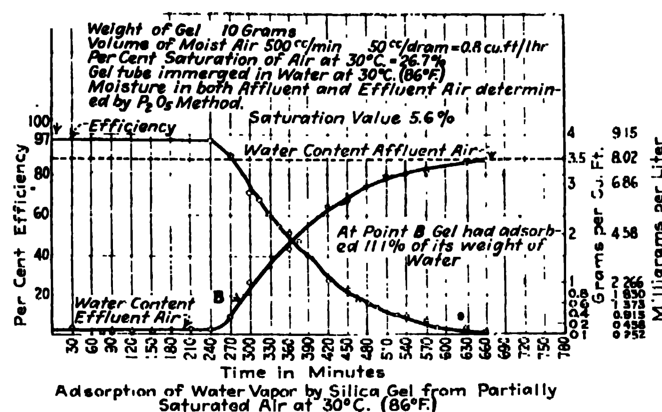


FIG. 9C. DRYING POWER OF SILICA GEL P/Po .. 0.267

ments on benzene. The curves follow very closely the corresponding curves for acetone. Concentrations were determined in the manner already described.

Recovery. Two experiments are given, differing with respect to the temperature of the condenser and the amounts of adsorbed benzene present.

Experiment 1. 100 g. of gel containing 21 g. of benzene. Temperature of condenser, 20 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to air.	Distillate		
	Benzene		Water
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	None	....	None
20 minutes of steaming	17 6282	83 9	4.1755
45 minutes of steaming	0 5489	2.6	51.5
Recovery	18 177	86 5	....

Experiment 2. 100 g. of gel containing 33 5 g. of adsorbed benzene. Temperature of condenser 0 deg. C. Temperature of receiver, 0 deg. C. Receiver vented through gel.	Distillate		
	Benzene		Water
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	None	....	None
10 minutes of steaming	30 9716	92 1	6 2852
30 minutes of steaming	1.1515	3 4	54 335
Recovery	32.123	95 5	....

WATER

We have seen that silica gel, even after activation, always contains some water. The water content varies between 5 and 7 per cent by weight, depending upon the temperature and time of activation. By prolonged heating in an air stream the water content may be reduced

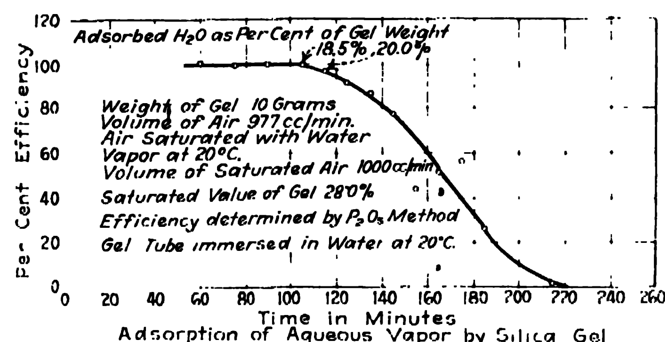


FIG. 10. ADSORPTION EFFICIENCY OF WATER VAPOR

below 5 per cent, but gel with 5 to 7 per cent gives better adsorption. For the sake of clearness in presentation we distinguish between this residual water, always present, and adsorbed water.

Fig. 9 shows the adsorption of water at 30 deg. C. from air saturated at 30 deg. C., using gel with an initial water content of 7 per cent. The air was passed through the gel at the rate of 50 c.c. per minute per gram of gel, thence over weighed phosphorus pentoxide. The increase in weight of the latter gave the water content of the air dried by the gel. For the first two hours the amount of water in the air as it left the gel tube remained constant at 0.3 mg. per liter, which corresponded to 99 per cent efficiency. In other words, the relative humidity of the air dried by gel was 1 per cent. At the end of two and a half hours the efficiency was still 98 per cent and the gel had adsorbed 21 per cent of its own weight of water. Adsorption continued till the gel had taken up an amount of water corresponding to 25.7 per cent of its own weight, which is here called the saturation value.

Figs. 9-A, 9-B, 9-C show the drying power of silica gel at 30 deg. C. using air with varying amounts of moisture ranging from 100 per cent to 26.7 per cent relative humidity at 30 deg. C.

Fig. 10 shows the adsorption of water at 20 deg. C. from air saturated at 20 deg. C., using a rate of 100 c.c.

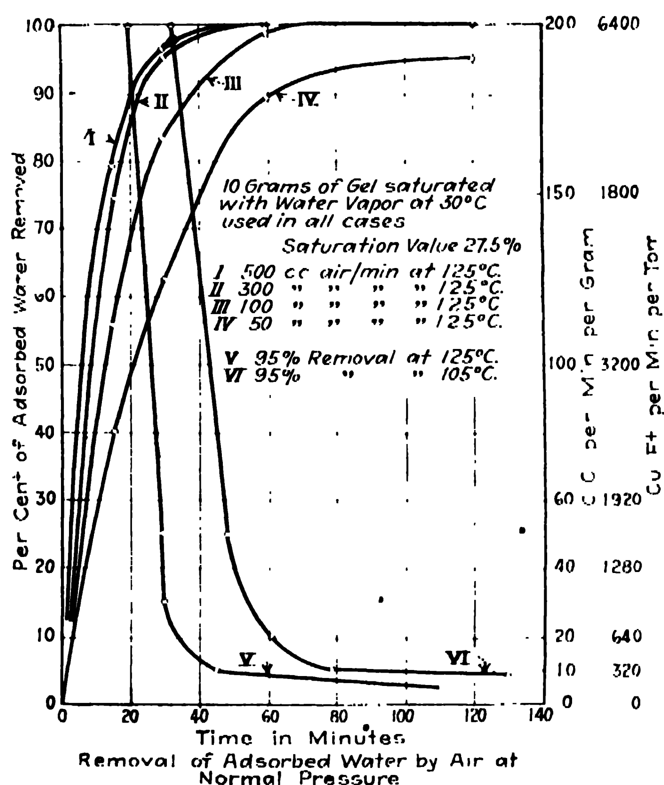


FIG. 11. REMOVAL OF WATER FROM SILICA GEL.

per minute per gram of gel. Here again we have 99 per cent efficiency for 105 minutes, at which point the gel had taken up 18.5 per cent of its own weight of water. Saturation value was 28 per cent.

Fig. 11 gives in graphic form a summary of a large number of experiments on the removal of adsorbed water by air displacement. Experiments have shown that at temperatures from 125 to 200 deg. C. the rate of removal is dependent mainly on the volume of air used, and increases only slightly with increase in temperature. We accordingly do not include here work done above 125 deg. C.

Curves I, II, III and IV show the percentages of adsorbed water removed against time for rates of air flow ranging from 5 c.c. to 50 c.c. of air per minute per gram of gel. An examination of Curves III and IV

indicates that the adsorbed water is removed about as rapidly with air at 30 c.c. per minute as with 50 c.c. per minute.

Curves V and VI show the same experimental results in which the rate of air flow is plotted against the time necessary to remove 95 per cent of the adsorbed water at 125 deg. C. and 105 deg. C. respectively. An inspection of these two curves will make clear that at these temperatures little will be gained by increasing the rate much above 20 or 30 c.c. per min. per g. of gel.

Gasoline

The results of two laboratory experiments at 25 deg. C. are given in Fig. 12. The mixtures of air and gasoline were made in the usual way. The decrease in concentration of gasoline vapor during each experiment was, of course, due to the removal of the more volatile constituents from the gasoline used to saturate the air.

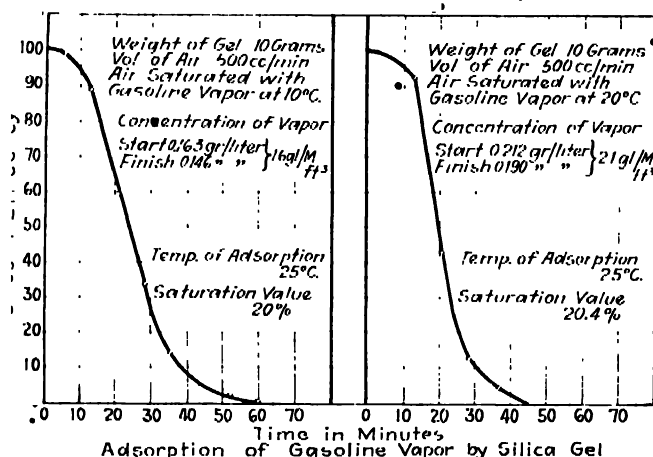


FIG. 12. ADSORPTION EFFICIENCY OF GASOLINE

In order to make the tests on recovery of gasoline as rigorous as possible we used in the experiments here described not ordinary gasoline, but petroleum ether, which contains only the lower boiling constituents of gasoline. The hydrocarbon vapors were introduced into the gel in the usual way, viz., by bubbling air repeatedly through petroleum ether at 23 to 25 deg. C. and leading the air thus saturated over the gel kept at the same temperature. For recovery the same procedure was followed as has already been described for other solvents.

Experiment 1. 100 g. of gel containing 15 g. of adsorbed material. Temperature of condenser, 20 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to the air.	Distillate: Petroleum Ether, Grams	Distillate: Petroleum Ether, Per Cent of Total	Distillate: Water, Grams
During heating to 107 deg. C.	1 1387	7 5	None
10 minutes of steaming	11.1815	74 5	3 6555
20 minutes of steaming	0 401	2.7	11 2215
Recovery	12 721	84 7	....

Experiment 2. 100 g. of gel containing 24.7 g. adsorbed material. Temperature of condenser, 0 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to air.	Distillate: Petroleum Ether, Grams	Distillate: Petroleum Ether, Per Cent of Total	Distillate: Water, Grams
During heating to 107 deg. C.	5 104	20 6	None
10 minutes of steaming	18 2625	73 9	11.329
20 minutes of steaming	None	....	......
Recovery	23 3665	94 5	......

The vent of tube absorbed 0.1018 g. of petroleum ether during distillation.

(Part III will appear in a subsequent issue.)

Legal Notes

By Wellington Gustin

Liability for Loss in Shipment Due to Leakage

The Supreme Judicial Court of Massachusetts has affirmed the judgments against the Florida Cotton Oil Co. in its suits against the Clyde S. S. Co. and the Maine Coast Co. The defendants were sued as common carriers to recover for the loss of 458 ⁴⁄₅ gal. of cottonseed oil, being part of a shipment of 100 bbl. of the oil.

The Florida company delivered to the Clyde S. S. Co. at Jacksonville, Fla., 100 bbl. of oil to be transported under a bill of lading to Machiasport, Me., for the Machiasport Packing Co. The oil arrived on Sept. 10 in Boston, where the barrels were transferred on the day of arrival to the Maine company, which forwarded the oil in two shipments, one on Sept. 12 and the other on Sept. 16, to Machiasport, where it was found there had been a loss of 458 ⁴⁄₅ gal. The oil had been received at Jacksonville in barrels which "were new six-hoop, white oak, hand-made barrels well coopered, made of well-seasoned timber and were tested" thoroughly before being used.

The Clyde company defended on the ground that when it delivered the oil to the Maine company no leakage had occurred, and under the eighth clause of the bill of lading, that "no carrier shall be liable for loss or damage not occurring on its portion of the route, nor after said property is ready for delivery to consignee, . . . it is not responsible if any loss thereafter occurred." It also contended that under the exemption clauses, that no carrier shall be liable for damages caused by leakage, chafing or loss in weight, it is not liable, because the Florida company failed to offer any negligence from which negligence can be found.

Rule of Law Well Settled

The court cited the rule laid down in another case, as follows:

"The law is well settled in this commonwealth and in most of the United States that a corporation established for the transportation of goods for hire between certain points and receiving goods directed to a more distant place is not responsible beyond the end of its own line, as a common carrier, but only as a forwarder, unless it makes a positive agreement extending its liability."

The Supreme Court said that while the shipment was an interstate shipment and under the act of Congress commonly called the Cormack amendment the initial carrier, where the shipment is by rail, or partly by rail and partly by water, is made liable for a loss upon the line of a connecting carrier even if the property had been received under a bill of lading restricting the initial carrier's liability to loss upon its own line, the transportation in the present case having been entirely by water, the initial carrier is not liable for loss on the line of a connecting carrier, except under common law rules.

The first and second provisions of the bill of lading agreed that negligence should not be presumed against the carrier, as is presumed under the common law; and further "no carrier or party in possession of all or

any of the property herein described shall be liable for any loss thereof or damages thereto by causes beyond its control . . . or by leakage, breakage, chafing, loss in weight, decay, vermin, changes in weather, heat loss or wet."

But the court held that though just and reasonable conditions may be imposed limiting the common law liability of a carrier, he cannot be relieved when the goods are lost or destroyed during carriage through his own negligence or the negligence of his servants or agents, though the contract of shipment may exonerate him in its terms. And a provision exempting the carrier from loss by leakage is reasonable.

The Florida company introduced no evidence other than leakage as the cause of the loss. Now the responsibility of the terminal carrier is the same as that of the initial carier. The Maine company took the oil under the bill of lading issued by the initial carrier, and any valid limitation therein inured to its own benefit. Since the provision against liability by leakage was valid, the Florida company to recover must prove that the leakage was caused by the active negligence of the carrier. This it failed to do, and judgment was affirmed against it.

Logan Patent for Creosoting Apparatus Held Not Infringed

The Logan patent, No. 836,592, for creosoting apparatus as limited by the prior art, has been held by the United States Circuit Court of Appeals, Ninth Circuit, not infringed in the suit brought by Logan and the National Lumber & Creosoting Co. against J. H. Baxter and W. H. Jordan.

The object of the Logan invention is to provide means for treating with preserving fluids the butt ends of poles used for telephone, telegraph, electric lights, etc., by what is known as the hot and cold process. The apparatus presents three vats, into one of which the poles to be treated are placed on end upon bars which are arranged between heating coils. Above the treating vat is a reservoir tank, from which creosote or other fluid runs by gravity through a pipe and a valve. Below the treating vat is a relief tank, into which hot fluid from the treating tank is suddenly discharged by gravity through a large pipe. In operation, as soon as the hot creosote is discharged, cold creosote is let immediately into the treating vat to complete the treatment.

The status of the prior art runs back to a patent No. 391 issued to August Gotthieff in 1837. Various patents cover every element of the Logan claim, says the court, except means for the sudden removal of hot fluid from the treating vat.

The apparatus of Baxter and Jordan is operated by heating the preserving fluid in the treating vat after the poles are inserted, afterward withdrawing the heat, the fluid remaining and being allowed to cool, the poles remaining in the single bath twenty-four hours. In view of the prior art the court says the scope of the Logan patent is limited to the apparatus described in claim 2 of his patent, that being a treating vat fitted with a small pipe to introduce fluid from a supply tank, and a large pipe to permit sudden and immediate discharge by gravity of the hot fluid into another tank, so that cold fluid may be immediately introduced into the treating tank for completing the process of impregnation. The apparatus of Baxter and Jordan has no means by which creosote may be immediately withdrawn from the treating vat into a relief tank. Their cylinder placed below the treating vat has no such office, and without adjustment it could not be so used. These differences, the court said, avoided infringement.

A decree for Baxter and Jordan was affirmed.

Chemical Company Liable for Deaths of Boys Bathing in Poisonous Abandoned Pool

The responsibility of a manufacturing plant for its vacated premises is the controversy involved in an action of Van Britt against the United Zinc & Chemical Co., decided in the United States Circuit Court of Appeals of the Eighth Circuit.

The facts involved show the chemical company owned and operated at Iola, Kan., a plant at which it manufactured sulphuric acid and zinc spelter. In 1910 it tore down the buildings on the premises, moved the machinery and wreckage away, and since then has not occupied or used the land for any purpose. There was a basement containing acid tanks with lead pipes in and out under what was known as the tower building, and when it was torn down chemical refuse was thrown into the open basement. As the tanks and pipes were taken out some sulphuric acid got into the basement. Other chemical refuse was left about on the surface, and the old basement later became a pool of clear water from surface drainage, strongly impregnated with sulphuric acid and zinc sulphate. The vacant property covers about twenty acres and is located on the outskirts of the town.

In 1916 Van Britt and family were traveling overland and camped for a few days not far from the pool. His two boys, eight and eleven years old, in passing it one afternoon, responded to boyish impulses and went in bathing. A short time after going in the younger was dead in the pool, the older was taken out, removed to a hospital and died two days later "from swelling of the bronchial tubes, and gastro-intestinal irritation, irritation of the stomach and bowels, which produced an inflammation of the bowels and stomach." He had colicky pains, vomiting and gasping for breath. Both deaths were attributed by experts to the poisonous chemicals in the water which had been taken internally. The water, when so taken, caused an immediate burning in the throat and choking; and applied outwardly it caused itching and slight sense of burning.

Van Britt brought action for damages against the chemical company, charging that it carelessly and negligently left the pool of poisonous water open and exposed, and without inclosure, barrier, danger signals or warnings of any kind about it, that it maintained the poisonous pool and failed to fill it up.

The general principle of law is that no one may use his property to the injury of another. The court says there is a conflict in the decisions as to the extent and under what conditions this rule may be carried against one as a basis for liability on account of injuries to children resulting from dangerous attractions which he places upon or suffers to continue on his premises. The application is made more freely where the thing complained of is put to no useful, ornamental or other purpose of enjoyment.

Where the inclosure around a tract of land formerly used, for manufacturing purposes had fallen away, so that the public were free to go at will and had made footpaths across it, if a pool of water impregnated with poisonous chemicals was attractive to boyish instincts and impulses as a place to go in bathing, and boys yielding to such impulses were killed by the poisons, it was immaterial whether the boys saw or could see

the pool before they entered upon the tract, said the court. The law does not class children of tender years with idlers, licensees or trespassers upon the property.

Further it was said that where a manufacturing plant had been abandoned and dismantled, and the inclosure had fallen away, so that the public crossed the premises at will, the law imputed knowledge and consent to such use to the owner. And where boys, who responded to the desire to go bathing, were killed by the poisonous chemicals, the owner's liability and amount of damage were questions of fact for the jury.

In another case the court said: "The occupant or owner of premises who invites, either expressly or impliedly, others to come upon them, owes to them the duty of using reasonable and ordinary diligence to the end that they be not necessarily or unreasonably exposed to danger; and an implied invitation to another to enter upon or occupy premises arises from the conduct of the parties, and from the owner's knowledge, actual or imputed, that the general use of his premises has given rise to the belief on the part of the users thereof that he consents thereto."

Judgment against the chemical company for the wrongful deaths was affirmed in the Court of Appeals.

Bills of Lading Construed in Light of Contemplated Adventure

In a suit by W. R. Grace & Co. against Frank Waterhouse & Co. to recover damages for injury to goods caused by the delay in transportation thereof from Hongkong to San Francisco, the United States Circuit Court of Appeals has affirmed the lower court's judgment in dismissing the suit, and holding that bills of lading are to be construed in the light of the nature and details of the adventure which was contemplated by the parties.

The merchandise involved was carried by the steamship from Hongkong to Seattle and there discharged and placed in a warehouse. It was delayed there two months by a stevedores' strike, and when forwarded by the Waterhouse company to its destination at San Francisco it was found damaged as a result of the delay in Seattle.

The court said that facts and oral evidence were admissible to explain ambiguity and to show the circumstances of the execution of the contract. Facts which were not inconsistent with the terms of the bill of lading might be adverted to to make clear what was not clear in the contract.

Again, a steamship bill of lading, providing for carriage of the products to the port of San Francisco and for delivery "there" to order, or at the vessel's tackles to another carrier on the route to destination, if consigned beyond a port of call, and by the connecting carrier to be transported into the port of San Francisco, did not restrict delivery to another carrier to such delivery at San Francisco, but, where San Francisco was not a port of call, authorized such delivery at another port.

And a steamship bill of lading providing for carriage to the port of San Francisco, to be there delivered unto order or at the vessel's tackles to another carrier, and referring to a condition on the back thereof which provided that the goods might be transshipped at any port, and for that purpose might be stored in bulk or craft, or landed, authorized the landing of the goods at Seattle for the purpose of transshipment to San Francisco, which was not a port of call.

Weir Measurement of Liquids

By L. G. Chase

THERE are many reasons for close and accurate measurement of all the elements entering into the manufacture of various products under present-day conditions. While production costs are at present decreasing somewhat in certain fields, there is little chance of great reductions for years to come. In modern industrial plants, with their complex departmental systems of supply from one central source or stockroom, it is necessary, to secure accurate records of production costs, that the amount of liquids used in the various processes be carefully measured. These liquids are usually handled in such quantities that it is not possible actually to weigh them and due to their corrosive and chemical action in most cases they cannot be measured by any ordinary type of meter.

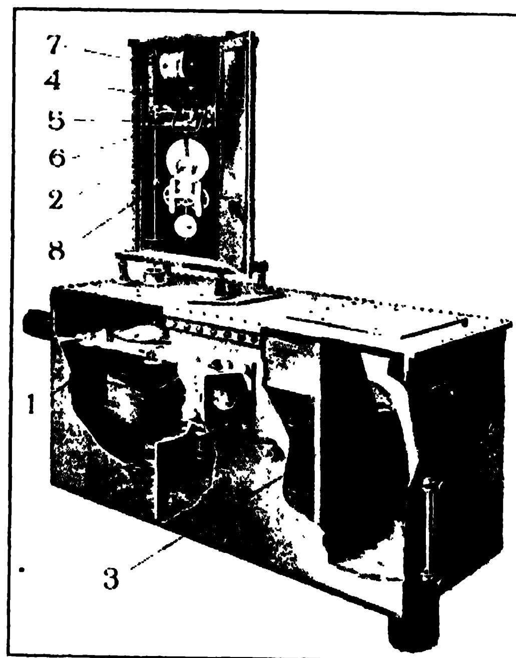


FIG. 1. GRAVITY FLOW METER

Operation: Float 1 raises or lowers rackrod 2, indicating on scale 4 height of liquid flowing over V-notch 3. Drum 5 connected by pinion 6 with rackrod 2 indicates rate of flow at any moment in pounds or gallons per hour. Twenty-four-hour chart 7 records flows graphically. Cumulative readings are shown by integrator 8.

For instance, meters which involve the principle of measuring the velocity of the liquid flowing in closed lines cannot be used at all in most cases, because they depend on a mercury valve to compensate for the differential or velocity head. Most chemicals would combine with this mercury in some form or the working parts of the mechanism coming in contact with the liquid could not be made of such material as would withstand the chemical action. Displacement meters would come under this same head. There is left for us, then, only the weir type of meter. This particular type has one disadvantage—it can be used only where gravity flow conditions are possible, but such a condition can usually be arranged for in services such as those contemplated.

V-Notch Type Weir

The weir type meter exists in many forms, but the V-notch type has been found to be the best adapted for accurate measurements of the relatively small volumes which would obtain. The formula of the V-notch was

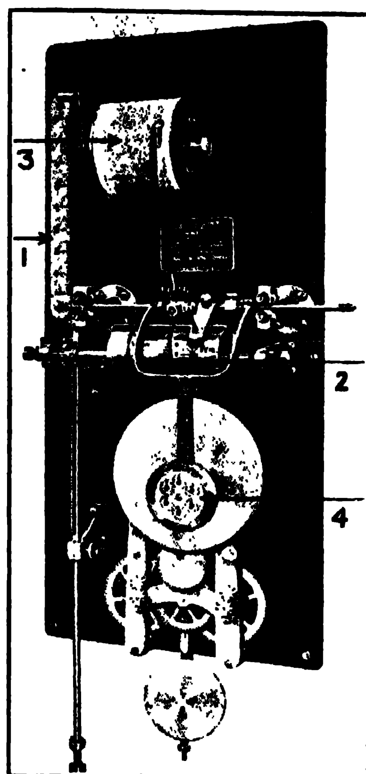


FIG. LEA RECORDER

1. Measuring the height of water flowing over the weir. 2. Cam drum giving instantaneous indications of the rate of flow. 3. Graphic recorder. 4. Integrator.

derived by Prof. James Thompson about sixty years ago. Recent exhaustive experiments have served only to prove his high engineering ability and the extreme accuracy with which he worked. The formula he derived is as follows: Q, the quantity of liquid in cubic feet per minute, equals $0.305H^{5/2}$ where H is the height in inches of the liquid passing over a right-angled V-notch. This formula is also true for a notch of any angle less than a right angle in direct proportion to the area. In the ordinary weir the constant used varies as to whether there are any contractions or not and also varies due to the friction of the water passing over the bottom of the notch. It has been found for the V-notch that the resulting friction forces are the same proportionately for any height over the notch, and therefore a fixed constant can be used. This is the constant which Thompson determined. Of course, the flow of liquid over any gravity weir is proportional to the area times the velocity times a constant. The area of a right-angled notch is equal to the square of the height. The velocity is of course equal to the square root of $2GH$ where H is the height. The square root of $2G$ can be combined with the constant due to any contractions, and we therefore have the foundation of the formula, the quantity equals a constant times H^2 into the square root of H, or a constant times $H^{5/2}$.

With the weir or V-notch type meter, it is possible to have all parts in actual contact with the liquid made out of materials which are not subject to chemical action. For instance, in the measurement of sulphuric acid, a wooden measuring tank can be provided with a sheet lead lining and the float rod and notch plate can be made of glass. For the measurement of caustic liquors, steel can be used throughout. If it is desired to measure milk or substances of like nature, which require extreme cleanliness, measuring tanks, notch plates and

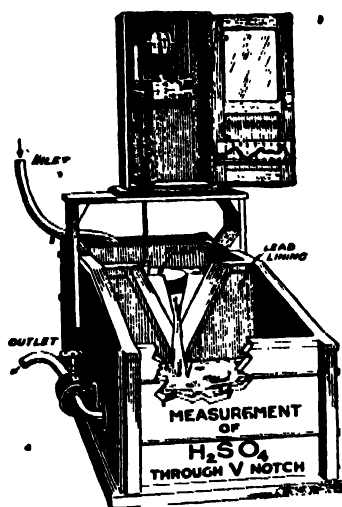


FIG. 4. SULPHURIC ACID METER

all other elements in contact with the liquid can be tinned. Monel is also largely used in making parts to resist the action of various chemicals.

THE LEA RECORDER

We will now briefly describe a commercial type of V-notch meter to show its simplicity and adaptability for this service. Fig. 1 shows the standard type of gravity flow meter for the measurement of any liquid not corrosive to steel. The various parts of the instrument and their uses are briefly described in connection with this cut. The recording mechanism, which is shown in Fig. 2, furnishes four kinds of information: First, the height in inches of water flowing over the weir. Second, it gives instantaneous indication of the rate of flow. This is suitably inscribed on the cam drum, cut of which is shown in Fig. 3. Third, a graphic paper record is given in pounds or gallons of liquid during any part of a 24-hr. period. Fourth, the integrator shows the total volume flowing between two different readings. In order to check the accuracy of the machine at any instant, it is necessary only to ascertain the height of the liquid actually passing over the notch, from the scale. Knowing this height, it is a simple operation to work out the formula as determined by Prof. Thompson and check the results as shown by the recorder. The cam

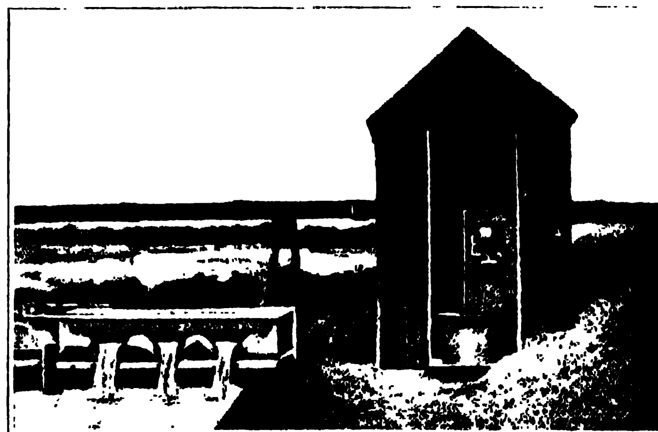


FIG 5 GAGE HOUSE FOR BLEACHERY

drum, shown in Fig. 3, has suitably inscribed on it the curve of flow worked out from the 5/2 power of the head, so that the chart is uniformly divided and equal increments of pen movement on the paper record actual values in volume. This permits the use of any standard type of planimeter in checking the charts.

The integrating device shown in Fig. 2 is driven by a powerful double-spring Seth Thomas pendulum clock. The aluminum disk on which the integrator friction wheel rides is driven by this clock at a speed of two revolutions per hour. The disk is 6 in. in diameter. The integrator and planimetered reading of the chart can be checked within [illegible] of 1 per cent.

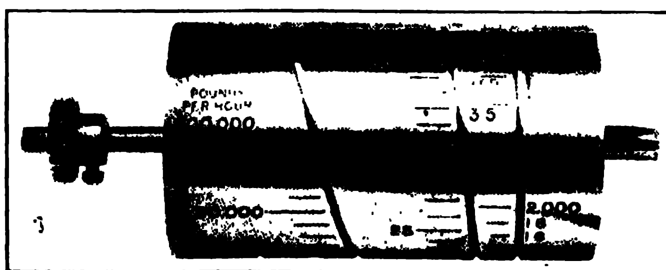


FIG. 3. CAM DRUM

Fig. 4 shows an instrument specially designed for the measurement of sulphuric acid and Fig. 5 an outfit of this kind applied to the measurement of trade waste from a bleachery.

A recording thermometer can be attached to these instruments in such a way that a continuous record can be made of both the quantity and the temperature of the liquid on one chart.

Special propositions, of course, can be worked out for special cases. Measurement of such liquids as sulphuric acid, caustic solution, pyroligneous acid, cyanide, coconut oil, etc., is handled successfully in actual practice.

Philadelphia, Pa.

Repairing Lips and Bottoms of Steel Ladles

Owing to the nature of the smelting process followed at the Nickelton, Ont., plant of the British American Nickel Corporation, the slag obtained sometimes runs high in matte, the action of which is very destructive to steel ladles, tending to wash away the steel at the point of contact and injure the vessel beyond further practical usefulness.

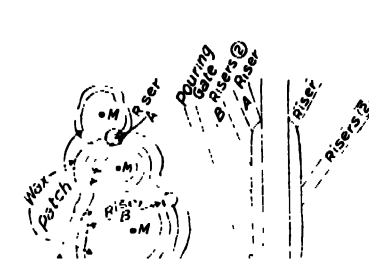
The company has recently been getting economical reclamation by means of thermit welding. The accompanying illustrations and sketches give an idea as to the work done. Pieces of steel were forged and welded to the kettle rather than completely filling up the burnt areas with thermit steel. By this method undue contraction strains were minimized.

In the case of the kettle with the holes in the bottom three forged steel patches and two thermit applications were made as shown in Figs. 1 and 2, owing to the irregularity of the holes and the facility of making two welds easier than one irregular patch. The welding of the bottom was spread over two operations, owing to the fact that there was insufficient material on hand to complete the job the first time. In lining up the patches approximately 1 in. was provided at the edges for the entrance later of thermit steel. These patches were surrounded by a yellow wax pattern and the usual thermit welding practice was then followed.

In arranging riser patterns these patterns were used both inside and outside, one coming off at the high point and two others placed about half way down on the wax. The latter two served to take care of the shrinkage of metal when the weld started to cool.

In the case of welds made on the sides of ladles or kettles (Fig. 3) care must be taken not to put too much stock in the collar of the weld, otherwise there would be a tendency to retard the cleaning or "skulling" of the kettle. In applying the wax collar the wax should be from ⅛ in. to $\frac{3}{16}$ in. fuller than finished shape in order to allow for shrinkage during contraction.

In forging the lip patch the blacksmiths followed the



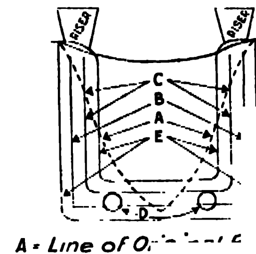


FIG. 2. METHOD OF WELDING KETTLE BOTTOM

New Trenching Machine

Construction companies or plant managers contemplating new plants or additions to present properties will note with interest the new multipedal trencher of the Austin Machinery Corporation of Chicago shown herewith. This machine is designed after the fashion of military tractors to operate through heavy friction clutches on each side, to turn practically within its own radius and to be operated by one man. It is particularly applicable to plant work where new pipe lines are being run underground.

A crew hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This hoist also acts effectively, because of its construction, as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut.

A cleaning device takes care of the sticky dirt and scrapes out each bucket as it passes a point at the head of the excavator boom, directly over the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine.

The gasoline engine is of four cyl. four cycle type, cooled by an inclosed radiator.

The digging width, with 18-in. buckets, will run from 20 in. to 28½ in. and with 24-in. buckets from 26½ in. to 29 in. The standard boom will dig up to 6 ft. in depth, although the machine is substantial for service with an extensive equipment for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each one of these multipedal tractions is driven independently by a friction clutch, so that in turning in a confined space one may be stopped while the other is going ahead, turning the machine practically within its own length.



FIG. 1. PATCHES IN PLACE BEFORE APPLICATION OF WAX COLLAR

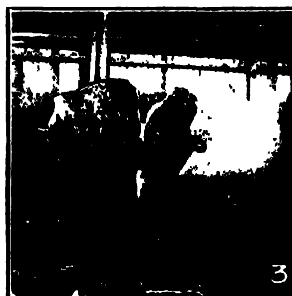


FIG. 3. SHOWING THE LIP BURNT AWAY BY HOT MATTE

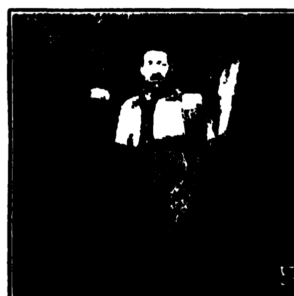
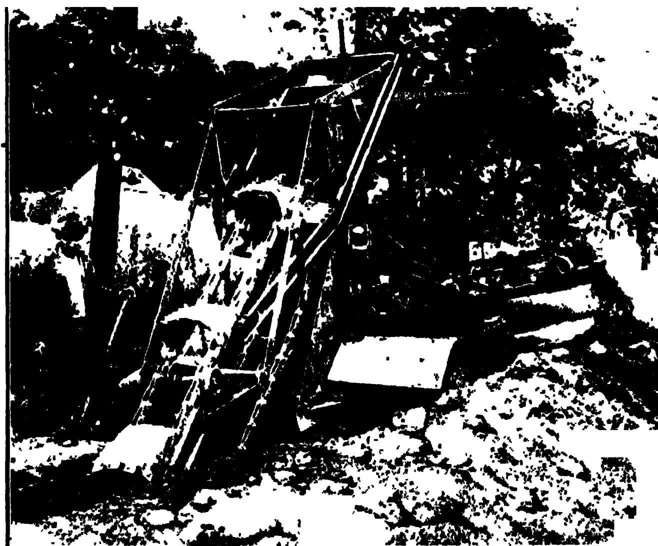


FIG. 5. WELDED LIP BEFORE REMOVING RISERS AND POURING GATE



MULTIPEDAL TRENCHING MACHINE

The conveyor belt is reversible, so that it can deliver dirt on either side. Adjustable screws are provided for taking up the slack.

An important feature of the working performances is its easy interchangeability for digging trenches with vertical banks or small ditches with sloping sides.

Synopsis of Recent Chemical & Metallurgical Literature

Unknown Points in Rail Manufacture.—C. W. GENNET, JR., of the firm of Robert W. Hunt Co., read an interesting paper before the Western Society of Engineers, Chicago, Nov. 18, 1920, in which he asked the following pertinent questions, which must sooner or later be answered, most probably in large part by metallurgists—that is to say, men interested in quality in metal:

1. Are rails made of steel by the continuous Talbot furnace process comparable with those made by the straight open-hearth method? In the continuous process the furnace is seldom emptied by a hundred tons or so of steel and is tapped every two hours, as against the ten hours of time required to make an equivalent heat in a regular furnace. Is the steel from the rapid-working Talbot furnace sufficiently free from oxides and other impurities to afford good, sound rails?

2. How can such a matter be quickly proved?

3. What effect, if any, on rails has steel made by the duplex process, wherein highly oxidized metal is added to the open-hearth furnace, sometimes very soon before tapping?

4. How can rails rolled from steel containing excessive amounts of impurities be detected?

5. What effect on rails is produced by recarburizing the steel in the ladle with coal or coke and then adding cold deoxidizers to the ladle?

6. What is the real effect produced by holding a ladle of steel prior to casting the ingots to permit time for the chemical reactions to settle?

7. What is the effect on rails rolled from ingots cast with running stoppers and sometimes without any control by the ladle operator? How does the size of the nozzle, pouring temperatures and time required to cast the ingots of a heat influence rails?

8. How soon after casting ingots should they be charged into the soaking pits in order to assure a minimum of piping and segregation? What effects are produced by delays in promptly charging the ingots to the pits, and what is the effect of unduly and rapidly chilling the outside or skin of the ingots?

9. How long a time and under what conditions of gas and air regulation should ingots remain in the soaking pits? What kind of control of the pits is best to insure against overheating or burning the ingots?

10. What is the effect of rolling rails from ingots one side of which has been heated so hot as to show a bright white spot significant of overheating?

11. What effect on rails have different rates of blooming the ingots? In some cases 8 x 8-in. blooms are made from ingots in nine passes and in other cases in twenty passes. Some mills work rapidly and others slowly; does this produce any difference?

12. What effect on the grain structure or the life of rails is produced by increasing the number of passes, or work given to the steel, when the ingots are rolled into rails? One mill makes a rail from a 19-in. square ingot in fifteen passes, while another mill makes the same rail from a 24-in. square ingot in twenty-nine passes. Has the average rate of reduction per pass any effect on the life of rails?

13. What matters mostly influence the production of rails showing seams on the surface? Some heats are practically free from indications of seams, while on other heats rolled at the same time seams are abundant.

Photography of Colored and Distant Objects.—In his first address as president to the London Section of the Society of Chemical Industry, Sir WILLIAM J. POPE discussed the photography of colored and distant objects. His address is printed in full in the Nov. 15 issue of the society's journal. In demonstrating the value of a spectroscopically pure red filter between the lens and a distant object to bring out greater detail, he availed himself of a familiar phenomenon with happy facility.

"The atmosphere," he said, "is not penetrated with equal facility by light of all colors or of all wave lengths. The rays of short wave length, the blue and violet, are most readily absorbed and diffused by the air, and, in passing from short to longer wave lengths, through the green and yellow to the red, the absorptive and diffusing effect of the atmosphere becomes progressively less and less.

"A simple demonstration of the truth of this statement is presented to us every day. When the sun is high it appears white or bluish-white, and its outline is sharp; but as the sun declines it appears yellow and loses its sharpness of definition. Just before the sun falls below the horizon it is bright red and shows a hazy outline. So that with perpendicular incidence the sun's light reaches us with but little absorption of the blue rays by the short lengths of atmosphere through which it has to pass. As the sun declines the blue is absorbed by the longer stretch of air, and just at the setting the atmospheric path through which the sun's rays reach us is so long that the blue, green and yellow are absorbed and diffused and nothing reaches us but the red light. The same thing happens in a fog; if the fog is slight the sun appears yellow and not sharply

defined, but if the fog is dense the sun shows red, and its circle is very indistinctly defined.

"These facts, based upon common observations, have a very important bearing. If a distant view is photographed on an ordinary plate sensitive only to the blue and violet, absorption and diffusion of the light are considerable; the resulting photograph is thus more or less ill-defined. But since the atmosphere is penetrated to a far greater extent by the red rays, it follows that if a spectroscopically pure red filter is placed between the lens and the object, the resulting photograph will reveal far more detail."

Intercrystalline Fracture in Mild Steel. – WALTER ROSENHAIN and D. HANSON, of the National Physical Laboratory, presented a brief note on the above subject before the British Iron and Steel Institute, Sept. 21, 1920. Investigations of several hundred fractures in mild steel convince them that fracture (except at very high temperatures) is by breakage across the ferrite crystals rather than between them. They now describe four noteworthy failures which are mainly intercrystalline, three from high-pressure steam boilers, and one from a tube in intermittent service in hot niter.

Case I (0.14 C) was from the combustion chamber of a marine boiler, showing severe cracking at the edges between rivet-holes, associated with low elestic limit, elongation and impact. The cementite was collected in thin layers at the boundaries of ferrite crystals. Normal results were obtained in all tests from the central part of the plate.

Case II (a boiler drum) cracked around the edges, starting from rivet-holes. Physical properties, edge to center, were little different, and the microstructure showed only part of the cementite as intercrystalline films; yet the cracks seemed to be most numerous in those portions of the plate containing the most free cementite.

Case III. Cracks in all plates, but especially the outside cover, in a boiler seam. Physical and microscopic tests revealed no abnormality. Sheared rivets (almost carbon-free) from the same joint also showed intercrystalline cracking. A piece of the sound plate was torn apart, but this fracture went across the grains— intercrystalline weakness appears to be associated with stresses operating for a period of years rather than minutes.

Case IV developed in mild steel tubing after six months' intermittent service without working stress in a niter bath at 300 deg. C. These cracks were badly corroded. Microstructure exhibited globular cementite, often noted in cold-drawn steel tubing annealed several times below the critical range.

This last failure is similar to season cracking, since only internal stresses are in operation. The three failures in boiler plates can hardly be ascribed to stresses set up during bending; forcing a fit seems a more likely source of serious internal stresses. All cases occurred after long-continued heating a prerequisite for this type of failure in steel as far as present information goes. Corrosion is a subsidiary cause and an accelerator, selectively attacking the intercrystalline cement and therefore weakening cohesion. Proper normalization of structure by proper heat-treatment does not seem to prevent intercrystalline failure, since Case III showed no microscopic abnormality, other than a banded arrangement of the pearlitic areas—if this can be regarded as an abnormality.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Utilizing Vegetable Refuse.—Refuse from fruit and vegetables, such as pea and bean pods, banana skins, and especially asparagus waste, is treated to obtain fibers suitable for spinning, food or flavoring material, and manure. The waste is crushed with water between rollers and then placed, with the extracted juice and water sufficient to cover it, in an autoclave, where it is heated under pressure for between two and three hours. The fibers are then strained free from the juice and again passed between rollers. They can then be dried and used for coarse weaving, ropes, etc., or they may be boiled with an alkali for two or three hours, washed, pressed and dried, when they are suitable for finer fabrics. The solid residue can be used for manure, either as it is, or after drying and neutralizing the alkali. The liquor is evaporated to any desired consistency, or to dryness, and can be used for making vegetable-soup cubes, seasonings, sauces and the like. (Br. Pat. 147,833, not yet accepted; W. MATZKA, Brunswick, Germany, Oct. 13, 1920.)

Aluminum Alloys.—Aluminum is alloyed with lithium, which may be partly or wholly replaced by barium or strontium, with or without the addition of other metals such as copper, zinc, manganese, tin, etc. The alloy may contain up to 40 per cent of lithium, and may be annealed one or more times by heating to over 100 deg. C. and cooling in air or liquid, or otherwise. (Br. Pat. 147,903, not yet accepted; METALLBANK UND METALLURGISCHE GES., Frankfurt-on-Main, Oct. 13, 1920.)

Molding Cellulose Acetate.—Relates to the production of molded articles from cellulose acetate and consists in subjecting the material in a finely divided state, preferably in the presence of very small amounts of low-boiling or volatile substances, to a high pressure at a temperature approaching the decomposition point and allowing to cool under pressure. The operation may be carried out at a lower temperature and pressure by adding 2 to 5 per cent of water, alcohol, etc., or solid substances such as naphthalene or camphor. Preferably the material obtained by a first pressure is disintegrated and subjected to a second pressing operation. In this case, the cooling under pressure may be omitted by providing the mold with channels, nozzles or slots of small diameter, through which the hot material is forced under pressure in the form of filaments or ribbons. The disintegrated material may be mixed with large quantities of mineral powders—e.g., two to five times the amount of cellulose acetate—before applying the final pressure. The material may be molded with inlays of wood, ebonite, etc. (Br. Pat. 147,904, not yet accepted; CELLON-WERKE A. EICHENGRUN, Berlin, Oct. 13, 1920.)

Fatty Acids.—The unsaturated aliphatic hydrocarbons contained in mineral oils or the liquid or gaseous products of their distillation or cracking, in natural

gas, in the liquid or gaseous products of the destructive distillation of coal, wood, peat, shale, shale oils or tar oils, or in carburetted water-gas, oil-gas, water-gas tar, oil-gas tar, lignite tar, producer gas, coal-gas, etc., are converted into fatty acids by first treating the gases, oils, etc., with mineral acids (sulphuric, hydrochloric, etc.) whereby the unsaturated hydrocarbons are converted into esters, and then treating these esters with oxidizing agents. For example, the acid sludge or acid resins obtained in refining mineral oils with sulphuric acid are treated with potassium bichromate and sulphuric acid. Volatile fatty acids formed are distilled off with steam, and the non-volatile fatty acids remaining are freed from chromium oxide by boiling with dilute acid and may be converted into soaps by alkali. Acid anhydrides may be formed in the oxidation process, these also being converted into soaps by alkali. The more volatile acids (butyric, valeric, etc.) may be converted into esters for use in perfumery. (Br. Pat. 147,905, not yet accepted; H. STRACHE, Vienna, Oct. 13, 1920.)

Ethylene Chloride.—The ethylene content of coal-gas, or other gases produced by the distillation of carbonaceous matter, such as lignite, oils, etc., is utilized for the production of ethylene chloride by treating the gases with chlorine in the presence of a suitable catalyst, and separating the ethylene chloride from the treated gas by liquefaction by compressing, cooling, etc. (Br. Pat. 147,909, not yet accepted; GOLDSCHMIDT AKT. GES., Essen, and F. BERGIUS, Berlin, Oct. 13, 1920.)

Cuprous Oxide.—Cuprous oxide is obtained by blowing air through liquid refined copper until the desired stage of oxidation is effected. The cooled material may be ground; it is suitable for the production of copper salts and cuprammonia solutions. (Br. Pat. 147,958—1919; HÜTTENWERK NIEDERSCHÖNEWEIDE AKT. GES. VORM. J. F. GINSBERG, Berlin, Oct. 13, 1920.)

Catalysts for Hydrogenating Fats and Oils.—Non-pyrophoric metal catalysts adapted for use in the hydrogenation of fats and oils are prepared by precipitating a solution of a salt of a catalytic metal with a solution containing a usual precipitant such as soda or caustic alkali, together with borax, and then reducing the precipitate in a current of hydrogen. In examples, a solution of nickel chloride is precipitated with a solution containing soda and borax so as to give a precipitate of nickel carbonate and borate; which is afterward dried, heated to decompose the carbonate and then reduced in hydrogen; a solution of protoxide of nickel dissolved in hydrochloric acid is mixed with kieselguhr, and precipitated with a solution containing soda and borax, and the precipitate then reduced as usual: a cobalt salt solution is mixed with kieselguhr and precipitated with a solution containing a usual precipitating agent and borax, and the precipitate is washed; dried and reduced in hydrogen. (Br. Pat. 148,111, not yet accepted; MULLER SPEISEFELTFABRIK AKT. GES., Neukolln, near Berlin, Oct. 13, 1920.)

Extracting Alkali-Metals.—Alkali-metals are obtained by heating a halogen salt of the metal with an alkaline-earth compound such as a carbide, hydride or silicide. For example, a mixture of sodium chloride and calcium carbide may be heated in a vacuum first to 350 deg. C. and afterward to 800 deg. C., whereupon sodium distils to the colder parts of the apparatus. A high-quality lampblack is formed as a byproduct. (Br. Pat. 148,122, not yet accepted; L. HACKSPILL and C. STAEHLING, Institut de Chimie, Strasbourg, Oct. 13, 1920.)

Wood Preservative.—Mercuric chloride solution is rendered more effective as a wood preservative by mixing with it a solution of a fluorine salt such as sodium fluoride, a fluosilicate or a mixture of fluorine compounds with fluosilicates. The specification states that the mercuric chloride is converted into complex salts. The salt solutions may be applied separately to the wood. (Br. Pat. 148,137, not yet accepted; F. BUB, Petershagen, near Berlin, Oct. 13, 1920.)

Synthetic Tanning Agents.—Synthetic tanning agents are prepared by sulphonating the alkali-soluble fractions of anthracene oil or soft pitch, and condensing the sulphonic acids with aromatic sulphochlorides in alkaline solution. According to an example, the parent substance is sulphonated with sulphuric acid monohydrate, the product dissolved in water and neutralized with caustic soda, sodium sulphate is removed by evaporation, and the concentrated solution is mixed with caustic soda and treated with toluene sulphochloride in benzene solution. (Br. Pat. 148,268, not yet accepted; M. MELAMID, Freiburg, Breslau, Oct. 20, 1920.)

Anthraquinone Derivatives.—A vat dye, giving claret-red shades, is obtained by condensing hydrozine or a salt thereof with 1-amino-anthraquinone-2-aldehyde or the azomethine compounds thereof. The parent azomethine compounds are obtained by heating 1-amino-2-methylanthraquinone with aromatic nitro compounds and alkalis, with or without the addition of primary aromatic amines; 1-aminoathraquinone-2-aldehyde results on hydrolyzing these azomethine compounds by acids. (Br. Pat. 148,339, not yet accepted; L. CASSELLA GES., Frankfurt-on-Main, Oct. 20, 1920.)

Vulcanizing India Rubber.—India rubber is vulcanized in an atmosphere of volatile alkali at atmospheric pressure. The alkali may be ammonia or a volatile organic alkali, and it may be diluted with an inert or reducing gas or a mixture of these, such as hydrosulphuric acid and carbonic acid. The addition of litharge is thus rendered unnecessary, and the color of mixings preserved. The temperature of vulcanization may be about 145 deg. C. (Br. Pat. 148,349, not yet accepted; E. TILCHE, Paris. See also 148,350, Oct. 20, 1920.)

Obtaining Liquid Products From Coal.—In obtaining liquid products from coal by hydrogenation under pressure coal is used which contains not more than 85 per cent of carbon referred to dry substance free from ash. In an example 5 kilos of coal having a carbon content of 74.48 per cent on the above basis was mixed with 10 kilos tar oil and heated for six hours under a pressure of 100 atm. of hydrogen; 87 per cent of the coal was converted into liquid products, as against 11 per cent of a coal with a carbon content of 92.1 per cent similarly treated. (Br. Pat. 148,436, not yet accepted; F. BERGIUS, Berlin, Oct. 20, 1920.)

Ferrochromium—Ferrochromium, low in carbon or in carbon and silicon, is made by transferring molten high-carbon ferrochromium from a blast furnace into a converter, which may be acid-lined, and blowing therein with or without the addition of lime or other basic materials, or the injection of steam or other gas or vapor into the blast. (Br. Pat. 148,456, not yet accepted; F. KRUPP AKT. GES., Essen, Oct. 20, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Isopropyl Alcohol From Petroleum

A meeting of unusual interest was held by the New Jersey Chemical Society at Stetters' Restaurant, Newark, Monday evening, Dec. 13. C. L. Bryden, chairman of the committee on membership, reported twenty-seven new applicants. These were duly elected, bringing the membership to a total of nearly 550. A petition to Congress urging immediate action on the dye bill was drawn up and Williams Haynes, publisher of *Drug and Chemical Markets*, was called upon to discuss the status of the bill. In pointing out the danger of Germany dumping dyes in this country he called attention to the situation in regard to potassium bromide. The pre-war price of this chemical was 30c. per lb. American-made bromide is now being sold for 45c. per lb., but the Germans are offering it at 20c. for spot, with future delivery as low as 15c.

Artistic Painting

Maximilian Toch delivered an entertaining and instructive address on pigments and paints used in ancient and modern artistic painting, including a discussion of the methods used in determining the genuineness of an old painting.

Institute of Chemistry Proposed

A report of the committee on an Institute of Chemistry was read by the chairman, who said that the tentative plan had been prepared in order to get opinions from all interested. The matter had been brought to the attention of several, but the publication of the report would reach a much larger number. The ideas of the committee were open to changes and suggestions, considerable interest had been shown, and it seemed best to set forth a definite scheme, which would be a basis for a further report.

In answer to several questions the chairman said that there seemed to be no one of the ten or more professional societies which either could or would undertake this matter, but that an offer to do so would be welcome. One very definite suggestion has already been made, that the project for the State of New Jersey be undertaken by the New Jersey Chemical Society. As far as the list making, which was the first step, was concerned, this was already under way; the next step, that of registration, would be considered by the committee. The further suggestion that probable vacancies in the chemical industries be reported to the Society, which would then bring them to the attention of unemployed members, would also be considered.

The report of the committee follows, and the views of all who are interested will be welcome:

At the October meeting of the New Jersey Chemical Society a paper was read which pointed out the need of a closer affiliation among chemists, and it was resolved that a committee be appointed to take action to ascertain if it is advisable to form an American Institute of Chemistry.

Such an organization could:

1. LIST, on request, and without charge: (*a*) all persons who wished to be considered chemists, in any sense of the word; (*b*) all chemical products; (*c*) all chemical industries, these lists to be public.

2. REGISTER any chemist who would furnish a certain amount of definite, accurate information as to education and experience, such information and all other pertinent facts to be subject to independent investigation and to be available to inquirers under reasonable regulations. For registration a moderate fee would be charged.

3. CERTIFY chemists of various kinds of chemical education and experience after the candidate had passed a definite examination suited to the grade of certificate desired. For these examinations reasonble fees would be charged.

4. LEGALIZE the practice of chemistry in its various grades, by securing the proper legislation in national and state legislatures.

5. CO-OPERATE with all institutions training chemists in order to harmonize courses of instruction, and with institutions and chemical societies to interest employers in properly trained chemists, without, however, acting as an employment agency.

Such an Institute of Chemistry would, in the first instance, consist of a self-perpetuating body of, say, fifty chemists, nominated by the existing chemical organizations, with the understanding that after five years one-half the vacancies would be filled from the certified chemists, after ten years all vacancies would be so filled.

We would be glad to have your definite opinion upon the following:

Should an Institute of Chemistry be established?
If so:
Should it function as outlined?
What else, if anything, should it do?
Should it be constituted as outlined?
How should it be financed?
If not, should anything be done?
If so, what?

Replies should be addressed to F. D. Crane, 74 N Willow St., Montclair, N. J.

Isopropyl Alcohol From Petroleum

Carleton Ellis, president of the Society, was introduced by Dr. R. P. Calvert, who took this opportunity to tell the members of Mr. Ellis' work on paint and varnish removers, hydrogenation of oils, recovery of potash from silicate rocks, and the preparation of cumarone resins, which are so extensively used in chewing gum manufacture. Mr. Ellis spoke on the development of his process for producing isopropyl and other alcohols from petroleum.

To make petroleum the raw material for a series of chemical products has been the aim of scores of research chemists. Chlorine has been the reagent employed in many cases to attack members of the paraffine series. Thus, chlorpentane serves as an intermediate for the production of amyl alcohol by saponification, or for the production of amyl acetate by treating with sodium acetate in an autoclave. One of the difficulties has been to limit chlorination to the desired compound.

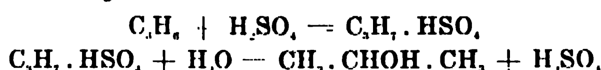
In the manufacture of gasoline by cracking processes many unsaturated compounds are formed and the gases which escape from the pressure stills are found to contain 2 to 3 per cent ethylene, about 5 per cent propylene, and 1 per cent of higher olefines, such as butylene, amylene, hexylene and heptylene. About 1 per cent of H_2S is usually present, although this may be higher when Mexican oils are being treated. Ordinarily these gases are simply used as fuel. One refinery produces over 10,000,000 cu.ft. per day, containing 10 to 12 per cent olefines.

Research on the utilization of the olefine content of these gases was started in the hope of finding a fusel oil substitute. After much experimentation it was

found that isopropyl alcohol could be obtained. An organization, the Melco Chemical Co., was formed for development work and a small plant was built near the Bayonne plant of the Tide Water Oil Co., which furnished the gases from its pressure stills. Later the Standard Oil Co. of New Jersey secured the rights to the process and is now producing isopropyl alcohol under the name of petrohol at its Bay Way refinery. M. D. Mann, Jr., of the company's chemical products division, is in charge.

Manufacture of Isopropyl Alcohol

The process depends upon the reaction between propylene and sulphuric acid to form propyl hydrogen sulphate, which hydrolyzes upon boiling the diluted solution, yielding isopropyl alcohol:



$$C_3H_6 + H_2SO_4 = C_3H_7 . HSO_4$$
$$C_3H_7 . HSO_4 + H_2O = CH_3 . CHOH . CH_3 + H_2SO_4$$

Removing hydrogen sulphide and water vapor from the gases constitutes the first step. The olefine vapors are then absorbed in 87 per cent H_2SO_4 (sp.gr. 1.8), the temperature being maintained between 15 and 20 deg. C. by refrigeration. Strength of acid and temperature must be controlled within narrow limits if the formation of tarry polymerization products is to be avoided. At the end of the reaction the specific gravity has fallen to 1.4 and there has been an 80 per cent increase in volume. Unabsorbed gases are used for fuel.

Any oil which may have been entrained in the acid solution is removed in settling tanks. About four volumes of water are added, reducing the strength of the acid to about 15 per cent H_2SO_4. This separates the tarry polymers.

Hydrolysis is completed and the alcohol separated by distillation in lead-lined stills. During distillation olefines are regenerated, sometimes to the extent of 20 per cent of the amount originally absorbed. These are returned for re-absorption.

The crude product is a mixture of several alcohols (with small amounts of ethers) and is, therefore, rectified to give isopropyl alcohol and several byproducts.

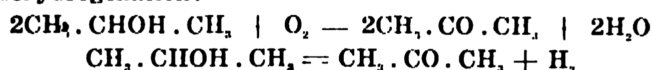
Properties of Isopropyl Alcohol

A comparison of the properties of isopropyl alcohol and ethyl alcohol indicates the close relationship between these compounds:

	Isopropyl Alcohol	Ethyl Alcohol
	Constant Boiling Mixture	
Boiling point, deg. C......	80.37	78.15
Per cent by volume.......	90.3	97.3
Specific gravity	0.8190	0.8060
	Pure Compound (Absolute)	
Boiling point, deg. C......	82.41	78.30
Specific gravity	0.7855	0.7893

Petrohol is the constant boiling mixture containing 90.3 per cent by volume of isopropyl alcohol and boiling at 80.2 deg. C. It may be used in place of ethyl alcohol for solvent purposes. It is not suitable for beverage purposes and is thus not subject to Government restriction. Physiological tests indicate that inhalation of the vapors produces less harmful results than ethyl alcohol or methanol.

During the war all possible sources of acetone were investigated. It was found that acetone could be made from isopropyl alcohol by catalytic oxidation or by dehydrogenation:



$$2CH_3 . CHOH . CH_3 + O_2 = 2CH_3 . CO . CH_3 + 2H_2O$$
$$CH_3 . CHOH . CH_3 = CH_3 . CO . CH_3 + H_2$$

The Bureau of Aircraft Production took over the plant for a time and prepared acetone by the first method, using copper as a catalyst.

Isopropyl acetate has been produced by a process similar to the direct method for amyl acetate:



$$C_5H_{11} . HSO_4 + CH_3COONa = CH_3COOC_5H_{11} + NaHSO_4$$

No attempt is being made at present to recover the ethylene in the still gases, since the formation of ethyl hydrogen sulphate requires higher temperature and more concentrated acid, which cause excessive polymerization.

Motor Fuel Symposium at the Meeting of the Washington, D. C., Section, A. C. S.

Four prominent speakers and an extended discussion aroused a great deal of interest at the 312th meeting of the Chemical Society of Washington Thursday, Dec 9, when the entire program was devoted to a symposium upon the present status and future prospects of motor fuel supply.

A. W. Ambrose, chief petroleum technologist of the Bureau of Mines, discussed petroleum products for motor fuel supply. He described the three classes of investigators of this subject as pessimists, optimists and super-optimists. The pessimist believes the problems cannot be solved; the super-optimist believes there is no problem. Neither of these classes is right, in Mr. Ambrose's opinion. The optimist believes that there is a problem of difficulty, but that it can be solved by proper planning.

The present gasoline requirements of the country indicate a need for 4 to 4.5 billion gallons of motor fuel for 1921. This represents many times the demand of ten years ago, but the crude oil available from domestic production is only about twice that of ten years ago. The output of motor fuel has been increased from petroleum by better recovery of crude, by higher percentage recovery of motor fuel during refining and by conservation in use of fuel. Efficiency on the part of the ultimate user is the most promising means of relief of the shortage.

Shale oil development, still in its infancy as a commercial business, offers little encouragement for the immediate present because of the difficulty of economical retorting to secure an easily refinable product for motor fuel production.

W. M. Rile of The Barrett Co. discussed the subject of coal-tar products as a source of motor fuel, especially motor benzene. This is really a mixture of benzene, toluene and xylene. Typical specifications for motor benzene are 0.878 specific gravity, neutral reaction, sulphur not exceeding 1 per cent, ability to pass the "doctor" test and the gumming test, and distillation as follows: first drop 79 to 80 deg. C., 60 per cent below 100 deg. C., 90 per cent below 121 deg. C., dry at 135 deg. C., with no appreciable residue. Because of the greater vapor tension at a given temperature and materially higher heating value of benzene per gallon as compared with gasoline, distinct advantages in the way of thermal efficiency and miles per gallon are experienced. However, under present conditions the total available motor benzene supply of the country even if all light oil from byproduct coking and city gas plants equipped for light oil recovery be included, is barely 2½ per cent of the gasoline requirements of the country. By extreme measures, including byproduct recovery from all coal coked, stripping of all city gas supplies for light oil and other increases to be expected during the next few years

in these lines, we cannot expect much over 5 to 10 per cent of the gasoline demand of today to be met from motor benzene as this term is now used.

Industrial alcohol as a motor fuel was discussed by B. R. Tunison, of the Industrial Alcohol Co. The present output of this product which might conceivably be diverted into motor fuel use if the requirements for solvent and chemical operations were ignored is approximately the same order of magnitude as the total available motor benzene. The estimated industrial alcohol plant capacity of the entire country is only about 100 million gallons per year—that is, about 2½ per cent of the motor fuel requirement of today.

The carburetion characteristics of alcohol, benzene and gasoline were contrasted by Dr. Tunison, and it was shown why the blended fuels including some of each of these three constituents could be expected to give superior motor performance. The great advantage of alcohol for motor use is that it fires quickly but does not increase its rate of burning as much during combustion as do the other motor fuels. Moreover the range of fuel: air ratio for successful operation is wider with alcohol than with either benzene or gasoline. Alcohol also permits much higher compression ratios, thus giving large possible increase in efficiency under the most favorable conditions, but it is not under normal circumstances best applied alone. It lends itself rather to the blended fuel application.

Forest products as a source of alcohol for motor fuel was discussed by a paper prepared by E. C. Sherrard, of the U. S. Forest Products Laboratory, presented by Dr. H. F. Betts, of the Forest Service. The possibilities of alcohol production from wood waste were fully set forth. It was pointed out that this was one of the most promising sources of cheap raw material for industrial alcohol production. The estimates indicated that about 15 gal. of alcohol could be expected under ordinary conditions of plant operation per ton of wood treated. The investigations of the Laboratory on the best conditions for cooking wood pulp with acid as the initial stage in alcohol production were discussed also in this paper.

The discussion brought out by questions and contributions from numerous members of the Society emphasized many of the economic aspects of the case, particularly the difficulty of control of living reagents such as the bacteria for fermentation, the necessity for utilization of some sugar-containing waste materials for feeding stuffs instead of for alcohol production, and the severe limitation of any alcohol production if waste materials are not cheaply available. The advantages of coal as a raw material for liquid fuel manufacture and the necessity of adapting the engine to available fuels rather than insisting that fuels must be made to suit present-day engines was also stressed.

Connecticut Valley Branch of T.A.P.P.I. Holds Meeting

The regular monthly meeting of the Connecticut Valley Branch of the Technical Association of the Pulp and Paper Industry was held in the Social Rooms of the American Writing Paper Co., Holyoke, Mass., on Dec. 13. It was in the nature of an experience meeting, the members bringing their troubles along for discussion. Among the topics presented were the presence of beater gum, the intensification of colors in paper after standing around for a short time, slack sizing on one side of machine-finished paper and standard practice of beating.

December Meeting of Connecticut Valley Section, A.C.S.

The regular monthly meeting of the Connecticut Valley Section, A.C.S., was held at the Highland Hotel, Springfield, Mass., on Dec. 11. After dinner and a short business meeting, Prof. Harold Hibbert of the Sheffield Scientific School, Yale University, spoke on "The Constitution of Cellulose." Much of the subject matter of Professor Hibbert's lecture has already appeared in abstract form in CHEMICAL & METALLURGICAL ENGINEERING (Sept. 22, 1920; vol. 23, p. 563). In addition, the lecturer discussed the recent work, particularly that of Hess, that has been published since he read his paper at the Chicago meeting of the A.C.S. The address proved to be very interesting, especially to the large number of paper-makers present, and provoked a discussion that lasted about forty-five minutes, much of which was devoted to colloid chemistry.

Patent Bill in Conference

The Patent Office bill with its Senate amendment providing for the administration of Government-employee patents by the Federal Trade Commission has reached the conference stage. There was some opposition on the part of a few members of the House in allowing the measure to go to conference on the plea that the salary increases in the Patent Office are not justified. None opposed the bill on the ground that it contained the Senate amendment. The conferees on the part of the House are Representatives Nolan, the chairman of the committee; Mr. Lampert of Wisconsin and Mr. Davis of Tennessee. The conferees on the part of the Senate will be Mr. Norris, the chairman of the committee; Mr. Brandegee of Connecticut and Mr. Kirby of Arkansas.

Tariff Hearings to Be Held

The tariff schedule covering chemicals, oils and paints is to be the subject of a hearing before the Committee on Ways and Means of the House of Representatives on Jan. 6, 7 and 8. In order that a tariff bill may be ready to be introduced at the opening of the extra session, the Committee on Ways and Means intends to complete the hearings and draft the bill between now and the opening of the session. The hearings on earths, earthenware and glassware will be held Jan. 10 and 11. The schedule covering metals will be the subject of hearings on Jan. 12, 13 and 14. Hearings on the sugar schedule are set for Jan. 18 and 19. The hearing at which the free list will be taken up is scheduled for Feb. 11, 12 and 14.

To Study Federal Reorganization

The resolution providing for the appointment of a joint Congressional committee to study the departmental machinery with the idea of recommending a form of rorganization is at this writing in the hands of the President, awaiting signature or veto. The House on Dec. 14 passed the resolution which had been adopted by the Senate at the last session. This allowed its immediate transmittal to the White House. Should this resolution become a law, it will be regarded as a distinct advantage for those favoring the creation of the Department of Public Works. As the committee likely to be chosen is expected to report its recommendations soon, it is believed that this will improve the chances of securing action on a reorganization bill.

Standardization of Industrial Laboratory Apparatus

Through the efforts of certain apparatus manufacturers, there met informally at the Chemists' Club, New York City, on Aug. 2, representatives of the following companies to discuss the advisability of drawing up standard specifications for laboratory apparatus to be used in their industrial research and works control laboratories: Barrett Co., General Chemical Co., Atmospheric Nitrogen Corporation, Grasselli Chemical Co., National Aniline & Chemical Co., New Jersey Zinc Co., Solvay Process Co., Standard Oil Company of New Jersey, and E. I. du Pont de Nemours & Co.

It developed at this meeting that material savings might be expected to develop from this work. Since most of these companies are members of the Manufacturing Chemists Association of the United States, a committee composed of these members was appointed by the Manufacturing Chemists Association to pass on the proposals of the informal committee and to recommend the adoption of the specifications resulting from the informal committee's work as standard for the members of the Manufacturing Chemists Association.

Arrangements have been made for full co-operation with the Committee on Guaranteed Reagents and Standard Apparatus of the American Chemical Society, and also with the Committee on Standards of the Association of Scientific Apparatus Makers of the United States of America. These specifications will be considered carefully by committees of these three societies, and it is expected that they will then be published as tentative for a period of six months in order to give time for general criticism. At the end of that time the specifications will be adopted as final.

In carrying on this work an effort will be made to obtain specifications which will insure the cheapest mode of manufacture of a given instrument consistent with the duties that it must perform.

To date, three meetings of this committee have been held and considerable progress has been made. The committee desires to co-operate fully with all industries, and any communications should be forwarded to the chairman, Dr. E. C. Lathrop, E. I. du Pont de Nemours & Co., Wilmington, Del.

Governmental Reorganization

While the matter of governmental reorganization is a subject of much comment on the part of lawmakers and others in Washington, it is very doubtful whether any consideration will be given to the subject on the floor of either house of Congress at the short session. Senator McCormick, of Illinois, has announced his intention of introducing a bill for the reorganization of the executive departments as a companion measure to his budget bill. This bill is along the same lines as that known as the Jones-Reavis bill. Senator McCormick's bill is not to supplant the Jones-Reavis measure, but it is apparent that no difficulties will be encountered in harmonizing the two measures in committee.

To Push Nitrogen Corporation Bill

Notice has been given in the Senate by Mr. Smith of South Carolina that he will insist upon prompt consideration of the bill providing for the establishment of a self-sustaining federal corporation for the production of atmospheric nitrogen. He expressed the hope that the bill would be acted upon before the holidays.

Forest Service Establishes New District in Alaska

The establishment of a new field district comprising the Chugach and Tongass National Forests in Alaska, with headquarters at Juneau, is announced by the Forest Service, to take effect Jan. 1, 1921. The new district will be in charge of District Forester Charles H. Flory, who is at present Superintendent of National Forests in Alaska. The establishment of the new district was decided upon in order to facilitate the transaction of the growing business of the two Alaskan national forests, and is in line with the policy of decentralized administration of the Forest Service. Nearly all of the business of the Alaskan forests will be transacted in the future on the ground by the district forester and the local forest officers, the officials of the Forest Service state.

The Tongass and Chugach national forests comprise 20,574,000 acres of land and include practically all of the best timber along the coast of Alaska. The sales of timber are increasing steadily and receipts from the two forests for the last fiscal year exceeded $100,000. With the development of a paper industry, which is now in sight, officials of the Forest Service expect that the receipts will be greatly augmented. A sale for 100,000,000 ft. of pulp wood has already been made to a company which will establish a paper plant, and a sale of 1,500,000,000 ft. is in prospect.

The establishment of a paper-making industry, according to members of the Forest Service familiar with Alaskan conditions, will do much to stabilize the development of the territory. Alaska, it is said, is now in a condition somewhat like that of a worked-out mining camp. The rich placer mines have been exhausted, present prices of metal make it unprofitable to mine many of the lode claims, the salmon fisheries have been depleted, and there is no good market or means of transportation for such agricultural crops as are raised. Yet the undeveloped resources of the territory are very great. A paper industry will be perpetual because the timber on the national forests will be so cut as to insure regrowth, and the establishment of large manufacturing plants with the necessary towns for the workmen will afford steady employment for a considerable number of people, will increase transportation facilities and will create a market for crops produced locally.

The administration of the national forests has already been largely decentralized, the officials of the Forest Service state, but the establishment of a new district in charge of a district forester with large discretionary authority to transact Government business will further facilitate dispatch.

Personnel Changes in Bureau of Standards

During October there were thirty-one additions, twenty-two separations and fifty-nine promotions in the scientific staff of the Bureau of Standards, and during November sixteen additions, eight separations and twenty-eight promotions. Walter A. Hull has been transferred from the work on fire-resistive properties of materials to the Division of Ceramics and placed in charge of the work in connection with the production of optical glass. The resignations included none of the more advanced members of the staff. The additions to the staff included Paul R. Heyl, physicist, and W. L. Simpson and R. A. Webster, associate electrical engineers, and the reinstatement of A. Halsted, associate electrical engineer, William H. Smith and Alfred N. Finn, chemists.

Personal

L. S. CATES. assistant general manager of the Utah Copper Co., has returned to his headquarters at Salt Lake City after a trip to Boston, New York and Florida.

M. HAZEN CHASE has resigned his position as office manager and assistant to the superintendent of the Copescook mill of the S. D. Warren Co., Gardner, Maine, to accept one as assistant to R. R. Campbell, vice-president, in charge of manufacturing, of the American Writing Paper Co., Holyoke, Mass.

HIRAM W. CLARK, consulting engineer of the United States Bureau of Mines at Salt Lake City, has been appointed deputy smoke inspector of Salt Lake City.

J. L. HARMAN has been appointed manager of the El Paso branch of the Mine & Smelter Supply Co.

HERBERT C. HOOVER spoke before the Chicago Engineers' Club recently.

WILMER H. KOCH, formerly analytical chemist with E. I. du Pont de Nemours & Co. at its Lodi plant, is now in the research laboratory of the Mathieson Alkali Works, Niagara Falls, N. Y.

J. L. OLDRIGHT, formerly superintendent of the leaching division of the Chile Copper Co. at Chuquicamata, Chile, is visiting mining and metallurgical plants in the West.

WILLIAM RUSSELL, London representative of the Dorr Co., who has been in this country several months and who has been visiting Western metallurgical and Eastern industrial centers, sailed for England Dec. 15 on the Adriatic. He was tendered a dinner by thirty members of the Dorr staff on Dec. 14.

DANIEL H. SCHWARTZ, for the past twenty years superintendent at the Chemical Paper Co., Unit 5, Holyoke, Mass., has resigned his position with that company to accept one as general superintendent of the Ironside Board Corp., Norwich, Conn.

HENRY N. THOMPSON, formerly superintendent of the International smelter at Tooele, Utah, has been appointed instructor in metallurgy at the University of British Columbia at Vancouver.

ETHAN VIALL, for ten years on the staff of *American Machinist*, has resigned as editor to become a partner in the firm of T. W. Minton & Co., Barbourville, Ky.

Obituary

ELIJAH PADDOCK HARRIS, emeritus professor of chemistry at Amherst College, died on Dec. 10 at Warsaw, N. Y., after a long period of ill health. Prof. Harris was born in LeRoy, N. Y., April 3, 1832, and spent his boyhood on a farm with four months of school in the winter. He attended LeRoy Academy and the Seminary at Lima, N. Y., and spent the first two years of his college course at Genesee College. He graduated from Amherst in 1855, having entered as a junior, and immediately after graduation spent several years in teaching. In 1859 he received the degrees of A.M. and Ph.D. from the University of Göttingen. He became professor of chemistry and natural history at Victoria College, Coburg, remaining until 1866, when he went to Beloit College. He succeeded W. S. Clark as professor of chemistry at Amherst in 1868, and for forty years was instrumental in training many successful chemists. He retired in 1907 under the Carnegie Foundation at the age of seventy-five. Victoria College conferred upon him the degree of LL.D. in 1890. He was the author of several books on chemistry and was a member of Phi Beta Kappa and Psi Upsilon fraternities.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 20, 1920.

Inquiries for chemicals appear to be covering a somewhat larger field, and while it is admitted that there is considerable room for improvement, business is reported of a better volume than in the past few weeks.

Spot *bichromate of soda* was held at 9½c. lb. in most prominent quarters affiliated with resale stocks. Some dealers claim to be able to shade this price slightly and quotations were heard at 9¼@9⅜c. per lb. for a few odd lots. December shipments were held at 9½c. per lb. works, while January was quoted about 1c. above this price for delivery in New York. No change was heard in producers' views for future contracts and 15c. seemed to be the prevailing quotation. Resale solid *caustic soda* was held at $3.75 per 100 lb. on spot in most resale quarters. Occasional sales were noted at $3.65@$3.70 per 100 lb. and outside makes were reported obtainable at 3½c. per lb. Demand for additional lots for shipment continued rather quiet. Producers' ideas were unaltered for future contracts and the market was quoted firm at 3⅜c. per lb. basis 60 per cent works, for delivery over 1921.

Cyanide of soda was the most active chemical on the entire list during the past week. A noted increase in orders and inquiries was reported for the imported material. It was stated that several large orders were received from automobile manufacturers. Round lots were scarce and the market displayed a distinctly firmer tendency. Small quantities of the American grade were quoted at 28@30c. per lb., the outside figure being the producers' standard price. The German variety for shipment was quoted at 18½@20c. per lb., according to quantity and seller. Spot material was quoted at 24c. per lb. Producers are not inclined to shade 8c. per lb. on concentrated *sulphide of soda*, 60-62 per cent, in drums, for spot material. Dealers are in possession of moderate quantities of stock intended originally for export which they are offering at 7@7½c. per lb. Sales on *formaldehyde* were reported at 18½c. per lb. in bbl. by dealers and the general quotation was from 18½c. to 19c. per lb., depending on quantity. In some second-hand quarters it was stated that a few small lots might be purchased a shade under the inside figure, although it was admitted that the undertone of the general market was firm. Inquiries were said to be reaching the market from both domestic and export sources.

Odd lots of *oxalic acid* were on the market at 18c. per lb. Dealers stated that it was doubtful if much prime stock could be purchased below 18½c. per lb., while leading sellers were holding the market at 20c. per lb. The recent advance in this chemical has not met with the approval of buyers and trading continued along very quiet lines. Prime American *sulphate of aluminum*, iron free, was offered on the open market at 4c. per lb. f.o.b. New York. Imported material was available down to 3½c. per lb. and possibly a shade under this figure. The commercial grade was quoted at 2½@2¾c. per lb., with most sellers asking the outside price. Producers reported a well-sold-up condition, but there seems to be relatively little activity in the open market at present. Increased inquiries on *prussiate of soda* were noted during the week, and a fair amount of business was reported to have been placed on the basis of 17½c. per lb. Offerings were not heavy and the tone of the market appeared quite firm. At the close, 17½@18½c. per lb. was the prevailing quotation.

Light *soda ash* for future shipment is being booked by the consuming trade at $1.82½@$1.90 per 100 lb., basis 48 per cent, f.o.b. works, in single bags. Inquiries were said to be reaching the market in better volume than noted earlier in the month. According to the views of dealers, there is not much resale stock pressing at the present time. The market was quoted at $1.90@$1.95 per 100 lb. in bags, while barrels

were held as high as $2.10 per 100 lb. At the works occasional lots brought $1.70@$1.75 per 100 lb. in single bags.

Coal-Tar Products

According to all advices, trading in coal-tar products was meager during the past week and prices in many cases were merely nominal. Consumers in all branches of the allied trades are holding off on account of uncertainty as to how far prices may be lowered. This is reflected in the coal-tar industry. Furthermore, if legislation on protective measures now before Congress is too long delayed, the market will reflect a serious uncertainty.

The crude market is in an easy position at present on supplies, and producers feel that there is a real demand and the time is not far off when it must be noticed. Intermediates in second hands still show irregular price levels with the tendency toward weakness. There is nothing radically new to report in the color market, except that considerable hard work is being put in on the dye protective measure and some interests feel very sanguine of favorable results. Supplies in second hands, while easy, are not being pushed to the extent they were a few weeks ago, and those that can afford to hold have determined not to take a conservative course in offering out supplies.

A rather stagnant condition is accorded to *cresol*, while makers report fair supplies ranging in prices from 16c. to 18c. per lb. Factors reported a moderate movement in *cresylic acid* against standing orders, but said there was very little new business coming through. Supplies were easy with continued shipments from abroad and prices ranged from 90c. to $1 per gal. for the 95-97 per cent, and $1@$1.05 per gal. for the 97-99 per cent. There have been no new developments of late that would signify any increase in the consuming demand for *metaphenylenediamine* and only small lots were said to be moving. Prices remained quotably unchanged at $1.25@$1.30 per lb. Reports on *paratoluidine* from most quarters showed very little new business and only small lots moving against standing orders. Supplies were available in fair volume at $1.75@$1.85 per lb. Buyers are only taking very limited quantities of *paranitraniline* at this period. Supplies were plentiful in most quarters and prices ranged from 92c. to $1 per lb., according to quantity and seller. *Beta naphthol* prices have halted in their downward course and seemed to be more uniform around 40@43c. per lb. *Phenol* has strengthened somewhat, with prices around 10@12c. per lb., none of the low quotations recently heard being in evidence.

Denatured Alcohol Production

All distilleries and industrial distilleries producing alcohol were required to requalify as industrial alcohol plants when the national prohibition act became effective, according to a recent report of the Commissioner of Internal Revenue for 1920. On June 30, 1920, there were thirty-seven industrial alcohol plants, compared with forty-seven distilleries operating prior to October, 1919.

At the close of the fiscal year 1919 there were forty-seven distilleries operating. There were in operation June 30, 1920, twenty-four denaturing plants, compared with forty-five denaturing warehouses and one redenaturing plant operated at the close of the fiscal year 1919. The number of bonded manufacturers using specially denatured alcohol increased during the fiscal year 1919, indicating an increased use of industrial alcohol.

During the fiscal year ended June 30, 1920, there was produced from materials other than fruit 99,615,792 taxable gallons of distilled spirits, an increase of 639,673 gallons compared with the quantity produced during the preceding fiscal year. Of this class of spirits there was removed from bonded warehouses on payment of tax 28,220,909 taxable gallons, a decrease of 53,377,176 from the quantity taxed during the preceding fiscal year, due to the prohibition laws which prevented the use of such spirits for beverage purposes. Herewith are shown the quantities of distilled spirits produced, withdrawn and remaining in bond during the fiscal years 1910, 1915 and 1920.

In 1910: Produced, 156,237,526.4 gal; withdrawn, 126,384,-726.7; in warehouse, 233,508,674.6.

In 1915: Produced, 132,134,152.2; withdrawn, 121,498,325; in warehouse, 253,668,341.3.

In 1920: Produced, 99,615,792; withdrawn, 28,220,909.6; in warehouse, 55,863,745.2.

During the fiscal year 1920 there was withdrawn from bond, free of tax, for denaturation, 45,640,948 gal. of alcohol and rum, as against 60,399,308 withdrawn for the same purpose the previous year. The growth of the denaturing industry in this country during the past 14 years is shown by the following data beginning with 1907:

In 1907: Eight denaturing warehouses, producing 397,861.16 wine gallons of completely denatured alcohol and 382,415.19 wine gallons of specially denatured, a total of 3,084,950.8 proof gallons.

In 1910: Twelve denaturing warehouses, producing 3,076,924.55 wine gallons of completely denatured alcohol and 3,002,102.55 wine gallons of specially denatured, a total of 10,605,870.7 proof gallons.

In 1915: Twenty-three denaturing warehouses, producing 5,386,646.96 wine gallons of completely denatured alcohol and 3,002,102.55 wine gallons of specially denatured, a total of 25,411,718.1 proof gallons.

In 1920: Fifty-two denaturing warehouses producing 13,528,402.99 wine gallons of completely denatured alcohol and 15,307,947.18 wine gallons of specially denatured, a total of 45,640,948.6 proof gallons.

While the 1920 total is much larger than for 1915, there was a reduction from last year's total of about 15,000,000 proof gallons. Total proof gallons for 1919 were 60,399,308.9.

The Iron and Steel Market

Pittsburgh, Dec. 17, 1920.

Changes in market prices in the iron and steel industry in the past week have been few and unimportant. Tin plate, bars, shapes, plates, wire products and sheets, in all of which the independent market recently dropped to the Steel Corporation level, have undergone no further change. Shading by some of the independents is expected, but this has not been observed as yet, partly no doubt because the situation is so new and partly also without doubt because there has been little if any business offered that would induce price competition. Already some members of the trade have picked out some producers as being most likely to shade prices eventually and others who are at least likely to do so.

Pipe, in which the independent market did not decline to the Steel Corporation or Industrial Board level when so many other products did, is unchanged in the independent market, but in the past week there have suddenly appeared a great many postponements of deliveries against contracts, with a few cancellations, and the independents will probably soon have occasion to replace their 54 per cent list with the 57½ per cent list the Steel Corporation has maintained. The difference is about $7 per net ton. Delivery premiums that were formerly obtained by independents have disappeared recently.

Operations

The altogether unprecedented performance of the Steel Corporation maintaining a certain set of prices and all the independents obtaining for a long time not only higher prices but in many cases very much higher prices would naturally have an aftermath, and that is now being experienced. The United States Steel Corporation has increased its rate of production, while the production rate of the independents is rapidly decreasing. The Steel Corporation's increase is not on account of its having more orders or being under greater pressure for deliveries, but because better transportation conditions have increased its supplies of coal and coke. A number of blast furnaces, long idle perforce, have lately been blown in. The corporation's rate of ingot production is now about 91 per cent of capacity, against 88 per cent two or three weeks ago. Some independents are down entirely, while others are operating at 50 to 75 per cent. The average independent rate is probably under 40 per cent and it is a common view that by the end of the year many independents will be closed entirely.

The Steel Corporation's steel ingot capacity, as indicated

by the last annual report, is about 23,000,000 tons per annum. The total capacity of the country may be taken at about 52,500,000 tons, which would set the independents at 29,500,000 tons. At 91 per cent the Steel Corporation would be making ingots at the rate of 21,000,000 tons per annum. The average production rate during the first ten months of this year was 42,000,000 tons, with only minor variations from the average for a month or two at a time. Consumption did not exceed the production rate, as there were no stocks Jan. 1, and there may have been some stocks Nov. 1. Thus the steel required from independents is only the amount by which consumption exceeds one-half the consumption during the period in which consumption was regarded as very heavy and steel was very scarce. If consumption is reduced by one-third, there is left a rate of 7,000,000 tons a year for the independents, or 24 per cent of capacity. This seems remarkable, but it appears less so when it is considered, first, that on account of various difficulties the steel industry operated at only about 80 per cent of capacity in the first ten months of this year and second, that after the very remarkable price performances of the past twelve months the relative positions of the Steel Corporation and independents could not possibly become normal in any short space of time.

Semi-Finished Steel

A large independent interest which has been particularly rigid in efforts to maintain prices has revised its sheet bar contracts to $47, which is commonly recognized as the Steel Corporation price. Other mills are understod to be willing to sell sheet bars at this price, but there is no demand. Some sheet mills insist that the Steel Corporation's advance from $42 to $47 last September must be regarded as merely temporary and they are therefore indisposed to buy at above $42, particularly since that is the Industrial Board price and the sheet market is now at Industrial Board prices. Billets are altogether indeterminate, there being no demand. Some slabs have been sold by plate mills at special prices.

Pig Iron and Coke

Resale foundry iron has been offered so freely at $35 valley basis or less and has met with so little sale that the market is easily quotable at not over $35, the last regular furnace quotation having been $37. Bessemer remains quotable at $35 valley, and basic at $33. Prices are practically nominal. The appearance of important inquiry would doubtless bring out competitive and therefore lower prices, but the demand does not appear. Part of the decline to date from the top prices reached last August has been more or less by way of voluntary action on the part of furnaces, but there is no disposition to go farther in that spirit. The lowest prices for pig iron on this decline will probably be developed after a regular buying movement has begun, whenever that may be, not when, as at present, furnaces are facing the prospect of going out of blast but rather when idle furnaces are thinking of getting into blast and are therefore desirous of selling some "backlog" tonnage for a start.

The average furnaceman is indisposed to consider the making of coke contracts for the first half of the new year, even though these contracts are by trade custom "requirement" contracts, so that the furnaceman is under no obligation if his stack is out. Furnacemen think developments of the near future will reduce Connellsville coke operators to lower terms than they are disposed to consider at present, while as a rule they see no definite prospect of having occasion to operate. This week an exception is to be recorded, however, as one coke interest has closed contracts with merchant furnaces involving coke equal to about 80 per cent of its capacity, or sufficient for four or five medium sized stacks. These contracts were all written on the general basis of a 5 to 1 ratio against basic pig iron, valley, the invoice price of the coke each month per net ton at ovens to be one-fifth the quoted market price of valley basic iron. That would be $6.60 if pig iron stayed at its present level. The contracts contain a minimum for coke, also a change to a stiffer ratio in case pig iron should reach a certain level above the present price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	... – ...	$0.55 – $0.60
Acetone	lb.	$0.13 – $0.13¼	.13½ – .14
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	7.25 – 7.50	7.75 – 8.00
Acetic, glacial, 99½ per cent, carboys	100 lbs.	10.50 – 11.00	11.25 – 11.50
Boric, crystals	lb.	14½ – .15	15½ – .16
Boric, powder	lb.	15½ – .16½	17 – 18
Citric	lb.	... – ...	52 – 54
Hydrochloric (nominal)	100 lb.	1.85 – 2.25	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	15 – .16	16½ – .18
Lactic, 44 per cent tech	lb.	10 – 11	11½ – .12
Lactic, 22 per cent tech	lb.	04½ – 05½	06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		... – ...	... – ...
Nitric, 40 deg	lb.	07 – 07½	08 – 08½
Nitric, 42 deg	lb.	.07½ – 08	08½ – 09½
Oxalic, crystals	lb.	18 – 18½	18 – 20
Phosphoric, Ortho, 50 per cent solution	lb.	18 – 18½	18¾ – .19
Picric	lb.	28 – 35	40 – .50
Pyrogallic, resublimed	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	... – ...	... – ...
Sulphuric, 60 deg., drums	ton	... – ...	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	... – ...
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	... – ...	... – ...
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 24.00	–
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 26.00	26.50 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 ...
Tannic, U. S. P.	lb.	... – ...	1.30 – 1.35
Tannic (tech.)	lb.	50 – .55	56 .60
Tartaric, crystals	lb.	... – ...	42 .44
Tungstic, per lb. of WO	lb.	– ...	1.20 1.40
Alcohol, Ethyl (nominal)	gal.	... – ...	5.50 – 6.00
Alcohol, Methyl (see methanol)		... – ...	... – ...
Alcohol, denatured, 188 proof (nominal)	gal.	... – ...	82 – .84
Alcohol, denatured, 190 proof (nominal)	gal.	... – ...	88 – .90
Alum, ammonia lump	lb.	04½ – 04¾	05 05½
Alum, potash lump	lb.	05½ 06	06½ 07
Alum, chrome lump	lb.	13 13½	14 – 14½
Aluminum sulphate, commercial	lb.	02¾ 03	03¼ – 03½
Aluminum sulphate, iron free	lb.	03½ 03¾	04 – 04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07 08	08 – 0½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	33 35	36 38
Ammonium carbonate, powder	lb.	14 14¼	14½ 15
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	10½ 11	11¼ .11½
Ammonium chloride, granular (gray salammoniac)	lb.	10 10¼	10½ .11
Ammonium nitrate	lb.	10	11 .14
Ammonium sulphate	lb.	03¾ – 04	04½ .04½
Amylacetate	gal.	... – ...	4.50 – 5.00
Amylacetate tech	gal.	... – ...	4.00 4.20
Arsenic oxide, lumps (white arsenic)	lb.	11½ 12	12½ .12½
Arsenic, sulphide, powdered (red arsenic)	lb.	15 15½	15 16
Barium chloride	ton	75.00 80.00	85.00 – 90.00
Barium dioxide (peroxide)	lb.	24 25	26 – 27
Barium nitrate	lb.	12 12½	13 – 13½
Barium sulphate (precip.) (blanc fixe)	lb.	04½ 05	05½ 06
Bleaching powder (see calc. hypochlorite)		... – ...	... – ...
Blue vitriol (see copper sulphate)		... – ...	... – ...
Borax (see sodium borate)		... – ...	... – ...
Brimstone (see sulphur, roll)		... – ...	... – ...
Bromine	lb.	50 – 52	54 – 56
Calcium acetate	100 lbs.	2.00 2.25	... – ...
Calcium carbide	lb.	04 04½	04 05
Calcium chloride, fused, lump	ton	30.00 32.00	33.00 – 35.00
Calcium chloride, granulated	lb.	03 02½	03 – 03½
Calcium hypochlorite (bleach'g powder)	lb.	03 03½	03½ – 04
Calcium peroxide	lb.		1.50 – 1.70
Calcium phosphate, monobasic	lb.	... – ...	75 80
Calcium sulphate, pure	lb.		25 – 30
Camphor	lb.		90 – .95
Carbon bisulphide	lb.	08 – 08½	09 .09½
Carbon tetrachloride, drums	lb.	12 12½	12 .13½
Carbonyl chloride (phosgene)	lb.	... – ...	60 75
Caustic potash (see potassium hydroxide)		... – ...	... – ...
Caustic soda (see sodium hydroxide)		... – ...	... – ...
Chlorine, gas, liquid cylinders (100 lb.)	lb.	09 – 09½	10 10½
Chloroform	lb.	... – ...	43 50
Cobalt oxide	lb.	... – ...	3.90 – 4.00
Copperas (see iron sulphate)		... – ...	... – ...
Copper carbonate, green precipitate	lb.	22 – .22½	24 23
Copper cyanide	lb.	... – ...	65 70
Copper sulphate, crystals	lb.	.06½ – .06¾	07 07½
Cream of tartar (see potassium bitartrate)		... – ...	... – ...
Epsom salt (see magnesium sulphate)		... – ...	... – ...
Ethyl Acetate Com. 85%	gal.	... – ...	1.05 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)		... – ...	... – ...
Formaldehyde, 40 per cent (nominal)	lb.	18½ – 18¾	19 – 19½
Fusel oil, ref	gal.	... – ...	3.60 – 3.75
Fusel oil, crude (nominal)	gal.	... – ...	3.00 – 3.25
Glauber's salt (see sodium sulphate)		... – ...	... – ...
Glycerine, C. P. drums extra	lb.	... – ...	20 .21
Iodine, resublimed	lb.	... – ...	3.85 4.00
Iron oxide, red	lb.		15 – .25
Iron sulphate (copperas)	100 lb.	1.50 1.75	2.00 – 2.25
Lead acetate, normal	lb.	... – ...	13½ – .16
Lead arsenate (paste)	lb.	13 – 14	.14½ – .15
Lead nitrate, crystals	lb.	... – ...	.90 – 1.00
Litharge	lb.	.12 12½	13 – .13½
Lithium carbonate	lb.	... – ...	1.50 – ...
Magnesium carbonate, technical	lb.	10½ – 11	.11½ – .12
Magnesium sulphate, U. S. P.	100 lb.	3.00 – 3.25	... – ...
Magnesium sulphate, commercial	100 lb.	... – ...	1.50 1.75
Methanol, 95%	gal.	... – ...	1.75 – 1.80
Methanol, pure	gal.	... – ...	2.20 – $2.25
Nickel salt, double	lb.	... – ...	.12 – .12½
Nickel salt, single	lb.	... – ...	.13 – .13½
Phosgene (see carbonyl chloride)		... – ...	... – ...
Phosphorus, red	lb.	.50 – .52	.53 – .55
Phosphorus, yellow	lb.	... – ...	.35 – .37
Potassium bichromate	lb.	.17½ – .17¾	.18 – .18½

		Carlots		Less Carlots	
Potassium bitartrate (cream of tartar)	lb.	$0 45	$0 47	$0 38	$0 40
Potassium bromide, granular	lb.			43	50
Potassium carbonate, U. S. P.	lb	50	55	56	60
Potassium carbonate, crude	lb	13	13½	13¾	14
Potassium chlorate, crystals	lb	12	13	13½	18
Ptoassium hydroxide (caustic potash)	lb	14	14½	15	16
Potassium iodide	lb			3 00	3 20
Potassium nitrate	lb	14	16	16½	17
Potassium permanganate	lb	60	63	65	70
Potassium prussiate, red	lb	55	57	58	60
Potassium prussiate, yellow	lb	33	33½	33	34
Potassium sulphate (powdered)	ton	$240 00	255 00		
Rochelle salts (see sodium potas tartrate)					
Salammoniac (see ammonium chloride)					
Sal soda (see sodium carbonate)					
Salt cake	ton			45 00	50 00
Silver cyanide (nominal)	oz			1 25	
Silver nitrate (nominal)	oz			41	42
Soda ash, light	100 lb	1 90	2 00	2 10	2 30
Soda ash, dense	100 lb	2 30	2 50	2 75	3 00
Sodium acetate	lb	06½	07	07	07½
Sodium bicarbonate	100 lb	2 45	2 60	2 65	3 00
Sodium bichromate	lb	09	09½	09¾	10
Sodium bisulphate (nitre cake)	ton	7 00	7 50	8 00	11 00
Sodium bisulphite powdered, U S P	lb	06½	07	07½	08
Sodium borate (borax)	lb	08½	08¾	09	09½
Sodium carbonate (sal soda)	100 lb	2 00	2 25	2 50	2 75
Sodium chlorate	lb	10	10½	10¾	11
Sodium cyanide, 96-98 per cent	lb	23	25	26	30
Sodium fluoride	lb	17	17½	17¾	18½
Sodium hydroxide (caustic soda)	100 lb	3 75	4 00	4 25	4 35
Sodium hyposulphite	lb			04	04½
Sodium molybdate	lb	2 50		3 25	
Sodium nitrate	100 lb	2 85		3 00	
Sodium nitrite	lb	06¼	06½	07	07½
Sodium peroxide, powdered	lb	30	31	.32	34
Sodium phosphate, dibasic	lb	03¾	04½	04½	05
Sodium potassium tartrate (Rochelle salts)	lb			33	35
Sodium prussiate, yellow	lb	17½	17	18	18½
Sodium silicate, solution (40 deg.)	lb.	01¼	01¾	.02	02¼
Sodium silicate, solution (60 deg.)	lb.	03	01½	03½	04
Sodium sulphate, crystals (Glauber's salt)	100 lbs	2 15	2 50	2.60	2 75
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	07	07½	07½	08
Sodium sulphite, crystals	lb.	04	04½	.04½	05
Strontium nitrate, powdered	lb.	20	20½	21	22
Sulphur chloride, red	lb	08	09	.10	10½
Sulphur, crude	ton	16 00	20 00		
Sulphur dioxide, liquid, cylinders	lb	09		.10	12
Sulphur (sublimed), flour	100 lb.			3 70	4 35
Sulphur, roll (brimstone)	100 lb.			3 40	3 90
Tin bichloride, 50 per cent	lb.	18	19		
Tin oxide	lb			50	51
Zinc carbonate, precipitate	lb	16	18	19	20
Zinc chloride, gran	lb.	.12	13	13½	14
Zinc cyanide	lb.	45	49	50	60
Zinc dust	lb.	12	13	13	14
Zinc oxide, XX	lb.	10	10½	11	11½
Zinc sulphate	lb.	.03½	03¾	04	06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb	$1 10	$1 15
Alpha-naphthol, refined	lb	1 45	1 50
Alpha-naphthylamine	lb	44	46
Aniline oil, drums extra	lb	26	27
Aniline salts	lb	32	33
Anthracene, 80% in drums (100 lb.)	lb	90	1 00
Benzaldehyde (f f c)	lb	2 00	2 10
Benzidine, base	lb	1 00	1 10
Benzidine sulphate	lb	85	90
Benzoic acid, U S.P	lb	75	80
Benzoate of soda, U.S.P	lb	75	85
Benzene, pure, water-white, in drums (100 gal.)	gal	33	36
Benzene, 90 , in drums (100 gal.)	gal	32	35
Benzyl chloride, 95-97%, refined	lb.	35	40
Benzyl chloride, tech	lb	25	35
Beta-naphthol benzoate (nominal)	lb	3 50	4 00
Beta-naphthol, sublimed (nominal)	lb	75	80
Beta-naphthol, tech (nominal)	lb	40	45
Beta-naphthylamine, sublimed	lb	2 25	2 40
Cresol, U. S. P., in drums (100 lb.)	lb	16	18
Ortho-cresol, in drums (100 lb.)	lb	23	25
Cresylic acid, 97-99%, straw color, in drums	gal	1 00	1 05
Cresylic acid, 95-97%, dark, in drums	gal	90	1 00
Cresylic acid, 50%, first quality, drums	gal	65	75
Dichlorbenzene	lb.	07	10
Diethylaniline	lb	1 45	1 50
Dimethylaniline	lb	65	90
Dinitrobenzene	lb.	30	37
Dinitroclorbenzene	lb	27	32
Dinitronaphthalene	lb.	42	45
Dinitrophenol	lb	40	45
Dinitrotoluene	lb	30	32
Dip oil, 25%, tar acids, car lots, in drums	gal.	38	40
Diphenylamine (nominal)	lb	75	77
H-acid (nominal)	lb	1 45	1 60
Meta-phenylenediamine	lb	1 25	1 30
Monochlorbenzene	lb	17	18
Monoethylaniline	lb	1 75	2 25
Naphthalene crushed, in bbls. (250 lb.)	lb	09	09½
Naphthalene, flake	lb	09	09½
Naphthalene, balls	lb	09½	10
Naphthionic acid, crude	lb	70	75
Nitrobenzene	lb	12	15
Nitro-naphthalene	lb	40	50
Nitro-toluene	lb.	18	25
Ortho-amidophenol	lb	3 20	3 75
Ortho-dichlor-benzene	lb.	15	20
Ortho-nitro-phenol	lb.	75	80
Ortho-nitro-toluene	lb.	25	40
Ortho-toluidine	lb.	30	.32
Para-amidophenol, base	lb	2 10	2 20
Para-amidophenol, HCl	lb	2 25	2 40
Para-dichlorbenzene	lb.	10	15
Paranitroaniline	lb.	.93	1 00
Para nitrotoluene	lb.	1 25	1 40
Para-phenylenediamine	lb	2 20	2 35
Para-toluidine	lb.	1 75	1 85
Phthalic anhydride	lb	60	70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb	10	12
Pyridine	gal	2 00	3 50
Resorcinol, technical	lb	2 90	3 00
Resorcinol, pure	lb	3 75	4 15
Salicylic acid, tech., in bbls. (110 lb.)	lb	35	38
Salicylic acid, U. S. P	lb	40	45
Salol	lb	85	95
Solvent naphtha, water-white, in drums, 100 gal	gal	30	35
Solvent naphtha, crude, heavy, in drums, 100 gal	gal	19	22
Sulphanilic acid, crude	lb.	32	35
Tolidine	lb	1 40	1 45
Toluidine, mixed	lb	45	55
Toluene, in tank cars	gal	30	32
Toluene, in drums	gal	33	35
Xylidines, drums, 100 gal	lb	45	50
Xylene, pure, in drums	gal	45	47
Xylene, pure, in tank cars	gal.	45	
Xylene, commercial, in drums, 100 gal	gal	37	38
Xylene, commercial, in tank cars	gal.	.30	

Waxes

Prices based on original packages in large quantities

Beeswax, refined, dark	lb	$0 26	$0 27
Beeswax, refined, light	lb	28	30
Beeswax, white pure	lb	35	40
Carnauba, No. 1 (nominal)	lb	80	90
Carnauba, No. 2, North Country	lb	70	80
Carnauba, No. 3, North Country	lb	25	26
Japan	lb	19	20
Montan, crude	lb	12	14
Paraffine waxes, crude match wax (white) 105-110 m p	lb	07½	08
Paraffine waxes, crude, scale 124-126 m p	lb	07¾	07¾
Paraffine waxes, refined, 118-120 m p	lb	09	09½
Paraffine waxes, refined, 125 m p	lb	09½	09¾
Paraffine waxes, refined, 128-130 m p	lb	10½	11
Paraffine waxes, refined, 133-135 m p	lb	13½	14½
Paraffine waxes, refined, 135-137 m p	lb	14½	15½
Stearic acid, single pressed	lb	17½	17¾
Stearic acid, double pressed	lb	18½	19
Stearic acid, triple pressed	lb.	22½	23

Flotation Oils

All prices are f o b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp gr., 0 930-0 940	gal	$1 90
Pine oil, pure, dest. dist	gal	1 50
Pine tar oil, ref., sp gr. 1 025-1 035	gal	48
Pine tar oil, crude, sp gr 1 025-1 035 tank cars f o b. Jacksonville, Fla	gal	35
Pine tar oil, double ref., sp gr. 0 965-0 990	gal	75
Pine tar, ref., thin, sp gr., 1.080-1 960	gal	36
Turpentine, crude, sp. gr., 0 900-0 970	gal	1 25
Hardwood oil, f o b. Mich., sp gr., 0 960-0 990	gal	35
Pinewood creosote, ref	gal.	52

Naval Stores

The following prices are f o b New York for carload lots

Rosin B-D, bbl	280 lb	$8 50	
Rosin E-I	280 lb	8 50	
Rosin K-N	280 lb	8 50	
Rosin W. G.-W. W	280 lb	8 75	
Wood rosin, bbl	280 lb	9 00	
Spirits of turpentine	gal	77	
Wood turpentine steam dist	gal	75	
Wood turpentine, dest. dist	gal.	75	
Pine tar pitch, bbl	200 lb.		8 50
Tar, kiln burned, bbl. (500 lb.)	bbl		15 00
Retort tar, bbl	500 lb.	15 00	15 50
Rosin oil, first run	gal	60	
Rosin oil, second run	gal	62	
Rosin oil, third run	gal.	75	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal	$0 41
70-72 deg., steel bbls. (85 lb.)	gal	39
68-70 deg., steel bbls. (85 lb.)	gal	38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal	30

Crude Rubber

Para — Upriver fine (nominal)	lb	$0 21	$0 21½
Upriver coarse (nominal)	lb	14½	15
Upriver caucho ball (nominal)	lb	15	15½
Plantation — First latex crepe	lb	17	
Ribbed smoked sheets	lb	16½	
Brown crepe, thin, clean	lb	16	
Amber crepe No. 1	lb	17	

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots

Castor oil, No. 3, in bbls	lb	$0 13½	$0 14
Castor oil, AA, in bbls.	lb	14½	15
China wood oil, in bbls. (f o b. Pac. coast)	lb	09	10
Cocoanut oil, Ceylon grade, in bbls.	lb	13	13½
Cocoanut oil, Cochin grade, in bbls. (nominal)	lb	13½	14
Corn oil, crude, in bbls	lb	09½	10
Cottonseed oil, crude (f. o. b. mill)	lb.	06	07
Cottonseed oil, summer yellow	lb	09	09½
Cottonseed oil, winter yellow	lb	10½	11
Linseed oil, raw, car lots (domestic)	gal	81	82
Linseed oil, raw, tank cars (domestic)	gal	75	77
Linseed oil, boiled, car lots (domestic)	gal.	83	.84

Item	Unit	Price		
Olive oil, commercial	gal.	2.75	—	3 00
Palm, Lagos	lb.	.08½	—	.09
Palm, Niger	lb.	.07½	—	.08½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½	—	.09
Peanut oil, refined, in bbls	lb.	.14½	—	.14½
Rapeseed oil, refined in bbls	gal.	1.15	—	1.20
Rapeseed oil, blown, in bbls	gal.	1.25	—	1.35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09½	—	.10
Soya bean oil, tank cars, f.o b., Pacific coast	lb.	.06	—	.07

FISH

Item	Unit	Price		
Light pressed Menhaden	gal.	$0.65	—	$0.70
Yellow bleached Menhaden	gal.	.67	—	.70
White bleached Menhaden	gal.	.72	—	.75
Blown Menhaden	gal.	1.05	—	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Item	Unit	Price		
Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—	$30.00
Barytes, ground, off color, f o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St Louis	net ton	26 50	—	28 00
Barytes, crude, first grade, Missouri	net ton	10.00	—	...
Blanc fixe, dry	lb.	.05	—	.05½
Blanc fixe, pulp	net ton	60.00	—	65.00
Caseine	lb.	.14	—	.18
Chalk, domestic, extra light	lb.	.05	—	.06
Chalk, domestic, light	lb.	.04½	—	.05½
Chalk, domestic, heavy	lb.	.04	—	.05
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.05	—	.06
Chalk, English, dense	lb.	.04½	—	.05
China clay, (Kaolin) crude, f.o b. mines, Georgia	net ton	8.00	—	10.00
China clay (Kaolin) washed, f o b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f o b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b Maine	net ton	7.50	—	10 00
Feldspar, ground, f.o.b Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N Y. State	net ton	17.00	—	21.00
Feldspar, ground f o b Baltimore	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York	net ton	16.00	—	17.00
Fuller's earth, granular, f o.b. Fla.	net ton	25 00	—	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	—	.....
Fuller's earth, imported, powdered	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.	lb.	......	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07	—	.09
Graphite, higher lubricating grades	lb.	.11	—	.40
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic, lump	lb.	.06	—	....
Pumice stone, ground	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o b Baltimore	net ton	......	—	10.00
Quartz (acid tower) 1½@2 in., f o b Baltimore	net ton	......	—	14.00
Quartz (acid tower) rice, f.o b Baltimore	net ton	......	—	17 00
Quartz, lump, f o b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	1.00	—	1.05
Shellac, orange superfine	lb.	1 05	—	1.10
Shellac, A. C. garnet	lb.	.90	—	.95
Shellac, T. N	lb.	85	—	.95
Soapstone	ton	15.00	—	25.00
Sodium Chloride	long ton	.....	—	17.50
Talc, paper-making grades, f o.b. Vermont	ton	12.00	—	22.00
Talc, roofing grades, f o b. Vermont	ton	9 50	—	15.00
Talc, rubber grades, f.o b. Vermont	ton	12.00	—	18.00
Talc, powdered, Southern, f o b. cars	ton	12 00	—	15.00
Talc, imported	ton	60.00	—	70.00
Talc, California Talcum Powder grade	ton	20.00	—	45.00

Refractories

Item	Unit	Price
Bauxite brick, 56% Al, f o b. Pittsburgh	1,000	160
Chrome brick, f.o b. Eastern shipping points	net ton	100-110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f o b Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	55 60
Fire clay brick, 2nd quality, 9-in shapes, f o b Pennsylvania, Ohio and Kentucky works	1,000	45–50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f o b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes f o b. Birmingham district	1,000	56 61
Silica brick, 9-in. sizes, f.o b. Mt. Union, Pa.	1,000	55 60

Ferro-Alloys

All f.o.b. Works

Item	Unit	Price		
Ferro-carbon-titanium, 15-18%, f.o b. Niagara Falls, N. Y.	net ton	$200.00	—	$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	16	—	17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	17	—	18
Ferro-manganese, 76-80% Mn, domestic	gross ton	140 00	—	145 00
Ferro-manganese, 76-80% Mn, English	gross ton	135 00		140 00
Spiegeleisen, 18-22% Mn	gross ton	60 00	—	65 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00	—	2.50
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-silicon, 50%	gross ton	78.00	—	80 00
Ferro-silicon, 75%	gross ton	..	-	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.65	—	.75
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Item	Unit	Price		
Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 4% moisture	gross ton	$10.00	—	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60		.65
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.60	—	65
Coke, foundry, f.o.b. ovens	net ton	8 50	—	9 00
Coke, furnace, f.o.b. ovens	net ton	7.00	—	7.50
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	—	26.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	—	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50	—	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	.01½
Manganese Ore, 50% Mn, c i f. Atlantic seaport	unit	45	—	.50
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO_2, c.i f., Atlantic seaport	unit	35.00	—	..
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	...
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.17	—	....
Pyrites, domestic, fines, f o b. mines, Ga.	unit	.12	—	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	.
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	4.25	—	4.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	4.00	—	4.25
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.50	—	.....
Zircon, washed, iron free	lb.	.05	—	....

Non-Ferrous Metals

New York Markets

Item	Cents per Lb
Copper, electrolytic	15.00
Aluminum, 98 to 99 per cent	22.00@33.00
Antimony, wholesale lots, Chinese and Japanese	5.62½
Nickel, ordinary (ingot)	43.00
Nickel, electrolytic	45 00
Tin, 5-ton lots	35 25
Lead, New York, spot	5.75
Lead, E. St. Louis, spot	6.25
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.75

OTHER METALS

Item	Unit	Price
Silver (commercial)	oz.	
Cadmium	lb.	$1.40@1.50
Bismuth (500 lb. lots)	lb.	2.40
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	85.00
Iridium	oz.	350.00@400.00
Palladium	oz.	85.00
Mercury	75 lb.	48.00@49 00

FINISHED METAL PRODUCTS

Item	Warehouse Price Cents per Lb
Copper sheets, hot rolled	22.50
Copper bottoms	34.00
Copper rods	29.00
High brass wire and sheets	22 25
High brass rods	18 25
Low brass wire and sheets	30 50
Low brass rods	19 50
Brazed brass tubing	36.25
Brazed bronze tubing	41.50
Seamless copper tubing	26 00
Seamless high brass tubing	25 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 00	17.00	10 00	11 50
Copper, heavy and wire	11 50	16 00	9 50	11 00
Copper, light and bottoms	10 00	14 00	9 00	9 50
Lead, heavy	4 00	4 75	4 00	4 50
Lead, tea	3 00	3 75	3 00	3 50
Brass, heavy	7 00	10.50	7 00	10 50
Brass, light	5 50	7 50	5 00	5 0
No. 1 yellow brass turnings	6 50	10 00	5 50	5 50
Zinc	4 50	5 00	3 00	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named.

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3 80	$4 15	$3 47	$3.58	$3 37	$3.58	$3.47
Soft steel bars	3 70	4.15	3.37	3.34	3.27	3 48	3.37
Soft steel bar shapes	3 70	4.15	3.37	3 48	3.27	3.48	3.37
Soft steel bands	4.65	5 50	4.07	6.25	...		....
Plates, ¼ to 1 in. thick	4 00	4.15	3.67	3.78	3 57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

BURBANK—The Linoleum & Window Shade Co. is having plans prepared for the construction of three buildings on Vine St. and San Fernando Rd., to include a 42x201-ft. main building, 25x25-ft. warehouse and a 20x30-ft. office building. Cost to exceed $50,000.

Connecticut

WEST HAVEN (New Haven P. O.)—The Tidewater Oil Corp., Wood St., will build an oil plant to include a 1½-story, 40x100-ft. oil warehouse and storage building and a 1-story, 40x50-ft. garage. Estimated cost, $25,000. Work will be done by day labor.

Idaho

WEISER—The city plans an election Jan. 4 to vote on $150,000 bonds to build a water system, including a filtration plant. L. C. Kelsey, Filer, engr.

Illinois

BLOOMINGTON—The city will receive bids in January for the construction of a sewage disposal plant. Estimated cost, $60,000. Alvord & Burdock, 8 South Dearborn St., Chicago, archts.

CHICAGO—A. M. Castle & Co., 715 North Morgan St., plans to construct an additional warehouse to have 150,000 sq.ft. of floor space. Estimated cost, $450,000.

Indiana

EVANSVILLE—The Evansville College will receive bids until Jan. 15 for the construction of a 3-story, 70x120-ft. science hall. Estimated cost, $250,000. Miller, Fullenwider & Dowling, 6 North Michigan Blvd., Chicago, Ill., archts.

FLINT—D. O. Oury, Trustee, Angola, will receive bids in January for the construction of a 2-story, 80x80-ft. school. A sewage disposal plant will be installed in same. Estimated cost, $75,000. A. H. Ellwood & Son, Elkhart, archts.

GARY—The American Pure Paint Co. is building a 40x100-ft. plant for the manufacture of paint pigment and putty. Estimated cost, $30,000. W. J. Schroeder, secy.

Iowa

SIOUX CITY—The Zonta Tire & Rubber Co. has awarded the contract for the construction of a 1-story, 100x120-ft. factory, to the Federation Constr. Co.

Louisiana

BASTRUP—L. H. Fox has awarded the contract for the construction of a reduction plant to include three 2-story, 50x200-ft. buildings and four 1-story, 30x60-ft. buildings, to the Widmer Eng. Co., Century Bldg., St. Louis, Mo. Estimated cost, $200,000.

Maine

ROCKLAND—The Rockland & Rockport Lime Co. will build an addition to its lime plant, to include 6 limekilns and gas producers, 1-story, 35x100-ft. main building and a 2-story, 60x108-ft. lime storage and packing house.

Massachusetts

AMHERST—The Massachusetts Agricultural College plans to build a laboratory building. Estimated cost, $200,000.

Michigan

HOLLAND—The city is having plans prepared for the construction of a sewage treatment plant. Estimated cost, $200,000. Greeley, Pearse & Hansen, 39 West Adams St., Chicago, Ill., archts.

RIVER ROUGE—The Bd. Educ., c/o A. R. Heuer, has awarded the contract for the construction of a 3-story high school on Dearborn Rd., to Bryant & Detwiler, 2336 Dime Bank Bldg., Detroit. A chemical laboratory will be installed in same. Estimated cost, $1,000,000. Noted Nov. 17.

Minnesota

BELLINGHAM—The Bd. Educ. is having plans prepared for the construction of a 2-story, 50x140-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $80,000. J. L. Mittlestadt, clk.

NEW PRAGUE—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $85,000. J. Joach, clk.

OWATONNA—The city plans an election Jan. 10 to vote on $475,000 bonds to construct a gas plant, etc. C. J. Servatius, city clk.

SHERBURNE—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $85,000. J. Schott, clk.

Missouri

MAPLEWOOD (St. Louis P. O.)—The St. Louis Paper Can & Tube Co., 4400 North Union Ave., St. Louis, has awarded the contract for the construction of a 1-story, 200x540-ft. factory on Big Bend Rd. along the tracks of the Missouri Pacific R.R., to the Widmer Eng. Co., Century Bldg., St. Louis. Estimated cost, $500,000.

North Carolina

MAIDEN—The town has awarded the contract for the construction of 3 sewage disposal plants, etc., to Boyd, Higgins & Goforth, Charlotte. Estimated cost, $115,000.

North Dakota

CARRINGTON—The Bd. Educ. is having plans prepared for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. E. T. Smith, Supt. Shannon, Boyd & Boyd, Jamestown, archts.

CARRINGTON—C. C. Carnahan, city clk., will receive bids in the spring for the construction of a sewage disposal plant. Estimated cost, $15,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, engr.

Ohio

PAINESVILLE—The Middle States Rubber Co., c/o E. Ewing, 708 Williamson Bldg., is having plans prepared for the construction of a 2-story, 60x200-ft. factory and warehouse. Estimated cost, $200,000. Osborn Eng. Co., 2848 Prospect Ave., archt. and engr.

PORTSMOUTH—The Bd. Educ. plans to build a 3-story, 110x130-ft. high school. Laboratory equipment will be installed in same. Estimated cost, $400,000. A. Pretzinger, 1155 Reibold Bldg., Dayton, archt.

Pennsylvania

CHARLEROI—The Federal Fdry. Supply Co., 2633 East 79th St., Cleveland, O., plans to build a 2-story, 40x92-ft. factory. Estimated cost, $30,000. J. Bayer, pres.

South Dakota

WATERTOWN—The Bd. Educ. plans to build a 2- or 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $250,000. A. Herzel, clk.

Utah

SALT LAKE CITY—The School Bd. will soon award the contract for the construction of a 2-story, 68x218-ft. junior high school. Science rooms and chemical equipment will be installed in same. Estimated cost, $250,000. F. D. Rutherford, 662 Second Ave., archt. and engr.

Virginia

EMPORIA—The Emporia Potassium Phosphate Co. plans to build a fertilizer plant. Carneal & Johnston, Chamber of Commerce Bldg., Richmond, archts.

Wisconsin

CHIPPEWA FALLS—The Bd. Educ. will receive bids about Feb. 1 for the construction of a 2-story, 125x160-ft. addition to the junior vocational school. A chemical laboratory will be installed in same. Estimated cost, $150,000. Beers, Schlintz & Bailey, engrs.

JANESVILLE—The Bd. Educ. will receive bids in the spring for the superstructure of a 3-story, 180x200-ft. high school, etc. A chemical laboratory will be installed in same. Estimated cost, $500,000. Van Ryn & DeGelleke, Caswell Blk., Milwaukee, archts. Noted Dec. 15.

Ontario

LONDON—The Bd. Educ., Hydro Offices, is having plans prepared for the construction of three 2-story, 100x220-ft. high school. Equipment for chemistry and physical laboratories will be installed in same. Estimated cost, $750,000. L. E. Carrothers, Hydro Offices, archt.

Quebec

SOREL—M. J. Danseveau will receive bids in January for the construction of a pulp mill to have a daily capacity of 100 tons of pulp. Estimated cost, $500,000.

New Publications

THE CHEMICAL FOUNDATION, New York City, has issued a booklet on the "Electrochemical and Electrometallurgical Patents," which are owned by them.

THE COKING INDUSTRY OF THE PACIFIC NORTHWEST. By Joseph Daniels, Bull. 9, Univ. of Washington, Seattle, Wash., Engineering Experiment Station.

THE COMMITTEE ON BIBLIOGRAPHY of the Technical Association of the Pulp and Paper Industry desires to call the attention of the paper industry, and especially those interested in scientific and technical cellulose chemistry, to two new German periodicals which are devoted entirely to cellulose:

Zellulose-Chemie. Wissenschaft Beiblatter zu der Zeitschrift "Der Papierfabrikant."

This periodical, which is issued as a supplement to *Der Papierfabrikant*, is edited by Emil Heuser of Darmstadt. Vol. 1, No. 1, appeared April 30, 1920. It appears at monthly intervals, each number containing from 8 to 12 pages. The scope of the magazine may be seen from the following contents of the first five numbers.

No. 1, April 30, 1920, Advances in Cellulose Chemistry, by Emil Heuser.

No. 2, May 28, 1920, Methylation of Cellulose, by Denham and Woodhouse. (Translation of articles appearing in the *Journal of the Chemical Society*, vol. 103, p. 1,735 (1913); vol. 105, p. 2,357 (1914.)

No. 3, June 18, 1920, Trimethyl Glucose From Cellulose, by Denham and Woodhouse. (Translation from the *Journal of the Chemical Society*, vol. 111, p. 244 (1917). The Estimation of Cellulose in Wood, by W. H. Dore. (Translated from *Paper*, vol. 26, No. 1, p. 10 (1920.)

No. 4, July 16, 1920, The Enrichment of "Kraftstroh," With Fungus Protein, by Pringsheim and Lichtenstein.

No. 5, Aug. 20, 1920, Preparation of Alcohol From Wood, by Emil Heuser. The Constitution of Cellulose; an abstract of the work, of Hess, appearing in *Z. Electrochem.*, 1920, p. 233.

In addition to the major articles, each number contains a number of abstracts of articles from other journals on the subject of cellulose.

Der Papierfabrikant is published by Otto Elsner, Berlin, S. 42, Germany.

Zellstoffchemische Abhandlungen.

This monthly magazine is edited by Carl G. Schwalbe of Eberswalde, and is published by Carl Hoffman, Berlin S.W. 11, Germany. The price of the first five numbers of 1920 is 20 marks.

The first number (June, 1920) contains an article by Rudolf Sieber on the determination of the calcium content of fresh sulphide liquors according to Feld-Sander; and also the first part of an article from the laboratory of Ost in Hanover on the acetolytic decomposition products of cellulose, by R. Proslegel. The July number completes the article by Proslegel and contains in addition an article by Schwalbe and Ernst Becker on the chemical composition of mechanical wood pulp.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 180, Bibliography of Petroleum and Allied Substances, 1917, by E. H. Burroughs; Bull. 184, The Manufacture of Sulphuric Acid in the United States, by A. E. Well and D. E. Fogg; Tech. Paper 259, Production of Explosives in the United States During the Calendar Year 1919, by William W. Adams.

U. S. TARIFF COMMISSION PUBLICATION: Industrial Readjustments of Certain Mineral Industries Affected by the War.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN PHYSICAL SOCIETY will hold its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION will hold its eighth annual meeting, Monday, Jan. 17, 1921, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25 Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

THE AMERICAN CHAMBER OF COMMERCE in London has just published its year book for 1920, containing the names, addresses and business classifications of over 1,000 American and British firms and individuals interested in developing business between the two countries. The book should be useful in connection with overseas trade and markets.

THE NASHVILLE INDUSTRIAL CORPORATION, composed of business men of Nashville, Tenn., has purchased from the U. S. Government the Old Hickory powder plant at Jacksonville, Tenn., located twelve miles east of Nashville, on the navigable Cumberland River. The purpose of the Nashville people is to industrially develop this immense war undertaking into a large manufacturing center, having available immense housing and manufacturing buildings and facilities. The village had a population of 35,000 when the plant was closed in 1918, and is now completely equipped with all necessary public utilities, schools, banks, clubhouses, etc., and offers many attractive inducements to new industries or those desiring a change in their location. This was the largest Government manufacturing undertaking during the war, costing over $87,000,000. It occupies 5,100 acres of land, has a water filtration system capable of supplying a city the size of Boston, one of the largest steam power plants in the world, a double-track railroad connecting with trunk lines, thirty-five miles of industrial track connecting manufacturing buildings, an immense refrigeration system, complete water-works, sewerage system, fire departments, concrete and macadam roads. A great quantity of surplus material in the manufacturing area will be dismantled and sold.

THE AMERICAN DRESSLER TUNNEL KILNS, INC., has removed its executive, engineering and thermal offices to 1740 East 12th St., Cleveland, O.

THE BARBER-GREENE CO., Aurora, Ill., has recently added to its sales force in St. Louis L. M. Dozier. Mr. Dozier was formerly with the Lakewood Engineering Co.

THE GORDON DRYER CORPORATION, maker of Gordon Atmospheric Driers, has for more than a year been operated in affiliation with Grinnell Co., Providence, R. I., stock control of the Gordon Corp. having been passed to the Grinnell interests in March, 1919. Under the new management the company's business grew rapidly and increased manufacturing facilities were soon required to meet the demand for its products. To secure output it was decided to discontinue the Gordon factory at Bush Terminal, Brooklyn, and last April manufacturing operations were transferred to the Grinnell plant in Providence. The construction of a large plant is now being started in Warren, Ohio.

THE OHIO EXPORT & TRADING CO., with offices in the Standard Parts Bldg., Cleveland, and branch offices in New York and several European centers, has recently organized a department dealing with export and import of chemical machinery, heavy chemicals and miscellaneous finished and semi-finished materials.

AMERICAN STEAM CONVEYOR CORP., Chicago, announce that the J. B. Engineering Sales Co. has been appointed its Connecticut sales agent, with offices at 60 Prospect St., Hartford, Conn.

THE BARTHOLOMAY CO., INC., has let a contract for converting the Genesee Brewery, Rochester, N. Y., into a vegetable oil refinery, using the Brown-Baskerville process. The plant will have a capacity of 50 tons of oil a day. H. E. Brown, New York City, is the engineer.

GROSS, SON & ROBERTSHAW have been appointed sole selling agent for Wild-Barfield electric furnaces for the counties of Northumberland, Durham, Cumberland and Yorkshire. In addition to the office in Newcastle, England, the firm has opened a branch office at 41 Great George St., Leeds, England, where a demonstration furnace is in course of erection. Macbeth Bros. & Co., Ltd., of Bombay and Calcutta, have taken over the sole selling rights for India, where these plants are already in operation.

THE KEWANEE BOILER CO., Kewanee, Ill., held a large celebration on the event of the completion of its million-dollar plant addition on Oct. 20. Many speeches were made by the local city officials and members of the Chamber of Commerce.

THE CUTLER-HAMMER MFG. CO., of Milwaukee and New York, has recently acquired the property at 137th St. and Southern Boulevard, in New York City, as an additional plant for the manufacture of "Thermoplax" and "Pyroplax" molded insulation. The five-story building on this property has been completely equipped with presses for this work. When working at capacity the new plant will have an output equal to the company's insulation plant in Milwaukee, which has been running two shifts, night and day, for the past three years. The New York plant will take care of the company's Eastern business in this line, and will relieve the Milwaukee plant, which is overtaxed in supplying the demand for molded insulation parts. F. J. Boller, formerly of the Milwaukee insulation department, is in charge of the new plant.

FAIRBANKS, MORSE & CO., has purchased the entire business, consisting of all stock on hand, good-will and liabilities, of the Luster Machine Shop & Railway Equipment Co., 917 Arch St., Philadelphia, and has opened a new branch at this address under the management of D. W. Dunn, who will sell the company's complete line of engines, motors, pumps, etc. The entire personnel of the Luster Machinery Co. has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

CHICAGO BRIDGE & IRON WORKS, Chicago, Ill., announces the opening of a new sales office at Atlanta, Ga., in the Forsythe Bldg. Joseph L. Zeller, who has been with this company for a few years, will be in charge and have the territory including the states of Georgia, Alabama, Tennessee and Florida.

THE CEMENT GUN CO., INC., announces new Report on Tests of Gunite Slabs, which gives working tables and safe load tables, established through tests. The company also announces the removal of its main office from Allentown, Pa., to Cornwells, Bucks Co., Pa.

SAMUEL LEDERER has purchased the plant of the Hammond Brewing Co., West Hammond, Ill., which will be put into operation for the manufacture of beverages.

MORSE CHAIN CO., Ithaca, N. Y., has established a Detroit branch factory, which will be devoted exclusively to the manufacture of silent chain sprockets and the Morse adjustment. The Morse Chain Co. will continue to manufacture chains and power transmission at the main plant at Ithaca. The Detroit branch will be under the general management of F. C. Thompson, with F. M. Hawley as chief engineer and C. B. Mitchell as factory manager. Sales and engineering offices are located at the Detroit plant, corner of Eighth and Abbott Streets. The Detroit plant has been added to partly relieve the Ithaca plant. Since the first buildings were erected at Ithaca in 1907 this company has been continuously adding new buildings; in fact, there are now three large construction gangs at work on two large new concrete buildings, making considerable addition to the 7 acres of floor space now under roof as well as another concrete stack 185 ft. high providing for additional power plant equipment. This company also announces that the Morse Chain Gang is always studying and looking for improved and more efficient machines, tools, and equipment, and would appreciate receiving the latest in catalogs, booklets and circulars.

THE CHICAGO PNEUMATIC TOOL CO. announces the removal of its rock drill plant from 864 East 72nd St., Cleveland, O., to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. Location of the company's Little Giant air drill plant at 1241 East 49th St., Cleveland, remains unchanged.

HUGO ZELLER announces that he has resigned as president, treasurer and general manager of the Egyptian Lacquer Mfg. Co., having offices at 5 East 40th St., New York City. Richard Zeller and Gustav Zeller, his brothers, who were also connected with the Egyptian Lacquer Mfg. Co. in the manufacturing end, occupying positions respectively of vice-president, secretary and plant managers and assistant secretary and assistant plant manager, have also resigned from this concern. The three brothers Zeller will continue to be identified together and announcement regarding their plans will be issued in the near future.

THE CHAIN BELT CO., Milwaukee, Wis., announces that Clifford F. Messinger has been appointed general sales manager to succeed L. C. Wilson, who has resigned to become secretary of the Federal Malleable Co., closely associated with the Chain Belt Co. Other promotions announced are C. E. Stone, assistant to the vice-president, and J. A. Monahan, purchasing agent. Mr. Messinger, for the last two years assistant to the vice-president, is a Yale graduate and has been connected with the Chain Belt Co. since 1911. He is perhaps best known in his capacity as manager of Rex Mixer Sales, which he held for three years, and has also been advertising manager. Recently Mr. Messinger has been elected chairman of a group of nationally known construction machinery manufacturers associated for the purpose of developing export business.

ALBERT H. HOPKINS has resigned from the presidency of the Engineering Advertisers' Association of Chicago and from the managership of advertising and sales promotion departments of the C. F. Pease Co., Chicago, to become Chicago manager for the J. Roland Kay Co., international advertising agents, at their new building at 161 East Erie St., just east of North Michigan Boulevard. Mr. Hopkins is known through the Middle West as a former publishers' special representative and through his activities as an organizer and charter member of the above association. His association with the J. Roland Kay Co. will also be in the capacity of manager of its domestic division.

THE TEXAS PORTLAND CEMENT CO., Dallas, Tex., in line with the policy to keep its mills thoroughly modernized and to adequately provide cement for its trade, and which has recently doubled the capacity of its Houston mill, now announces that plans are prepared and work has actually started on the installation at its Dallas mill of one 9x200-ft. kiln, together with additional raw mill machinery and other construction necessary for the increased output.

E. F. HOUGHTON & CO., Philadelphia, announce that George H. Morgan has been elected treasurer. The position of secretary, formerly held by Mr. Morgan, has been filled by the election by the board of directors of George W. Pressell, chief of the Houghton research staff. Mr. Morgan will retain the position of managing director of the leather manufacturing department.

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CHEMICAL & METALLURGICAL ENGINEERING

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Volume 23 — New York, December 29, 1920 — Number 26

A Lagging Public Conscience

THE other day we saw an advertisement of one of the most popular magazines which has a large circulation among intelligent and thinking people. In what follows we do not criticize its editorial policy; indeed when we find ourselves quoted in its columns we admit frankly that we like it. What disturbs us is that in looking for opinions as expressed in American journals and periodicals it evidently has missed something, and the reason is because what we have in mind isn't there. The advertisement reads, "If we join the League of Nations will it glorify us or destroy us? Shall we be able to 'readjust the affairs of civilization' or shall we 'surrender the republic'? Will (*sic*) we be safer in or out? Read both sides of the great national debate in . . ."

There we are! Shall we be glorified or injured or become the boss of all civilization or lose power, and how can we play for safety? How can we beat the game? Where does our advantage lie?

As a member of the great family of nations, if that is the substance of our interest, it indicates that we must be rather a mean brother. Or if we are a great business organization, it might almost be taken as a warning to look out for us. Every question has to do with jockeying for position, and not one touches our obligations or shows even an interest in how the other fellow is to live.

Now that does not represent the heart of the United States. It does not indicate the outcome of the Spanish war, the freedom of Cuba, or the intent of effort with Filipinos or Porto Ricans, irrespective of whether we have been successful in these efforts or not. We have no opinion to impose on our readers concerning the League of Nations; indeed a vote of our editorial staff would very likely show a considerable division of opinion on the subject, and we do not set up to be wise in the matter. International politics is not our *métier*. We merely claim that there is such a thing as a public conscience in this country. When we entered the great war we did so with a will, and we gave our best for a great human purpose and with no intent or thought of any gain at all. The fat profiteer at home does not detract from the glory of the silent heroes buried in France. The ideals were present among those who died and among those who fought and struggled and lived. The trouble is that having done a big and great thing we have called a halt, and that halt has entered into our souls. It almost seems as though, during the past two years, we had closed our minds to all consciousness of our obligations. We miss the idea in our newspapers, in our talk, in the air.

Now our obligations loom big, bigger than ever before. We hold a strategic position on the earth, we have the richest land and the advantage of long experience in self-government. This indicates intelligence among our people. But all this will not keep us complacent and warm and rich unless we make ourselves desired for what we are just as much as if not more than for what we have to spend or to sell. Every business man knows the value of a good name and that good names are not achieved by astute jockeying for position or by trickery of any kind. Of course we must take care of our own, and of course we have immense duties at home and with our own people. We are not pressing any specific reform in this discourse; we are merely noting the absence of even the semblance of thought about our obligations, anywhere. The splendid magazine to which we refer is not to blame for this, even though the editor may have given the advertising man a little too loose a rein. What the editor found in comment was doubtless correctly set forth. What he did not find is that consciousness of what we owe to one another and to all men which it were better for us to consider. We need to do this thing by way of insurance for the next generation.

What to Do With The Patent Office Bill

IT IS EXCEPTIONAL, if not unprecedented, for a conference committee of the Senate and House of Representatives to re-open public hearings on a bill referred to it for final consideration. Accordingly it is a matter of gratification to all concerned that plans have been perfected for hearings on the Nolan Patent Office bill, to which the Senate has attached a rider providing for patenting the inventions of Government employees and administration of such patents by the Federal Trade Commission. These hearings will be held January 5, so we are informed.

Two things should be urged upon the conference committee: First, the bill should be relieved of its rider relating to patenting the inventions of Government employees; and second, the provisions of the House of Representatives for enlarging the examining and clerical forces of the Patent Office, and increasing their salaries, should be sustained as against the reductions recommended by the Senate.

The Nolan bill should be relieved of its rider because the two things have nothing in common except that they relate to patents. The bill has to do with administrative conditions in the Patent Office, on which there is unanimity of opinion, while the rider relates to a question of policy on which there is a marked difference of opinion between representatives of industry and the Government. There can be no possible excuse for confusing the two ideas or combining them for legislative purposes.

The salaries of examiners and clerks in the Patent Office should be greatly increased and made commensurate with the technical ability required of incumbents of those positions. It was in 1848, we believe, that the

salaries of chief examiners and Congressmen were identical. Since that time Congress has not forgotten to increase the salaries of its members several hundred per cent but has been curiously neglectful of the Patent Office, recognizing its employees with only minor increases in salary. As it exists today the condition in the Patent Office is a discredit to Congress, as well as a cause of dissatisfaction to industry, and should be remedied immediately.

Economic Lessons From Other Countries

RECOGNIZING the truism that necessity is the mother of invention, we of the United States have good reason to study what is being done in other countries where the pinch of necessity is forcing intelligent and vigorous action. Unless or until we all recognize that the people of the United States were spoiled by the war we shall get nowhere. In February, 1916, Sir GEORGE PAISH in an elaborate article in the New York *Sun* said:

"The idea that the United States is deriving or can derive any advantage whatever from the war is a complete delusion. All that is happening to the advantage of your country is that it is suffering less than the belligerents as a result of this titanic conflict."

Since we afterward entered the war, we lost, according to Sir GEORGE'S philosophy, the advantage we enjoyed as non-combatants. It may be that the statement is not strictly true, but there is something in it—more than we have thus far recognized.

A common delusion has been that inasmuch as the war interrupted certain kinds of progress we fell just that far behind, and that hence we should be the better off afterward because we would make progress more rapidly so as to catch up. If such a thing could be done, why didn't we just resolve unanimously a quarter century ago to double our rate of progress and then go ahead and do it?

We are now under the necessity of doing harder and more efficient work or of suffering the consequences; but, being spoiled, we do not yet recognize the fact. It is quite appropriate, then, to consider what other countries, under necessity, have done and are doing. After the Franco-Prussian war all France turned in and worked like a beaver to earn and pay the indemnity. France became highly prosperous. Germany, receiving the indemnity, became slothful and extravagant. The condition was so marked that a German comic paper a few years after the war exclaimed: "Let us have another war; let us be beaten and pay an indemnity and then we shall be prosperous again."

Many a true word is spoken in jest. Is that utterance of nearly a half century ago to prove prophetic? It is not as to France, for France is working, hard and intelligently. The French realize how much they lost, even though they won the war. Probably they would not be spoiled in any event, but they are not receiving the indemnity fast enough to put them in any danger. We need to take a lesson from France, for we are not as much better off as we think.

Now as to Germany, our latest advice from our Berlin correspondent tells of the progress the Stinnes movement is making in the German coal industry. In the Essen field an understanding has been reached on the Stinnes basis and the idea is spreading. The basis is far removed from Marxian socialism, which it is downing so far at least as concerns the coal industry. Our correspondent says of it: "Socialization, as is now proclaimed, can be nothing else than a process for obtaining the most complete and economical utilization of all industrial products in the interest of the whole nation, whereby all classes taking part in the production should have a share in the control and in the responsibility." No change from existing conditions is to be tolerated except it promises improvement along this line. Ownership in the mines is unchanged, but workers are given opportunity to buy stock. Trusts as hitherto known are abolished. Production is to be increased, the existing mines being worked more intensively, instead of new shafts being sunk, strong and weak mines being joined to provide capital for improvement.

The operators and miners are to join hands, on the principle of "the interest of the whole nation." In the United States we have seen grounds for suspecting the operators and miners agreeing with each other too readily, with shortage of coal and high prices coming next, and the "percentage of operation" of the mines computed by dividing the number of hours in a day worked by eight, which is one-third of the twenty-four hours during which the capital involved is expected to draw interest and profits. Recently there have been some disclosures as to the building industry in New York where a curious mutuality of interest was shown to exist between labor unions and their employers.

We delude ourselves into thinking that we can afford to do these things, to be unintelligent and lazy and to exploit one another, that only the countries that are in a bad way need to work hard and efficiently. But we did lose by the war and we had better recognize the fact. Sir GEORGE PAISH "said something."

British Progress In Chemistry

REAL discourses for the guidance of the chemist are far from plentiful. Elsewhere in this issue will be found Mr. MACNAB'S thoughtful introduction to the Ministry of Munitions' publication "Preliminary Studies for H. M. Factory, Gretna," which is a true sermon for chemists and chemical engineers everywhere. If men of the profession are to assume the higher positions in industry they must secure experience in common-sense methods of procedure for construction and operation of plants, in things mechanical as well as chemical, in finance and organization. With such training, plus scientific education, they cannot fail to become the keymen in many industries now unaware of the benefits of technical control of operations.

Review of the book noted above will also be found in this issue. The methods of studying problems of plant design introduced by Mr. QUINAN as shown in the text have been the subject of favorable comment from several sources and hold the lesson of simplicity and clearness for technical procedure. QUINAN was a tower of strength to the British Ministry of Munitions. Not only was he forceful and vigorous in combating official ignorance and apathy, so that his plans and proposals were accepted, but he was unusually successful as a teacher in training the members of his technical staff. His final reports are models of excellence in portraying graphically the technical operations at various munition factories. Since Mr. QUINAN was a native American, we too may take some pride in his achievements for one of the Allies.

Arsine Poisoning

A BRIEF statement in Mr. HANLEY'S contribution on electrolytic cadmium, published on another page in this issue, warrants especial emphasis. He gives an alternative scheme for treatment whenever arsenic is present in the copper-cadmium-zinc precipitate to be placed in solution, so as to protect workmen from the "violently poisonous gas of reaction," arsine.

Many living chemists and electrometallurgists have had more or less close contact with this specter, and have almost instinctively closed their lungs to its disagreeable smell before inhaling a fatal amount—pure luck, which other men have not had. An amount as little as ½ mg. of the gas has proved fatal to human beings, although more resistant persons have apparently absorbed as much as 8 mg. and yet recovered. Tests at the American University Experiment Station during the war showed that ½-hr. exposure to a concentration of 0.3 mg. arsine per liter of air is fatal to dogs. Mr. HANLEY is therefore correct in calling it a violent poison, a thing always to be safeguarded against.

Any electrolytic process liberating nascent hydrogen in solutions likely to contain arsenic, or on metal anodes containing arsenic, may under certain conditions as to acidity and concentration generate enough arsine to kill all the employees in that department. It is also formed whenever hydrogen is liberated in a solution containing arsenious acid or an arsenite. It will usually be liberated in quantity when acid acts on arsenic-bearing ores, residues or metals. Many electrolytic and solution processes which are potential arsine generators can readily be called to mind; it has been evolved in fatal quantities in tinning sheet iron, and in the solution of argentiferous zinc from Parkes process lead refining; it has killed lead-burners who used hydrogen from impure zinc.

Since the gas is nearly three times as heavy as air, dangerous concentrations may be reached within rooms, or even in the open air, unless all possible generators are covered and the hoods exhausted by fan suction, discharging preferably into a chimney, there to be highly diluted before again reaching the ground. Good ventilation is also necessary, and should be especially insisted upon in winter time, when the tendency of course is to shut the buildings tightly. Portions of a plant under suspicion should also be carefully walled off from adjacent departments, if it is not practicable to house them separately. Finally, the atmosphere from appropriate places should be tested by drawing a continuous stream of bubbles through an indicator like a silver nitrate solution, placed in a conspicuous position so that the darkening caused by traces of arsine will be immediately observed. Or one might devise a continuous Marsh test. Any arsenic mirror would absorb a portion of a beam of light falling upon a selenium cell, which through relays would then operate any electric alarm.

In view of the minute amount which causes death, attention of the responsible engineers should be focused on a careful study of the possibility that arsenic may accidentally or habitually enter an electrolytic or solution process. If it is impossible to eliminate this contingency absolutely, the process should be isolated, and the surroundings well ventilated and constantly tested.

Often the presence of arsine is unknown until its effect on the workmen's health is observed—then, perhaps, only too late! Would it not be well then to inquire among the employees, whether they are at times subjected to unexplained attacks of tonsillitis or jaundice?

Symptoms of arsine poisoning are delayed—often as much as twelve or eighteen hours. One effect it takes, often in mild doses, is to cause partial or complete destruction of the mucous membranes in mouth and throat. The sufferer loses the sense of taste, finds it very hard to swallow, and is treated for "malignant tonsillitis." As a rule, however, the first symptoms are nausea, headache and giddiness, followed by jaundice of the skin and inner surface of the eyelids, the latter of which assumes an intense coppery hue. Its essential action is to destroy red blood corpuscles in enormous number, and the liver and kidneys ultimately break down in an effort to eliminate the products of disintegration. The duration of illness, whether fatal or not, is materially longer than that caused by other arsenicals. Eight days would be a minimum period of recovery—more than eight months is often required. Death may come within a day, or wait three or four weeks.

Facilitating Government Service to Industry

INDUSTRY has frequently resented Government efforts to investigate or assist in technical or commercial problems which industrial executives consider "none of the Government's business." Particularly this problem has confronted the technical man in cases where Government investigators working in chemical or engineering fields have striven to study specific industrial processes instead of confining their efforts to a study of fundamental problems common to all branches of one or more industries. Most recently vigorous objection has been raised on the score that the Government was seeking to influence patents, which in the opinion of many are distinctly commercial property.

There are two methods of preventing undue encroachment of public officials on subjects of concern to individual companies. One of these is purely a restrictive obstructionist policy by which the industry attempts to stop work that some Government specialist or executive happens to find interesting or believes to be properly subject to Government study. This policy always results in hostile feeling and very often defeats its own end, by making it appear that the industry has some unwarranted advantage it seeks to preserve.

Why not go to the Government with those problems which it can properly be asked to solve and which industry would like to have it study? Go with assurance that in most cases the Government worker and executive really wants to be of service. If convinced that the work suggested to him is useful and will be appreciated, the worker gladly will follow the desired channel of investigation and the only objection which industry will incur is to convince the legislative and appropriating agencies of the Government (that is, the Congressmen) that financial support should be given to these needed investigations. Once these investigations are properly explained and support of all proper sorts assured, the Government department will no longer show a desire to stray into those other lines which can best be studied by industry itself. Furthermore, the industry will thus obtain that effective Government work which it is entitled to expect from properly supported public agencies.

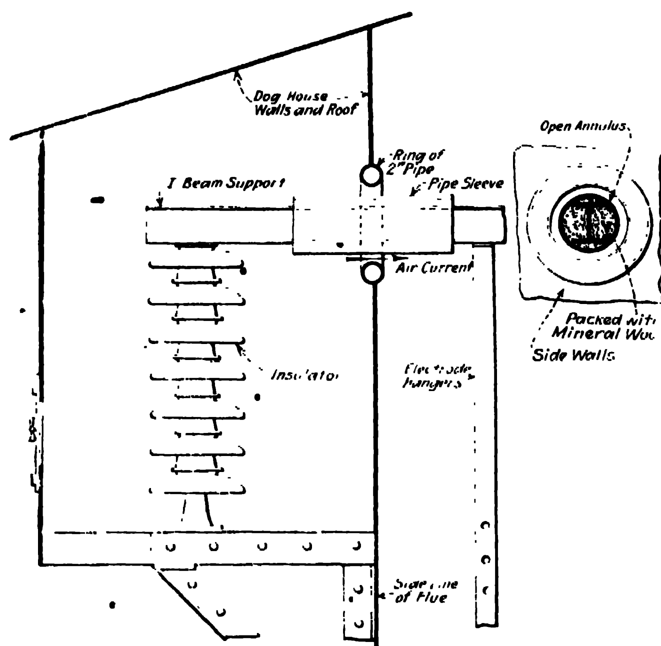
In other words, for the future when we deal with the Government investigations, let's boost what we do want, as well as knock what we don't want.

Western Chemical & Metallurgical Field

Novel Electrical Precipitator

At the Tooele plant of the International Smelting Co. a battery of thirty-two McDougall roasters discharge their smoke into a roomy dust-chamber immediately alongside, connected in turn to the main smelter chimney by a short stretch of brick flue. The dust chamber was designed to support Roesing wires, and these were installed but proved unsuccessful. A great deal of trouble was experienced with loose wires falling into the hoppers due to rapid corrosion near the point of support, the coolest portion. Consequently the wires were removed from the entire chamber.

After work with a small experimental plant, a so-called flue-type treater was installed, and has worked excellently, the recovery of values as indicated by filtration tests exceeding 90 per cent in all cases and at a remarkably low power input. Briefly, the installation consists of a short length of flue in which corrugated iron sheets are hung from the roof and set parallel to the flue-walls, to act as collecting electrodes. Discharge electrodes between plates are formed of gridirons of small iron pipe placed horizontally, and hung from supporting beams at the ends and middle point. Dusty gas thus passes through an electrified zone on its direct



DETAIL WHERE ELECTRODE SUSPENSION PASSES THROUGH SIDE WALLS

route from dust chamber to stack without suffering the usual twistings and turnings of the conventional Cottrell installation.

The flue itself is rectangular in cross-section, with steel top, transite sides, and steel-hopper bottom. Gas velocities approximate 20 ft. per second when twelve McDougall furnaces are operating, yet very high clearances are effected. There is also, curiously enough, a very definite selective action on the mixed smoke—the first hoppers collect material high in copper, while toward the far end the dust runs sufficiently high in lead that its yieldings are sent to the lead blast-furnace plant.

Butterfly dampers, hinged both vertically and horizontally, control the gas distribution at both ends of this short flue; between are four sets of collecting electrodes extending from top of flue to top of hopper, and 10 ft. long. Between sets is left enough open flue to accommodate the discharge-electrode suspension. A particularly clever detail is illustrated in the accompanying sketch, where the electrode suspension passes into a dog-house covering high-tension insulators. A short length of wrought-iron pipe (machined smooth on the outside) is slipped over the I-beam, and this assembly passes the sheet-iron wall through a port-hole framed with a ring of 2-in. pipe. A minimum clearance (equivalent to sphere to plate conditions) prevents large leakage of outside air; any puffs of gas passing outwardly are cleared of dust particles by the charged field existing at the opening. In this manner the insulator is thoroughly protected from dust accumulations, and the treater is protected from a continual inrush of cold air.

Obscure circumstances led to a large overestimate of the electricity needed for operation. Preliminary experimentation indicated that about 50 kva. would be needed, while actually in operation not more than one-quarter of this amount can be put into the treater, this sufficing to catch eight or nine tons of dust daily.

From the description of the installation it may be observed that in effect the treater is really a series of four, each with a gas-travel of 10 ft. Between plate-banks considerable mixing occurs in the current and a solid particle enters the succeeding set at a position random to that at which it emerged. Yet considerable dust is caught on the last plates! Evidently, here is evidence contrary to the idea that a particle in a treater has a path the resultant of a translational velocity and an electrical impulse at right angles. Rather it is that a particle wanders along somewhat aimlessly until fortunately it becomes ionized, and then moves quickly to its oppositely-charged electrode.

Salines in Utah

The assessed valuation of non-metalliferous mining deposits in Utah for 1920 is $22,686,748. The largest amount is for coal lands and totals $19,091,647; sulphur deposits are assessed at $22,530; lime quarries, $31,943; cement rock deposits, $1,372,755; salt and potash deposits, $644,447; alunite deposits, $274,477; asphalt deposits, $1,062,764. These figures are for taxation purposes. In 1917 the assessed valuation of the above lands was $11,012,926.

The potash deposits are in Piute County, and according to the estimate of Prof. William Peterson, geologist for the State Board of Equalization, there is a total of 643,000 tons of material that might be considered valuable for taxation purposes. The phosphate deposits are in Rich County, and consist of patented lode claims totalling 1,375 acres. Mr. Peterson estimates the tonnage assessable at 13,348,000. The gilsonite deposits in

Uintah County aggregate 3,490 acres, with an estimated tonnage of 3,438,500.

The Utah Salduro Co. has been granted a patent to 30,658 acres of land in the Great Salt Lake Desert, title to which was established under placer mining locations, made prior to the date of the leasing law. The company paid a fee of $76,645. This entry covers probably the largest area ever patented under one mineral application. The company extracts potash salts from brine collected by means of dikes, ditches and canals covering a large area. Thus a section of the West heretofore considered so arid and alkaline as to be of absolutely no value is being made to supply a valuable commercial product. The potash industry in this region, however, is in a rather uncertain condition at the present time, owing to the fear of ruinous foreign competition.

A group of Chicago and Indiana capitalists have made application to the State Land Board for the lease of 640 acres of land for the development of potash, alunite and associate minerals. The section of land involved is east of Marysvale, in Piute County.

The Minerals Salt Co. has been recently incorporated with a capitalization of $500,000. The company owns deposits of sodium sulphate on the south shore of the Great Salt Lake.

For some time past, the existence of sodium sulphate around the shores of the Great Salt Lake has been known, and the Midwest Dye & Chemical Co. has been producing glauber salt ($Na_2SO_4.10H_2O$) and salt cake at its plant about two miles southwest of the Garfield smelter. A chemical analysis of the sodium sulphate, made by Walter D. Bonner, head of the department of chemistry at the University of Utah, showed the following results:

	Per Cent
Sulphate, SO_4	63.87
Chloride, Cl	3.64
Magnesium, Mg	0.24
Calcium, Ca	0.36
Potassium, K	0.15
Sodium, Na	31.37
Total	99.63

Overlying the deposit, the extent of which has not been determined at either the south end or the north end of the lake, is 18 to 24 in. of sand, with some boulders. The overburden is easily removed, exposing the sodium sulphate, which is hard and crusty, and contains about 50 per cent sand. The deposit itself is from 5 to 7 ft. thick. After removing the sand overburden, live steam is injected into the deposit by means of an open-end pipe. The heat causes the salt to go into solution very rapidly, and practically all of the sand settles to the bottom of the deposit. When sufficient solution is accumulated, it is pumped into a small storage tank, where additional settling takes place. This solution is then decanted and stored in shallow evaporating ponds. As the solution cools, crystals of glauber salt form.

To Develop Sodium Sulphate Deposit

A deposit of anhydrous sodium sulphate has been purchased by Western Chemicals, Inc., of Tonopah, Nev., development of the deposit having located considerable quantities of 95 per cent sodium sulphate which can be removed by mining methods and put on the market as dug. The deposit is located about twenty-three miles south of Clarkedale, Ariz., to which place the material is now being hauled by truck.

Preliminary exploration indicates the deposit to be quite large. Not all of the material is of a high degree of purity and it is the intention of the company to build a purification plant of sufficient size to supply any market demand which can be developed.

Canada Copper Corp. Reorganized

The Canada Copper Corporation, Ltd., has again been reorganized—the second time within the last few months. It will be recollected that the old company embarked about two years ago upon a rather ambitious development plan, which it was unable to carry entirely to completion, owing to the unfortunate incidence of high construction costs and low copper prices. Under more normal conditions operation of its 2,000-ton mill at Allenby would have doubtless been successfully under way some time ago.

New Process for the Treatment of Natural Brines

Shortly after the first of the year Wrinkle & Kuhnert, of San Francisco, will begin the operation of a demonstration plant at Keeler, Cal., for the recovery of potassium chloride and borax from Owens Lake's brines. The lake water will be evaporated to the maximum degree of concentration by solar evaporation, and the liquor freed from the mono- and bi-carbonate of soda by treatment with carbon dioxide. Further evaporation in double-effect evaporators will be followed by fractional crystallization. The process differs from others that have been tried in that the borax and potassium chloride are both recovered in a marketable form. The plant has a capacity of about twenty tons of sodium bicarbonate and about ten tons each of borax and potassium chloride.

Bituminous Sand Deposits, Athabasca Region

In the District of Fort McMurray, about 200 miles north of Edmonton, occur vast deposits of bituminous sands, popularly referred to as tar sands. The area of occurrence is vast, that indicated by exposures being estimated from 750 to 1,000 square miles with probably wide extensions under heavy cover. The outcrops along the main river and tributary streams have been estimated as 175 miles in length.

Along these exposures the overburden varies on some stretches it is reported as too heavy to allow of commercial development, but on others it is comparatively light or easily removable, consisting of shales and sandstones. It is estimated that about 20 per cent of the exposures are of commercial interest owing to the comparative cheapness with which the bituminous sand can be won, and that systematic boring would no doubt disclose many other localities where overburden was sufficiently light to allow of development at reasonable cost.

Analysis of seventy-two samples made in the Department of Mines gives the bituminous content of the sands as from 12 to 17 per cent.

General W. Lindsay claims to have a process for extraction of the crude oil and other values. The results of the General's proposed activities are awaited with interest. The total known deposits have been estimated to hold about 30,000 million barrels of oil.

A sample of the bituminous sands recently displayed in New York at the American Exhibition of Chemical Industries, in the booth of the Canadian Pacific Railway Co., attracted an immense amount of attention. This sample was subsequently treated by two processes and gave a return of over 20 per cent of crude per ton of raw material.—*Agricultural and Industrial Progress in Canada*, Montreal, vol. 2, No. 12, December, 1920, p. 2 7.

Low-Temperature Coking of Utah Coals

A Summarized Description of Laboratory Investigations Made to Determine the Coking Property of a Series of Utah Coals—Analysis of Coals Tested—Apparatus Used—Tabulated Results Obtained

BY OSBORN MONNETT

COKING processes fall into two general classes—high-temperature processes and low-temperature processes. In the first class coal is carbonized at temperature of from 900 to 1,200 deg. C., producing a coke with very low volatile content which is correspondingly difficult to ignite. The low-temperature process, now being given considerable attention by engineers, proposes to carbonize coal at temperatures of 450 to 600 deg. C. and produce a coke with higher volatile content, which can be more readily ignited.

Of the commercial plants in operation in the United States at the present time practically all are high-temperature processes. These include beehive ovens, in which the byproducts are not recovered; byproduct ovens of the Koppers or Semet-Solvay type, and the ordinary gas retorts for the manufacture of illuminating gas. When a ton of coal is carbonized in a byproduct oven at a temperature of 900 to 1,200 deg. C. the following products are obtained: 1,100 to 1,400 lb. of coke; 10,000 to 12,000 cu.ft. of gas (measured at 60 deg. F. and 30 in. pressure); 8 to 12 gal. of tar and 20 to 24 lb. of ammonia as ammonium sulphate.

To supply the present needs of Salt Lake City for domestic fuel only 210,000 tons of coke would have to be produced annually. This would necessitate the carbonization of about 350,000 tons of coal and would produce nearly 4,000,000,000 cu.ft. of gas, 3,500,000 gal. of tar and 4,000 tons of ammonium sulphate.

High-temperature coke usually contains only about 2 per cent of volatile matter and for this reason is difficult to ignite or control in a domestic stove or furnace. However, with proper methods such coke can be made to give good results. Where a supply is available the public should be urged to buy coke and educated in the proper methods of burning it. There are about 15,000 tons of gas coke available yearly in Salt Lake City, most of which is shipped out of the state. A small number of Salt Lake residents have burned this coke for years with satisfactory results. Steps should be taken to bring about the consumption of all this coke in Salt Lake City.

LOW-TEMPERATURE COKE

During the past ten years increasing attention has been given to the possibilities of low-temperature carbonization. A low-temperature coke is one containing sufficient volatile matter to make a fuel which ignites and burns readily. When coal is carbonized at temperatures of 450 to 600 deg. C., coke and byproducts differing in nature and amount from those produced by the high-temperature process are obtained. The coke still contains from 8 to 15 per cent of volatile matter and is more suitable to domestic use. It ignites readily, somewhat similar to semi-bituminous coal and burns without smoke. The smoke-producing constituents have been decomposed and driven off during the carbonization process.

The tar produced in such a process is a thin fluid better called an oil. It is produced in twice the quantity given in high-temperature carbonization. It contains considerable quantities of motor fuel, burning and lubricating oils, a small amount of pitch and 20 to 40 per cent cresols and other phenols. The gas is produced in smaller amount but is of high calorific value. One ton of coal carbonized at a temperature of about 450 to 600 deg. C. will give 1,300 to 1,500 lb. of coke; 2,000 to 7,000 cu.ft. of gas; 20 to 30 gal. of tar, and 2 to 8 lb. of ammonium sulphate.

DISPOSAL OF BYPRODUCTS

Disposal of the gas produced offers the most difficult problem in the operation of a high-temperature carbonizing plant at Salt Lake City. Tar and ammonia can be sold at points some distance away. Gas must be consumed as soon as produced and sold in or near the city.

As heretofore shown, a plant of sufficient size to supply a high-temperature coke to domestic consumers in the city would produce nearly 4,000,000,000 cu.ft. of gas. Salt Lake City uses at present about 420,000,000 cu.ft. of gas, or about one-tenth of the amount produced by a plant of the above size. Part of this gas might be used in carbonizing the coal, but disposal of the remainder would be a difficult matter necessitating the selling of the gas at a low rate for industrial and domestic purposes and holding down the production of coke for many years while the demand for gas was being built up.

Low-temperature carbonization produces about one-third as much gas, practically all of which can be used in the carbonization process itself. In this respect low-temperature carbonization seems the more feasible.

LOW-TEMPERATURE COKING INVESTIGATION

In view of the importance of this subject and the fact that little was known of the behavior of Utah coals in low-temperature processes, it was thought advisable to make a rather detailed study of the coking properties of Utah coals and inquire into the state of the art of low-temperature carbonization as represented by various investigators. Results obtained together with an outline of the methods used in the investigation will be set down.

Sunnyside coal is the only known Utah coal of good

EDITOR'S NOTE: This article forms a part of the Bureau of Mines report (June, 1920) on its smoke-abatement investigation in Salt Lake City, as studied in co-operation with that city and with the University of Utah. Published by permission of the Director, Bureau of Mines.

TABLE I. SOURCE OF COALS TESTED

Name of Coal	Salt Lake No.	Pittsburgh No.	Operating Company	Location of Mine
King Lump	34	34103	U. S. Fuel Co.	Mohrland, Utah
Spring Canyon Lump	35	34033	Spring Canyon Coal Co.	Storrs, Utah
Clear Creek Lump	36	34034	Utah Fuel Co.	Clear Creek, Utah
Castle Gate Lump	37	34035	Utah Fuel Co.	Castle Gate, Utah
Royal Castle Gate Lump	39	34104	Cameron Coal Co.	Castle Gate, Utah
Peacock Lump	40	34105	Union Pacific Coal Co.	Rock Springs, Wyo
Peerless Lump	41	34106	Peerless Coal Co.	Spring Canyon, Utah
Aberdeen Lump	42	34107	Independent Coal & Coke Co.	Kenilworth, Utah
Wattis Lump	43	34108	Lyon Coal Co.	Wattis, Utah
Liberty Lump	44	34109	Liberty Coal Co.	Carbon County, Utah
Hi-Heat Lump	45	34110	Carbon Fuel Co.	Rains, Utah
Standard Lump	46	34111	Standard Coal Co.	Standardville, Utah
Pleasant Valley Lump	47	34112	Utah Fuel Co.	Winter Quarters, Utah
Scofield Lump	48	34113	Union Pacific Coal Co.	Scofield, Utah
Wattis Lump (Special sample)	49	34036	Lyon Coal Co.	Wattis, Utah
Wasatch Coal Co. (Special sample)	50		Wasatch Coal Co.	
Sunnyside		33798	Utah Fuel Co.	Sunnyside, Utah

coking value. A large quantity of this coal is coked in beehive ovens at Sunnyside. This coke is used for metallurgical purposes in Utah and on the Pacific Coast. Sunnyside makes an exceedingly good grade of coke which compares favorably with the best coking coals of the East. Castle Gate coal was at one time used in the beehive ovens, but produces a coke inferior to Sunnyside.

Coals Tested

Fifteen 30-lb. samples of coal were collected from the yards of Salt Lake City. These include practically all the different varieties of coal on the market. Samples of these coals were sent to Pittsburgh for complete analysis. A rapid survey of the coking power of these coals was made, using the 20-g. byproduct apparatus shown in Fig. 1A. Ten of those showing the best performance were shipped to Chicago for testing in the 8-lb. apparatus shown in Fig. 1B.

Description of these coals is set down in Table I. Proximate and ultimate analyses and calorific values appear in Table II.

Description of Apparatus and Methods

Apparatus for Testing 20-g. Sample. This is essentially that described in "Methods of the United States Steel Corporation for the Commercial Sampling and Analysis of Coal, Coke and Byproducts." An electric furnace was used instead of the gas furnace as used by the Steel Corporation. This was found to give a more easily regulated temperature and to be much simpler to operate. The methods of the Steel Corporation call for a progressive distillation process, in which one burner at a time is lighted. This can be accomplished with an electric furnace by surrounding the tube containing the coal with a metal water jacket which is moved backwards at intervals.

Referring to Fig. 1A: An electric furnace (1) sup-

TABLE II ANALYSES OF COALS

Coal	Lab. No.	Condition	Proximate: Moisture	Proximate: Volatile Matter	Proximate: Fixed Carbon	Proximate: Ash	Ultimate: Sulphur	Ultimate: Hydrogen	Ultimate: Carbon	Ultimate: Nitrogen	Ultimate: Oxygen	Air Drying Loss	Calorific Value: Calories	Calorific Value: B.t.u.
King Lump	34,103	1	4.60	39.57	46.94	8.89	0.47	5.52	70.12	1.37	13.63	[illegible]	6,968	12,542
		2		41.48	49.20	9.32	0.49	5.25	73.50	1.44	10.00		7,304	13,147
		3		45.74	54.26		0.54	5.79	81.06	1.59	11.02		8,055	14,499
Spring Canyon	34,033	1	3.88	42.15	46.93	7.04	0.51	5.67	71.99	1.46	13.33	1.5	7,197	12,955
		2		43.85	48.83	7.32	0.53	5.45	74.90	1.52	10.28		7,488	13,478
		3		47.31	52.69		0.57	5.88	80.82	1.64	11.09		8,080	14,544
Clear Creek	34,034	1	4.24	42.18	47.46	6.12	0.60	5.75	71.96	1.44	14.13	1.3	7,238	13,028
		2		44.05	49.56	6.39	0.63	5.51	75.15	1.50	10.82		7,559	13,606
		3		47.06	52.94		0.67	5.89	80.28	1.50	11.56		8,075	14,535
Castle Gate	34,035	1	3.08	42.26	48.51	6.15	0.32	5.49	72.97	1.27	13.80	0.8	7,288	13,118
		2		43.60	50.05	6.35	0.33	5.31	75.29	1.31	11.41		7,520	13,536
		3		46.56	53.44		0.35	5.67	80.39	1.40	12.19		8,030	14,454
Royal Castle Gate	34,104	1	3.27	41.18	49.07	6.40	0.47	5.52	73.48	1.39	12.66	1.1	7,277	13,099
		2		43.57	50.73	6.70	0.49	5.33	75.96	1.44	10.08		7,523	13,541
		3		45.63	54.37		0.53	5.71	81.41	1.54	10.81		8,063	14,513
Peacock Lump	34,105	1	9.66	38.68	48.11	3.55	1.34	5.73	68.37	1.54	19.47	6.1	6,756	12,161
		2		42.81	53.26	3.93	1.48	5.16	75.68	1.70	12.05		7,478	13,460
		3		44.56	55.44		1.54	5.37	78.68	1.77	12.54		7,784	14,011
Peerless	34,106	1	5.39	40.47	46.86	7.28	0.43	5.57	69.92	1.37	15.43	2.9	6,917	12,451
		2		42.78	49.53	7.69	0.45	5.25	73.91	1.45	11.25		7,311	13,160
		3		46.34	53.66		0.49	5.69	80.07	1.57	12.18		7,920	14,256
Aberdeen	34,107	1	6.50	42.39	45.14	5.97	0.56	5.78	69.68	1.33	16.68	3.7	6,884	12,391
		2		45.34	48.28	6.38	0.60	5.41	74.52	1.42	11.67		7,362	13,252
		3		48.43	51.57		0.64	5.78	79.59	1.52	12.47		7,863	14,153
Wattis	34,108	1	6.92	40.77	45.28	7.03	0.86	5.69	68.48	1.35	16.59	4.0	6,801	12,242
		2		43.80	48.65	7.55	0.92	5.29	73.57	1.45	11.22		7,306	13,151
		3		47.38	52.62		1.00	5.72	79.58	1.57	12.13		7,903	14,225
Liberty	34,109	1	4.42	43.92	45.93	5.73	0.63	5.89	72.23	1.45	14.07	2.1	7,227	13,009
		2		45.95	48.06	5.99	0.66	5.65	75.57	1.52	10.61		7,561	13,610
		3		48.88	51.12		0.70	6.01	80.38	1.63	11.29		8,043	14,477
Hi-Heat	34,110	1	3.96	44.40	43.95	7.69	0.39	5.52	70.76	1.31	14.33	2.1	6,970	12,546
		2		46.23	45.76	8.01	0.41	5.29	73.68	1.36	11.25		7,257	13,063
		3		50.26	49.74		0.45	5.75	80.10	1.48	12.22		7,889	14,200
Standard	34,111	1	3.76	45.37	44.89	5.98	0.47	5.80	72.42	1.36	13.97	1.7	7,286	13,115
		2		47.14	46.65	6.21	0.49	5.59	75.25	1.41	11.05		7,571	13,628
		3		50.26	49.74		0.52	5.96	80.23	1.50	11.79		8,072	14,530
Pleasant Valley	34,112	1	8.86	41.92	44.59	4.63	0.53	5.90	68.90	1.36	18.68	4.5	6,806	12,251
		2		45.99	48.93	5.08	0.58	5.40	75.60	1.49	11.85		7,468	13,442
		3		48.45	51.55		0.61	5.69	79.64	1.57	12.49		7,868	14,162
Scofield	34,113	1	2.58	41.40	49.83	6.19	0.54	5.46	74.34	1.39	12.08	0.5	7,326	13,187
		2		42.50	51.15	6.35	0.55	5.31	76.31	1.43	10.05		7,520	13,536
		3		45.38	54.62		0.59	5.67	81.48	1.53	10.73		8,030	14,454
Wattis	34,036	1	7.05	41.43	49.20	2.32	0.81	5.85	72.21	1.47	17.34	3.4	7,191	12,944
		2		44.57	52.93	2.50	0.87	5.50	77.68	1.58	11.87		7,736	13,925
		3		45.71	54.29		0.89	5.64	79.67	1.62	12.18		7,934	14,281
Sunnyside	33,798	1	4.99	36.27	48.56	10.18	1.43	5.34	69.29	1.52	12.24	3.1	6,934	12,481
		2		38.17	51.12	10.71	1.51	5.04	72.93	1.60	8.21		7,298	13,136
		3		42.75	57.25		1.69	5.64	81.67	1.79	9.21		8,173	14,711

NOTE: 1—As received. 2—Moisture free. 3—Moisture and ash free

TABLE III. BYPRODUCT TESTS WITH 20-G APPARATUS

Coal	Condition	Coke per Cent	Gas Cu.Ft. per Lb.	Tar, Gal. per Ton	Ammonium Sulphate Lb. per Ton	Crude Benzene Gal. per Ton	H_2S per Cent	CO_2 per Cent	H_2O per Cent	Illuminants	CO	H_2	CH_4	C_2H_6	N_2	Calorific Values B.t.u. per Cu.Ft.
										Composition of Gas						
Clear Creek	A	69.1	6.25	20.8	5.3	3.1	0.10	2.15	8.30	5.4	14.7	17.7	49.7	11.0	2.5	929
	B	65.4	3.20	2.5	24.5	3.6	0.08	4.04	8.68	8.8	12.5	36.5	36.5	3.2	2.5	787
Castle Gate	A	70.5	1.34	25.3	5.6	3.4	0.06	2.06	5.88	6.2	11.6	20.8	48.1	12.8	1.5	963
	B	63.6	4.50	9.0	26.8	3.5	0.05	4.05	8.26	10.1	12.6	36.6	37.9	2.9	0.0	831
Royal Castle Gate	A	73.5	0.96	26.7	6.0	3.6	0.16	2.04	7.02	6.6	11.0	16.3	48.5	16.2	1.4	1,020
	B	62.3	4.00	10.9	28.2	3.2	0.02	3.55	9.00	9.4	14.2	39.4	30.5	6.5	0.0	818
Aberdeen	A	75.0	0.97	29.8	6.6	3.1	0.12	2.22	6.84	5.8	16.3	16.6	47.4	13.9	0.0	966
	B	63.0	3.88	3.0	32.0	2.4	0.01	3.80	9.80	9.2	14.2	35.7	37.8	3.1	0.0	815
Liberty	A	74.0	1.48	28.1	6.8	3.2	0.13	2.12	7.52	3.7	13.0	16.9	53.6	12.8	0.0	951
	B	69.5	3.80	3.2		3.9	0.04	3.53	4.71	11.7	11.4	33.5	34.4	4.8	4.2	853
Hi-Heat	A	65.0	1.30	42.8	5.0	3.5	0.14	2.13	5.51	9.4	12.5	14.6	40.6	22.9	6.0	1,123
	B	64.5	3.78	3.6	24.4	3.0	0.02	4.00	3.90	9.5	13.9	33.5	35.3	4.5	3.3	813
Standard	A	70.0	1.30	28.9	5.4	3.2	0.09	2.00	6.68	6.0	10.4	18.5	48.3	14.6	2.2	980
	B	57.3	4.65	11.2	23.3	4.5	0.03	3.88	7.59	11.0	12.5	34.2	36.4	3.7	2.2	844
Pleasant Valley	A	67.0	1.30	22.1	9.4	3.3	0.19	2.67	9.73	7.8	15.7	18.5	50.4	7.6	0.0	938
	B	66.0	3.62	0.9	20.4	2.8	0.03	3.70	6.15	10.4	13.3	34.9	33.5	4.0	3.9	810
Wattis	A	63.5	1.40	32.1	7.1	3.0	0.29	2.05	8.94	6.3	14.7	14.7	50.3	14.0	0.0	1,079
	B	63.0	3.66	2.5	27.6	3.8	0.06	3.10	9.90	10.5	13.9	31.6	40.2	3.8	0.0	867
Sunnyside	A	75.0	1.25	23.3	5.3	2.5	0.34	1.14	6.05	5.2	9.4	23.5	50.3	11.6	0.0	942
	B	67.0	3.10	12.5	28.0	2.5	0.04	2.41	7.91	4.8	12.5	35.8	43.1	3.8	0.0	772
½ Sunnyside. ½ Standard	A	71.3	1.19	28.3	4.3	3.3	0.19	1.72	6.05	4.9	8.3	19.0	46.7	13.5	7.6	914

NOTE: A—Carbonized at 540 deg. C. B—Carbonized at 700 deg. C.

plies heat for carbonizing the coal contained in a glass combustion tube. The products of distillation pass through a tar filter packed with absorbent cotton heated by the steam bath (2). The Geissler bulb (3) contains normal sulphuric acid for absorbing the ammonia, a U-tube containing calcium chloride absorbs water, Geissler tube (4) contains strong KOH solution which absorbs H_2S and CO_2, the tubes (5) and (6) contain paraffine oil for absorption of benzene. The gas is measured in the aspirator bottle (7). The furnace was tilted at an angle of 15 deg. to the horizontal to avoid cracking of the tar. Results give the yield of coke, tar, gas, ammonia and crude benzene.

The apparatus was designed to run in comparison with regular coke plant operation until a correlation was obtained. Results are naturally somewhat relative. A maximum temperature of 900 deg. C. is called for in the Steel Corporation methods. The apparatus affords a rapid means of determining in a general way the suitability of coals for byproduct coking.

Tests were made with this apparatus at temperatures of 700 deg. C. and 550 deg. C. It was found impossible to use higher temperatures than 700 deg. C. due to the fusibility of the glass tubes employed. In the tests at 700 deg. C. the progressive distillation method was employed, making use of the sliding water jacket previously described. In the tests at 550 deg. C. the entire tube was gradually heated to the desired temperature.

Results are tabulated in Table III. The low tar yields obtained at 700 deg. C. with some of the coals are not to be taken as indicative of the actual performance of the coal. In the tests at 700 deg. C., the furnace was not tipped at an angle with the horizontal as in later tests and the tar in some cases ran back in the tube and was decomposed.

APPARATUS FOR CARBONIZING 8-LB. SAMPLES

This apparatus shown in Fig. 1-B is modeled after the apparatus used by Prof. S. W. Parr of the University of Illinois.[1]

[1] Use of the apparatus was obtained through the courtesy of the Commercial Testing & Engineering Co., 1785 Old Colony Bldg., Chicago, Ill. Our thanks are due to W. D. Langtry, president of the company, for making possible use of the apparatus and to J. F. Kohout, chemical engineer, for valuable assistance and advice in making the tests.

TABLE IV. RESULTS OF LOW-TEMPERATURE CARBONIZATION

Tests run on 8 lb of coal. Maximum temperature 1,000 deg. F.

Coal	Condition	Coke Lb. per Ton	Coke Per Cent	Gas At 60°F. and 30 In. Pressure, Cu.Ft. per Ton	Gas Cu.Ft. per Lb.	Tar Lb. per Ton	Tar Gal. per Ton	Ammonium Sulphate, Lb. per Ton	CO_2	Illuminants	H_2	CO	CH_4	C_2H_6	N_2	Calculated Calorific Value B.t.u. per Cu.Ft.
									Composition of Gas							
King	1	1,464	73.2	2,580	1.29	155	19.0	10.0	8.1	6.9	26.0	7.2	36.1	8.6	7.1	784
	3	1,425	71.3	2,980	1.49	179	22.0	11.6								
Spring Canyon	1	1,464	73.2	4,100	2.05	129	16.1	.	6.0	4.9	34.4	9.9	42.0	2.8	0.0	732
	3															
Castle Gate	1	1,416	70.8	3,040	1.52	214	25.5	10.4	8.0	7.0	27.0	7.7	41.0	7.0	2.3	813
	3	1,397	69.8	3,350	1.68	236	28.1	11.6								
Royal Castle Gate	1	1,376	68.8	2,780	1.39	213	26.4	8.0	8.1	7.1	26.6	5.5	41.0	8.7	3.0	838
	3	1,331	66.6	3,040	1.52	233	29.0	8.8								
Aberdeen	1	1,290	64.5	3,860	1.93	174	21.2	10.4	[illegible].9	5.5	30.0	8.6	40.8	4.9	2.3	753
	3	1,292	64.6	4,300	2.15	199	24.2	12.0								
Liberty	1	1,406	70.3	2,340	1.17	194	24.0	7.2	4.6	8.7	24.0	7.6	49.8	5.3	0.0	904
	3	1,390	69.5	2,620	1.31	216	26.8	8.0								
Standard	1	1,384	69.2	2,840	1.42	182	22.5	7.2	6.2	7.1	24.8	7.9	45.0	9.0	0.0	887
	3	1,310	65.5	3,140	1.57	202	24.9	8.0								
Scoffield	1	1,392	69.6	2,540	1.27	180	22.4	8.4	8.1	8.3	25.0	7.3	38.9	9.9	2.5	868
	3	1,365	68.3	2,780	1.39	197	24.6	9.2								
Wattis	1	1,262	63.1	3,900	1.95	152	18.2	11.2	5.6	4.9	34.6	8.3	32.8	5.6	8.2	685
	3	1,282	64.1	4,320	2.16	168	20.1	12.4								
Wasatch Special	1	1,250	62.5	4,940	2.47	192	23.9	8.8	6.8	4.9	33.5	8.2	34.4	9.1	3.1	757
	3	1,230	61.5	5,550	2.79	216	26.8	10.0								
Sunnyside	1	1,360	68.0	3,240	1.62	189	23.0	10.0	5.0	7.1	27.8	6.4	43.7	7.9	2.1	858
	3	1,365	68.3	3,650	1.83	212	25.6	11.2								
½ Sunnyside. ½ Standard	1	1,328	66.4	3,860	1.93	217	26.3	12.4	6.3	8.1	30.5	6.4	39.7	6.4	2.6	824
	3	1,335	66.8	4,300	2.15	242	29.4	14.0								

NOTE: 1 As received 3 Moisture and ash free.

TABLE V. ANALYSES OF COKES

Coal	Lab. No.	Condition	Proximate: Moisture	Proximate: Volatile Matter	Proximate: Fixed Carbon	Proximate: Ash	Sulphur	Air Drying Loss	Calorific Values: Calor's	Calorific Values: B.t.u.
King. . .	34,348	1	1 00	19 84	64 35	14 81	0 53	Gain	6,793	12,227
		2	. . .	20.04	65.00	14 96	0 54	0 1	6,862	12,352
		3	. .	23.57	76 43	. .	0 63	. .	8,069	14,524
Castle Gate.. ..	34,349	1	1.22	16 51	72 09	10 18	0 40	0 2	7,093	12,767
		2	. .	16 71	72.98	10 31	0 40		7,181	12,926
		3	. .	18.63	81.37	. . . .	0 45	. . .	8,007	4,413
Royal Castle Gate ..	34,350	1	1 28	16 26	72 08	10 38	0 49	0 2	7,112	12,802
		2		16.47	73 02	10 51	0 50	.	7,204	12,967
		3		18.40	81.60	. .	0 56		8,050	14,490
Aberdeen.	34,351	1	0 86	14 87	72 85	11 42	0 56	Gain	7,081	12,746
		2	. . .	15 00	73.48	11 52	0 56	0 3	7,143	12,857
		3		16 95	83.05	.	0 63	.	8,073	14,531
Liberty .	34,352	1	1 60	19 24	69.69	9 47	0 64	0 5	7,226	13,007
		2	. .	19 55	70.83	9.62	0 65		7,344	13,219
		3	. . .	21.63	78.37	. . . . .	0 72	.	8,125	14,625
Standard..	34,353	1	1 48	16 84	68.55	13.13	0.56	0 5	6,913	12,443
		2	.	17 09	69 58	13 33	0 57		7,017	12,631
		3	.	19 72	80.28	. . . . .	0.66	.	8,096	14,573
Scofield...	34,354	1	1 18	16 39	73 06	9 37	0 52	0 1	7,240	13,032
		2		16 59	73.93	9.48	0 53	.	7,326	13,187
		3	.	18 33	81.67	. . . .	0.59	.	8,093	14,567
Wattis. . . .	34,355	1	1 93	10 46	81.67	5.94	0 73	0 6	7,509	13,516
		2	. .	10 67	83.27	6.06	0 74		7,657	13,783
		3	. .	11.36	88.64	. . . . .	0 79		8,151	14,672
Wasatch Coal Co. Special	34,356	1	1 22	13 38	73 88	11.52	0.50	0 0	7,130	12,834
		2		13 55	74.79	11.66	0 51	. .	7,218	12,992
		3		15 34	84 66	.	0 58		8,171	14,708
Sunnyside	34,357	1	1 39	12 32	76 85	9 44	1 09	0 5	7,272	13,090
		2		12 49	77.94	9 57	1.11		7,375	13,275
		3		13 81	86 19	. . . . .	1.23	. .	8,155	14,679
½ Sunnyside ½ Standard	34,358	1	1 44	11 35	78 54	8 67	0 70	0 3	7,342	13,218
		2		11 52	79 68	8 80	0.71	.	7,449	13,402
		3		12 63	87 37	. . . .	0 78		8,168	14,706

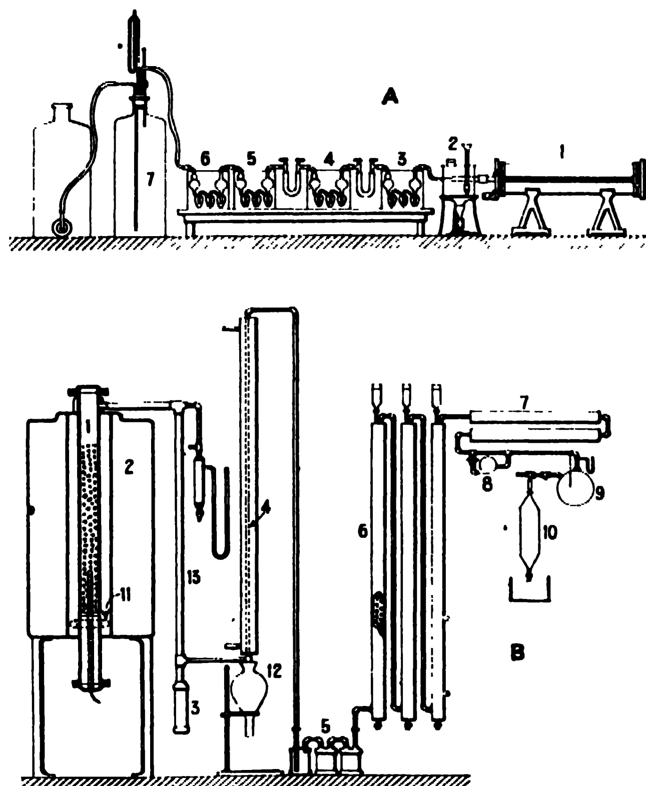


FIG. 1. DIAGRAMS OF EQUIPMENT FOR BYPRODUCT COKING TEST

A. Apparatus for carbonizing 20-g. samples. B. Apparatus for carbonizing 8-lb. sample.

The coal is carbonized in a vertical retort of 3½-in. pipe (1). This is surrounded by firebrick jacket (2) and heated by ring burner (11). The flame of the burner is so regulated that it surrounds the pipe from bottom to top. Tar condensed in the air condenser (13) is caught in the trap (3). Condensate from the water condenser (4) is caught in the separatory funnel (12). The gas then passes through the scrubbers (5) and (6), through the H_2S purifier (7) and is measured in the meter (9). Samples of gas are taken for analysis by means of the sampling tube (10). The rotary pump (8) serves to regulate the pressure, which is measured by a manometer.

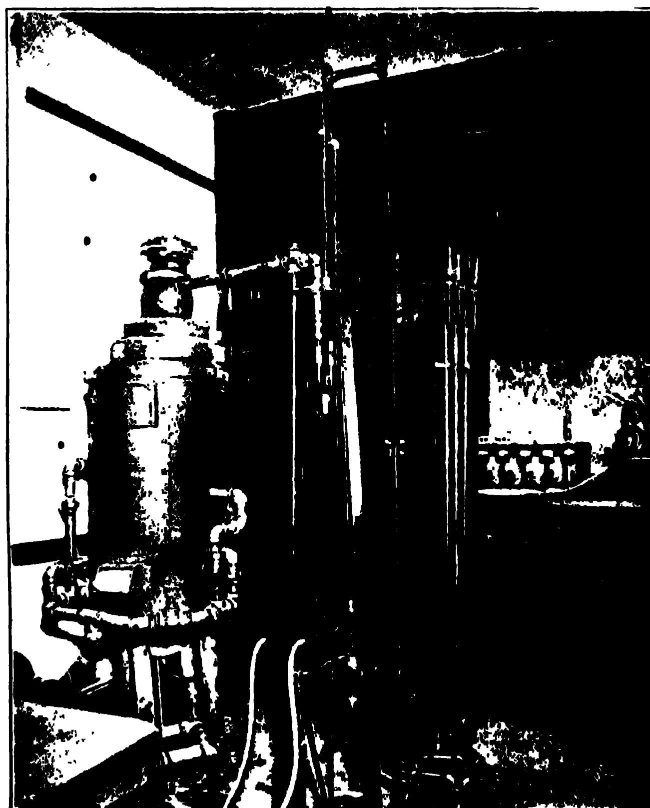


FIG. COKING APPARATUS, 8-LB. SAMPLE, SET UP IN THE LABORATORY

In the tests on Utah coals, the maximum temperature of carbonization was 1,000 deg. F. This temperature was reached in about two hours and maintained for two hours longer. Tar and gas evolution was as a rule practically complete after the first two hours.

Results are tabulated in Table IV. Analyses of the coke are given in Table V. The sample of Sunnyside coal used in coking tests was a different sample from the one analyzed. In figuring the moisture and ash free values for the byproduct yields on this coal an approximation was used.

Character of Coke Produced

Results show that while a number of the coals have a marked tendency to coke, Sunnyside is the only coal which can be called a good coking coal. Castle Gate makes a fair grade of coke. A mixture of one-half standard and one-half Sunnyside made a good coke.

A number of investigators are working on modified methods of coking and claim to have made satisfactory coke from coals not known as strictly coking coals. More research work is necessary before it can be established definitely how far such processes will go in making satisfactory coke from non-coking coals. In the meantime the matter must be considered as in the experimental stages and as something to be worked out in the future.

Legal Notes

By Wellington Gustin

Where Trade Custom Becomes Part of Contract

The Colfax Gin Co., of Colfax, Ga., sued for the purchase price of a carload of cotton seed sold by it to the Buckeye Cotton Oil Co., contending that it was entitled to recover for the amount of seed as shown by the weights when loaded at Colfax, the point of shipment. It was provided by the contract of purchase that the defendant was to pay for the cotton seed a stated price per ton "f.o.b. Colfax, Ga." The Buckeye company contended that it should pay only for the amount of seed received at the point of destination, and alleged that "in the cottonseed oil business it is a custom to settle and pay for all shipments of cotton seed at mill weights—that is, the weight at time and place of delivery—and said custom is of such universal practice that it becomes a part of all contracts for shipment and purchase in carload lots of cotton seed, and was a part of the contract in this case."

The trial court allowed the Buckeye company thus to amend it answer. But the Colfax company objected, contending that "the contract sued on was not ambiguous and that the Buckeye company could not set up and prove in defense of the suit the alleged custom which sought to vary the terms of the contract," and that "f.o.b. Colfax," as contained in the contract, meant that title to the seed passed to the buyer as soon as loaded and that any loss in weights would fall on the purchaser.

On this controversy the Court of Appeals of Georgia held that while a custom or usage of trade cannot be set up to vary a written unambiguous contract whose terms are incompatible therewith, the words and letters "f.o.b. Colfax," as contained in the contract of purchase, would ordinarily mean merely "free on board" at that point, and that the purchaser was to be responsible for the cost of shipment, and the contract as made was therefore silent as to what weights were to govern in the settlement for the cotton seed. Therefore the amendment allowed the Buckeye company was proper. (75 Am. S.R., 73.) And while, in the absence of an agreement to the contrary, delivery of freight to a common carrier is regarded as delivery to the consignee and any loss or damage to the goods while in transit would fall on the purchaser, this rule may be varied by agreement (80 S.E., 863); and if at the time the contract of purchase in the instant case was made there existed such a custom as that alleged by the Buckeye company which was of such universal practice that it became by implication a part of the contract, this would amount to such an agreement as would prevent the application of the general rule above stated.

The defendant debtor herein sent a check to plaintiff creditor for the amount which the debtor claimed was due. The creditor held this check and the debtor contended this was accord and satisfaction. On the point the court said that in the absence of an agreement to the contrary, a bank check thus tendered as in full payment is not such until it is itself paid, under the Georgia statute. Thus, where a claim is unliquidated because of a bona fide dispute as to the amount due, and the debtor sends a check to the creditor for the amount which the debtor claims is due, but for less than the amount claimed by the creditor, with and upon the express condition written upon the check that it is to be in full settlement of the disputed claim, it is only where the creditor either has agreed to accept or after the tender actually does accept such a check as being of itself in full settlement of the unliquidated demand that the mere retention of such an unpaid check can be set up as an accord and satisfaction.

The evidence in this case being in conflict as to whether or not there had been an express agreement that the check itself was to be accepted as payment, the trial court erred in directing a verdict for the Colfax company and the judgment was therefore reversed.

When Broker Earns His Commission

The United States Circuit Court of Appeals, Second Circuit, reversed the District Court for the Southern District of New York in the action brought by Francis H. Baldwin against Jardine, Matheson & Co., in which judgment was given the defendant. Baldwin sued to recover commissions in procuring a purchaser for 10,000 base boxes of tin plate. His commission was to be the sum obtained in excess of $8.50 per base box. After hearing the evidence the court directed a verdict for defendant, and plaintiff appealed. The question argued on appeal was whether a jury question was presented which required its submission to the jury.

The plaintiff alleged that he secured a buyer, the American Trading Co., for the 10,000 base boxes of tin plate at a price of $9.25 per base box; that Jardine, Matheson & Co., Ltd., agreed to and accepted the terms of the sale, payment to be made upon receipt of the tin plate at the dock of the American Trading Co. at Yokohama, Japan. It was further alleged that, in violation of the agreement made with the American Trading Co., the defendant refused to make delivery of the boxes of tin plate, or to pay the commission.

On the question presented on appeal the court said that in an action by a broker for commission on a sale of merchandise, whether the agent who made the purchase had authority, or whether, if not, his action was ratified by his principal, are both questions for determination by the jury.

The plaintiff was entitled to succeed, irrespective of whether the defendant acted in good or bad faith in endeavoring to deprive him of his commission. There is no difference between failure to perform because of bad faith or inability. It is sufficient to entitle a broker to his compensation if it appears from the evidence that a sale was effected through his agency in procuring a buyer. If his communications with the purchaser have been the means of bringing the purchaser and principal together and the sale is agreed upon in consequence thereof, his right to compensation is perfect. The broker is not entitled to compensation for unsuccessful efforts to make a sale unless the failure has been caused by the fault of his principal. When he has been allowed a reasonable time to effect a sale, and has failed, and the principal has in good faith terminated the agency and effected the sale through his own efforts, the latter is not liable for commissions.

Again it was said that a court may direct a verdict only where the evidence is undisputed and so plainly preponderant on one side that it practically becomes conclusive, so that reasonable minds could not differ as to the conclusions to be drawn from the testimony.

Adsorption by Silica Gel*—III

Physical Properties Affecting Plant Design for Solvent Recovery, Drying Air and Industrial Vapor Recovery — Vertical Cylindrical and Bed Type Absorbers — Typical Plant Testing Records†

BY E. B. MILLER

SILICA gel is prepared under carefully standardized conditions and when dried and activated has a moisture content of 5 to 7 per cent. It is a semi-transparent, glassy, brittle, highly porous substance. Its hardness is from 4.5 to 5.5 on the mineral scale and it suffers but slight abrasion with ordinary handling. If, when activated, it comes in contact with water or other liquid rapid adsorption takes place with evolution of heat and the granules are shattered.

The pores are ultramicroscopic and neither the structure nor adsorptive properties are measurably altered by pulverizing the gel to pass 200 mesh or heating gradually to 650 deg. C. Its internal volume is indicated by the fact that 1 g. of gel will adsorb 0.41 c.c. of water.

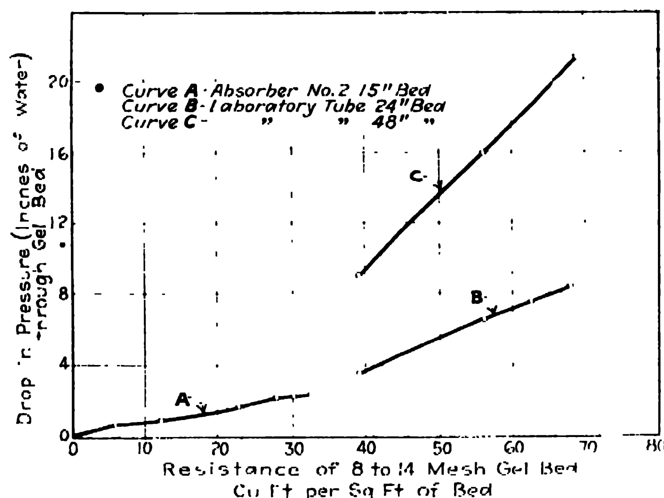


FIG. 13 RESISTANCE TO VAPOR AND GAS PASSAGE

Gel sized from 8 to 14 mesh and containing 7 per cent water weighs 44 lb. per cu.ft.

The resistance of an 8 to 14 mesh gel bed to the passage of air or vapor through it is an important practical factor. Laboratory and plant results are given in Fig. 13. Plant absorbers have staggered heating flues in the bed which modify the laboratory test conditions.

During adsorption the heat of condensation is liberated and, despite radiation losses, a rise of as much as 25 deg. C. in gel temperature has been noted when there was no attempt to cool the gel by ventilation or water jacketing during the adsorption cycle.

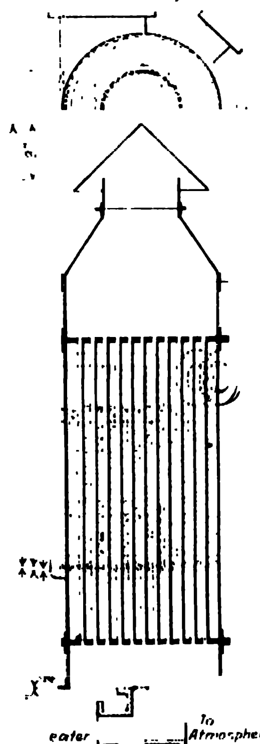
Gel can be used either in the granular or pulverized form and the work with semi-commercial scale bed type absorbers for granular gel and that now under way with pulverized gel will now be described.

The first plant absorber is shown in Fig. 14. It is a vertical cylinder with vertical heating and cooling tubes 1 in. in diameter on 2-in. centers passing through the gel bed, which is 26 in. deep supported on a screen about the middle of the cylinder. Hot gases or cooling air or water may be passed vertically through the tubes and the gas for adsorption enters and leaves by side outlets below and above the gel bed, which contains 250 lb. of 8 to 14 mesh gel. Most of the practical work on SO_2 adsorption and recovery was done with this absorber.

The first absorber did not have welded tubes, and to overcome difficulties in keeping it tight and getting even distribution of the heat the second absorber was built.

Figs. 15 to 17 show the second bed type absorber plant. The absorber A is a rectangular steel box 3 ft. 9 in. x 3 ft. 6 in. x 2 ft. 10 in. high with a 420-lb. gel bed 9.75 sq.ft. x 13 in. deep, supported on a perforated metal screen. Through the gel bed passes a series of horizontal 1-in. tubes on 2-in. centers. These tubes are welded to the tube sheets, which are inclosed on both sides of the absorber by flue boxes so that combustion gases, air, or cold water can be run through the tubes to heat or cool the gel.

The plant as shown is arranged for drying air. The air enters through an orifice meter B, Figs. 15 and 17, passes into the absorber A at the lower right corner and up through the cool gel bed, where it is deprived of its moisture, thence by the upper left corner of the absorber through valve 1 to a Roots exhauster C and out by valve 2 for use as desired.


FIG. 14 VERTICAL CYLINDRICAL ABSORBER

If it is desired to continuously make a high extraction of the vapor a second absorber should be connected in series when the effluent from absorber A indicates it is reaching the break-point and absorber A is continued in circuit until the gel is saturated. The air is then cut off at damper 1 and the gel is dried or reactivated by heating and sweeping hot air through it. The heating or evacuating cycle is shown in Fig. 15. Combustion gas or hot blast is admitted alternately by the dampers 2 and 3, passing through the tubes in the gel and out by dampers 5 and 6 to the heat exchanger D. Air is admitted to the heat exchanger on the lower right side, is heated and passes through valve 5 to the bottom inlet of the absorber, thence through the gel to the blower

*Paper presented before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 24 and 25, Dec. 15 and 22, 1920, pp. 1,155 and 1,219.

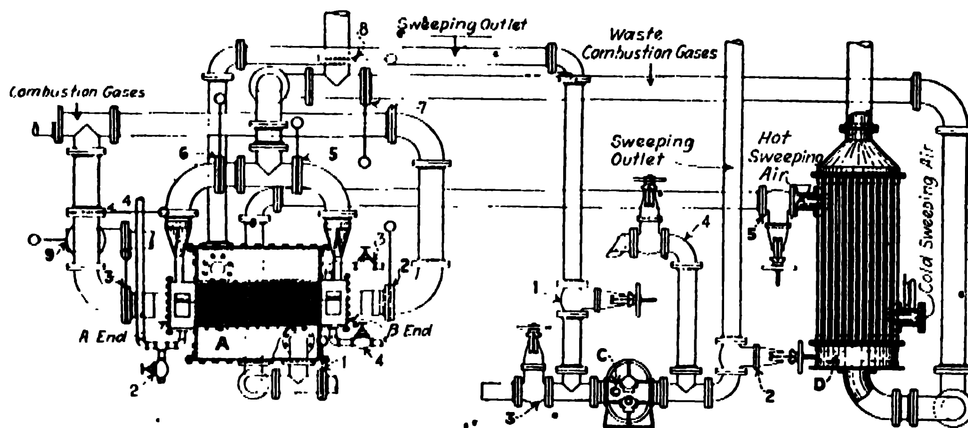


FIG. 15. BED TYPE ABSORBER AND CONDENSER PLANT

and to waste through the valve 2, carrying with it the released moisture.

When the gel is dried cooling may be hastened, if necessary, to prepare it for the next absorption cycle by blowing cold air from inlet valve 3 through valve 4 and dampers 9 and 3 through the absorber tubes and out by damper 5. Water spray is used with this cooling

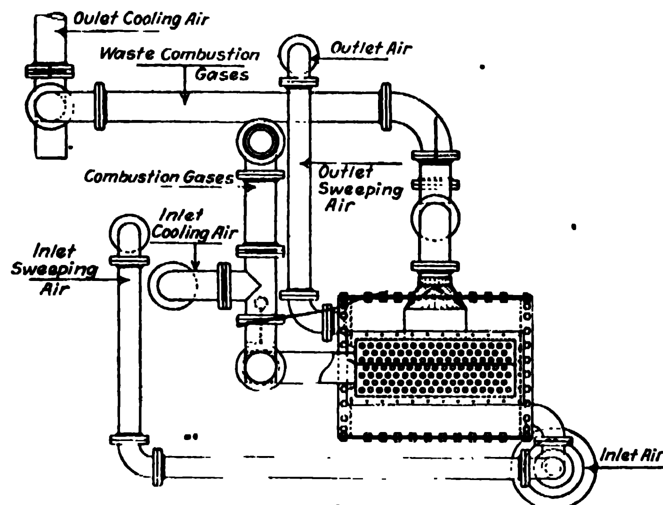


FIG. 16. ABSORBER BOX AND CONNECTIONS

air at the start and the tubes and flue boxes are flooded with water when the temperature is below the boiling point. The next cycle can be started when the temperature has been reduced to 75 deg. C., as the air being dried will assist in the cooling and the jacketing water will lower the gel to a moderate temperature before the break-point is reached.

The air drying tests were made in this absorber.

A third type of bed absorber using granular or unsized gel flowing slowly through a louvered or screened compartment, thus making a continuous absorber, is under consideration.

For continuous operation and uniform product three fixed bed type absorbers are needed so that a second one can be put in circuit a safe interval before the first one reaches its break-point while the third one is on its heating and cooling cycle.

In the pulverized gel absorber the activated dust is fed into the gas stream discharging into a dust filter, adsorption taking place in the duct and filter bags.

This method is attractive from several points of view. It requires only standard equipment such as is regularly used in feeding powdered coal and in dust separating in metallurgical plants.

It seems clear that a smaller quantity of gel would be required for a given duty than with a bed type absorber, because there is no time lost in heating and cooling an absorber nor is there any idle gel in an absorber bed.

The heat is economically applied since the heater is always hot, as against the intermittent heating and cooling of the bed absorber.

Preliminary tests in the laboratory using 80 and 200 mesh gel in a current of air with 2 to 6 grains of moisture per cu.ft. reduced the effluent in one stage to from 1.0 to 1.3 grains. In the above tests the time of contact between air and gel did not exceed four seconds, which later experiments have shown to be inadequate. Apparatus now under construction will permit longer and better contact.

Fig. 18 is a suggested flow diagram for a pulverized gel absorption plant.

Experimental Plant Results

A large number of tests were made with the No. 1 absorber on the adsorption and recovery of sulphur dioxide from air mixtures ranging in concentration from 2.5 to 8.75 per cent by volume. The data are too bulky to include in this paper.

Fig. 19 gives the results of a typical run on adsorption from an 8.75 per cent mixture. The mean temperature of the gel at the end of the run was about 40 deg. C. and it adsorbed 17 lb. of sulphur dioxide, or 6.8 per cent of its own weight.

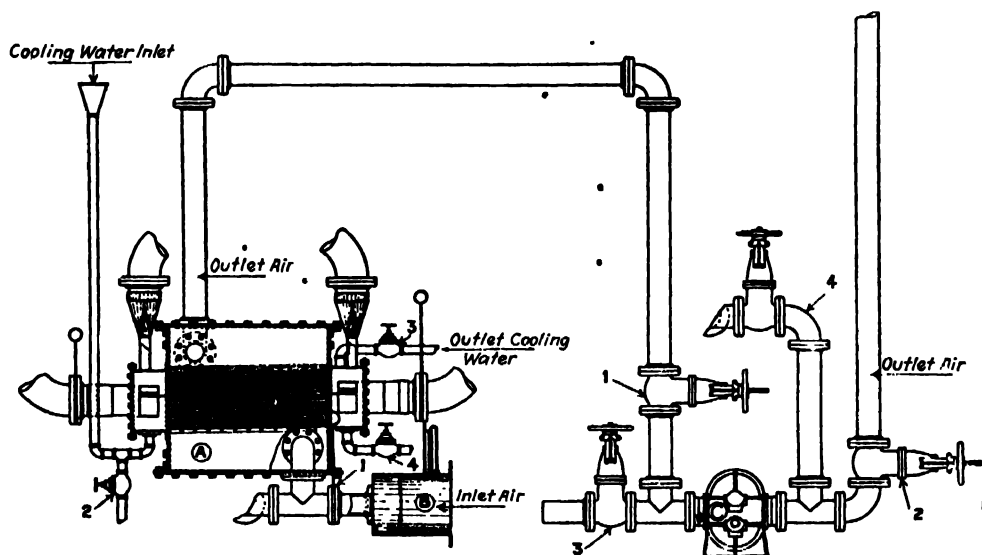


FIG. 17. OUTLET AIR VENT PIPING

Referring to the curves already given it will be seen that this corresponds approximately to the saturation value.

A number of tests on the recovery of adsorbed sulphur dioxide were made using absorber 1.

Starting with an 8 per cent mixture of sulphur dioxide and air, the gel adsorbed 5 to 6 per cent of its weight of sulphur dioxide. The absorber was then heated to about 125 deg. C. and the vapor pumped off.

FIG. 18. FLOW DIAGRAM PULVERIZED GEL PLANT

Most of it came off at a 25-in. vacuum. The liberated vapor was liquefied at 25 deg. C. by compression. The details of these experiments it is not necessary to give here.

In other tests the gas was delivered by the vacuum pump directly to a dry gas meter. At frequent intervals analyses of the gas were made and the volume noted.

Fig. 20 shows the results of a typical run made in this way. It will be observed that the absorber was partially evacuated for a few seconds before heat was applied and the gas wasted for this brief interval, in order to eliminate as much of the air in the apparatus as possible without waste of sulphur dioxide. The first analysis, made at the end of four minutes, when the temperature of the gel was about 65 deg. C., showed 85 per cent sulphur dioxide.

In plotting the curve which expresses the vapor

Total SO_2 used 132.7 Cubic Feet
SO_2 adsorbed 96.63 Cubic Feet 15.95 Lb.
Efficiency
Per Cent. SO_2
250 Lb. of Gel
Air dried by H_2SO_4
Temp. 67°F.-129°F.
Gas Concentration 8.75%
Rate 36.4 cu.ft/min.
3.202 cu ft. SO_2/min.
Per Cent. Efficiency
SO_2 Adsorbed Expressed as Per Cent by Weight of Gel
Time in Minutes
SO_2 Adsorption

FIG. 19. PLANT RECORD ON SO_2 ADSORPTION

Volume Recovered, Cubic Feet
Time in Minutes
Recovery of SO_2
% SO_2 in Total Mixture
Mean 75% of
Liberated SO_2 as % of

FIG. 20. TYPICAL PLANT RECORD

liberated as percentage of the total quantity adsorbed it was assumed that the average composition of the vapor during the first four minutes was 57 per cent.

Making this assumption, we see that during the first eighteen minutes about 90 per cent of the total vapor was liberated at a mean concentration of 75 per cent. The 25 per cent air resulted partly from the air originally present in the absorber and connecting pipes, but mainly it resulted from leaks in absorber, valves and pump.

Air Drying

Fig. 21 is a composite of the results obtained in eight runs with the second absorber with an air current through the absorber of 330 cu.ft. per minute, or at

Inlet Air
Air Rate 330 cu.ft/min.
Outlet Air
Time
Air Drying in Absorber No. 2
Composite Result of Eight Runs

FIG. 21. COMPOSITE OF EIGHT RUNS ON DRYING AIR

the rate of 33.8 cu.ft. per sq.ft. of gel bed, or 0.78 cu.ft. per lb. of gel. These runs were made in March, so that unfortunately the atmospheric humidity in none of these tests exceeded 5.3 grains per cu.ft. Few of our large-scale tests as yet show the sharp break-point obtained in the laboratory work, but it will be noted that if we assume the allowable end point to be when the dried air rose in water content to 0.7 grain per cu.ft. the gel was in service an average of three hours, or that one 420 lb. absorber dried over 59,000 cu.ft. of gas before the water content of the outgoing air rose to 0.7 grain.

The 0.7 grain end point is assumed because it is

below the moisture content in any continuous run of a Gayley dry blast plant of which we have record.

Fig. 22 is of a run at 225 cu.ft. per minute rate when the humidity averaged about 4.5 grains per cu.ft. and the outlet air reached the 0.7 grain end point in four hours, forty-five minutes, finally rising above this point

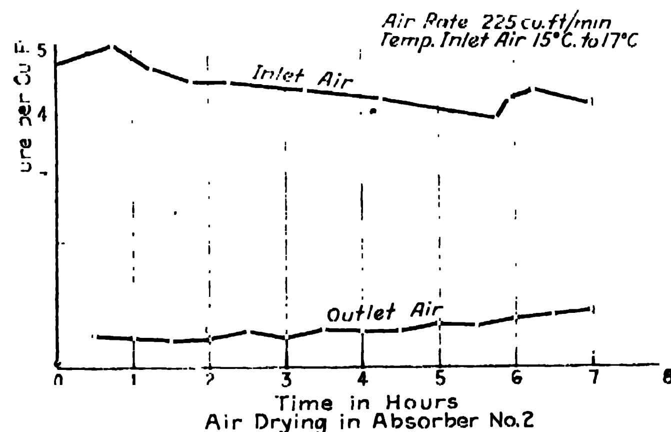


FIG. 22. DRYING AIR AT A RATE OF 225 CU.FT.

in five and one-half hours. When atmospheric humidity was below 2 grains runs of six and seven hours have been made without reaching the 0.7 grain end point.

Industrial Applications

It will have been seen from the preceding discussion that silica gel is adapted to recovering the vapors of all liquids.

This property may be applied to the following among many other practical commercial problems:

Drying air: Air conditioning; dry-air blast for furnaces.

Gasoline recovery: From gas wells; casinghead gases; losses from storage tanks; losses in oil refineries.

Solvent recovery: All industries using volatile solvents.

Recovering industrial vapors: Notably sulphur dioxide and oxides of nitrogen.

Selective separation of mixed gases.

A more specific list of possible applications is not within the limits of the present paper.

While further work remains to be done to reduce the above applications to commercial practice, we feel that the theoretical and scientific aspects of the problem have been completely solved, and that to make commercial application requires only the perfection of mechanical equipment, which presents no serious engineering difficulties.

The progress already made in this direction, as indicated by the results of the experiments here recorded and other experimental operations now under way, conclusively establish the practicability of silica gel as a means of recovering the various vapors mentioned above.

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British Progress in Chemistry*

By William Macnab

THE war has shown up very clearly many of the weaknesses in our technical educational system. On the other hand, it has brought many professors into close association with technical men and processes, and this no doubt has produced a greater appreciation on their part of the necessity of providing more technical instruction for students who purpose to enter chemical industry. Many of the drawings and reports to be issued should prove of much assistance to universities and teaching institutions in carrying out technical instruction, by showing good methods of applying scientific data to industrial questions, and, by presenting concrete examples, thus vitalize to many students the apparently less interesting field of thermochemistry and other branches of physical chemistry.

The resources and ingenuity displayed in meeting the complicated problems arising from the necessity of devising means of protection against gas attacks and the production of gases for attacks show that the country possesses ample chemical ability to meet any calls which may be made.

Closer Co-operation Essential

But to meet the chemical industrial competition closer co-operation between the more strictly theoretical and technical workers is essential, and above all a class of business and financial men must be developed whose education has been sufficiently broad to enable them to realize the sure foundations on which scientific conclusions rest, and to trust their scientific and technical advisers.

In this country there has been too little mutual trust and appreciation of each other, and it must be the serious endeavor of all concerned to develop such sure methods of working out new processes in all details, and clearly presenting the results, that the business man may have a well-defined picture of the advantages to be gained and the cost to be incurred, in so far as the factory is concerned.

Chemical Enterprise Suffers From Ignorance

Chemical enterprise has suffered much from the comparative ignorance of many who entered upon its difficult path. On the one hand, the air of mystery which often surrounds it to the lay mind leads to expectations of almost magical results and exaggerated hopes which are rarely fulfilled.

The business man is often not entirely to blame, for the chemical projects have often been presented to him in a very insufficiently considered manner, so that the attractive points—although no doubt truly put forward—were not sufficiently counterbalanced by a well-reasoned statement of all the sides of the question. Hence disappointment and loss of faith, or, at any rate, considerable skepticism in regard to future chemical projects.

On the other hand, if a non-scientific man has the final decision in regard to a chemical process, his lack of understanding of his technical staff and of faith in their requests, which may go against his so-called common sense, may be as prejudicial as the unreasoning hope before referred to. Unfortunately this trouble

*From the introduction to Ministry of Munitions' publication "Preliminary Studies for H. M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture."

arises from the lack of general scientific knowledge among all classes of society and the failure to appreciate what scientific work stands for, as well as reluctance to make use of the scientific information which is available.

Attitude Toward Chemical Industry Must Be Altered

But if we are to hold our own in the world competition, the attitude to chemical industry must be altered very considerably. Greater knowledge on the part of those directing chemical work and the substitution of the rule-of-thumb men (who are often in complete charge of complicated processes) by intelligent chemists who will make it possible for real progress to be made are among the more obvious reforms to be introduced.

Shrewd common sense and good powers of observation have enabled some of our non-scientific owners or managers of chemical factories to achieve sometimes a considerable amount of success, which has developed in them a corresponding contempt for, and distrust of, scientific control.

It must be admitted that when a young chemist has been taken on in such a works the results frequently have been unsatisfactory, due to lack of knowledge on both sides. Truly Solomon was right when he insisted: "Get wisdom, get understanding." To get it, however, implies hard work and a certain amount of modesty which does not count too much on the influence of heredity.

Problems of Young Chemists in Industry

Our teaching institutions do not turn out industrial chemists ready to step into a works and successfully control processes straight away, nor perhaps is it to be expected or desirable that they should, for after all, works experience and the controlling of men can only be learned in a works. Sometimes the young chemist's position in a works run on rule-of-thumb principles is very trying. His inexperience may lead him into trouble, and his mistakes will cause unholy joy to the rule-of-thumb foreman and anger or dissatisfaction to the uncomprehending employer, with the probable result that he is confined entirely to the laboratory or even dismissed, and scientific control has thus apparently been found to be a fraud.

Or he may develop an unjustified contempt for the "rough and ready" people with whom he has to work, forgetting that the ability to produce something, although unable scientifically to understand and explain the process, is worth more in a works than scientific comprehension of the process along with lack of technical ability to carry it out, or knowledge of pitfalls, should a change be undertaken in the existing practice.

It seems ridiculous to have to plead for the full and proper use of chemists in chemical works, but to those acquainted with the smaller works, and even some of the larger ones, it is known that the necessity exists.

The difficulty would be largely solved if men with good chemical training were in charge of chemical works, for then they could see to the works' training of the young chemists who came under them and prevent them from making rash experiments and, at the same time, utilize to the full extent any knowledge or initiative which they might possess. Above all, such a manager would not be jealous of the chemist.

Repeated opportunities of visiting during the war most of the French factories employed in making explosives and allied chemical products filled one with great admiration for the work accomplished and the developments carried out, and it is evident that a chemical industrial renaissance has taken place in France and manifestly they intend to develop chemical manufacture which the war has shown they can carry on well.

In this country there has also been great chemical development and a new spirit of scientific control and efficiency has been made known widely. Magnificent results have been achieved, but not through rule-of-thumb methods, which one would fain hope were buried forever.

Development on Scientific Lines Urged

It has been abundantly shown that the chemical knowledge and ability in this country, when adequately directed, can hold its own with that of any other land, but the stimulus of the common aim of quantity of output and excellence of production, generated by the war, must not be allowed to die out. Every endeavor should be made by professors and students, technical and business men interested in chemical manufactures, as well as by the government, to get to understand better the aims and requirements of one another, and co-operate in remedying any weaknesses in our system and in developing chemical industry on sound scientific lines.

Progress means change, and the chemical manufacturer should be prepared for having one process ousted by a newer and better way of working, and should reckon with the necessity of scrapping plant from time to time if he is going to keep pace with improvements.

Progressive Spirit Necessary

Sometimes chemical enterprise is deprecated on the ground that no sooner is one method established than a new process threatens to supersede it and therefore there is no certainty of permanence. A truly progressive spirit is necessary and the mental laziness which tends to condemn new ideas because they upset a smoothly running process must be replaced by greater alacrity to undertake new methods with all the attendant trouble, otherwise a back seat will soon be taken by the firm or nation which will not wake up and keep awake. More friendly and intelligent co-operation among masters and staff and ordinary workers will do much to make progress easier. Already there are indications of sounder and humaner ideas coming to the surface, and seeing we have all to spend the greater part of our life working in some capacity or other it is surely worth while endeavoring to make the work as interesting as possible.

Competition Must Be Met

All the chemical manufacturers of the world have been greatly developed and stimulated by the war and competition will be keener than ever on all sides. The old rule-of-thumb practice which prevailed in so many of our chemical factories must go and be replaced through scientific control of every stage of the process.

The necessary data and information are available in the country and there are plenty of chemists with brains who can carry on and develop the good work begun.

The young chemist who starts work in a chemical factory finds himself confronted with plant instead of apparatus, much of which involves mechanical devices

of various kinds, pumps and blow casks for moving liquids, mechanism and compressed air for agitating liquids, various methods of applying heat, etc. He should make it his business to get first-hand knowledge of the way each part of the plant acts and a thorough understanding of the principles on which it works and is constructed.

To do this he should take his coat off when a breakdown or stoppage occurs and see for himself what has been the cause, and learn and help to put matters right. Only in this way can he develop that knowledge of the capacities of a plant and sympathy with it which will enable the best results to be obtained.

A plant should be treated well and considerately, and its legitimate work capacity not overtaxed. Careful attention to its smooth running and maintenance in good condition will be richly repaid in steady and uniform output.

Manual Work by the Chemist Sometimes Necessary and Expedient

There is nothing *infra dig.* in a highly trained scientific man doing the manual work involved in any of the processes under his control. Thereby he acquires a greater sympathy with and understanding of the men who have to do the regular manual work, which enables more just judgments to be formed as to what constitutes a fair day's work, and develops a mutual respect between chemist and workman.

One does not rejoice in dirty work *per se*, but, as a means to an end—viz., the intelligent understanding of plant and process—it should be cheerfully undertaken when occasion arises. Also the more carefully a plant is controlled the fewer interruptions and occasions for rough work will arise.

In the laboratory the chemist is trained to work quantitatively in so far as the main constituent he is preparing or substance he is analyzing is concerned, but he is seldom required to account for the quantity of reagents he employs or the amount of heating or cooling and water for washing he utilizes to effect his end.

Problems of the Plant Chemist

In the factory these questions become of first-rate importance and must be carefully attended to. Every part of the process should be quantitative, and thereby it acquires added interest. The plant should be carefully calibrated, so that accurate measurements and weights of all materials used can be ascertained, and frequent stock taken in order that yields and losses may be accurately known and any departure from the normal at once detected. Let the chemist keep prominently before him in large figures the losses, so that they may be a constant incentive to greater efforts to bring them down to the irreducible minimum.

In order that the chemist in charge of a process may work it to the greatest advantage he must be provided with all available knowledge on the subject, and must be encouraged to investigate by means of laboratory and plant experiments all obscure points and losses. To this end he should be taken as far as possible into the confidence of his employer in regard to costs, so that he may realize the necessity of economy in all directions and be able to measure in one of the terms of industrial success—viz., money—the results of modifications and improvements which he may introduce.

Intelligent and sympathetic co-operation among those in charge of different departments is necessary if the greatest efficiency is to be obtained. Some works have followed the opposite practice and kept the sections in water-tight compartments. Profits have no doubt been made under such systems, but not so great as when the heads and their assistants have opportunity to discuss their several problems together and help one another by trying to work into one another's hands. Without this co-operation the nation loses greatly both in material and the improvements which are sure to flow from the brightening of intellects by free discussion together.

It sometimes happens that owing to exceptional circumstances profits are made alongside of great waste of material. Such a state of affairs is a national misfortune and, apart from the loss of material, which is also likely to be a nuisance to other people, it is demoralizing and engenders a careless, unscientific spirit in those conducting the operations. Preventable waste of any kind should be considered a sin against mankind.

Interest by the Employee an Aid to Better Results

One of the most powerful aids to success would be the intelligent and loyal co-operation between employer and employee with the object of getting the best results from the process being worked. Interest in the work in hand leads to better work being done, and one tendency of the time seems to be a revolt of the individual from being regarded as a "hand" or human machine, and a demand that some of the necessary monotony of the daily task should be brightened by learning as much as possible of the meaning of what is being done and the ideals to be striven for.

The work of a chemist on a plant, although much more varied, can become monotonous too, unless he can see beyond the immediate daily round, and have the interest and stimulus of knowing the profit or loss on his operations, while his attention should be concentrated on the production of the manufactured article at the lowest cost and greatest efficiency.

British Cast Iron Research Association

Good progress is being made with the organization of the British Cast Iron Research Association, which has abandoned the somewhat cumbersome title of the British Gray and Malleable Cast Iron Industries Research Association in favor of the shorter one. Articles of association have been drawn up and approved by the council. Lord Weir of Eastwood has accepted the office of president, H. B. Weekes, F.I.C. (Vickers, Ltd., Barrow), has been appointed chairman of the council, and three additional vice-presidents have been elected.

The basis of subscription of ordinary members has been fixed according to the number of persons employed in the iron founding departments of the businesses. For gray iron foundries the rates are five guineas per annum for less than twenty-five employees, ten guineas for between twenty-five and fifty, and an extra five guineas for every fifty additional employees or fraction thereof. For malleable iron foundries, five guineas per annum for under twenty-five employees, and above that number the rates are those for gray iron foundries increased by 25 per cent. Pattern-makers, clerks, etc., are not to be included in the count of employees. Many of the largest firms in the industries are supporting the association, and ample financial assistance is promised.